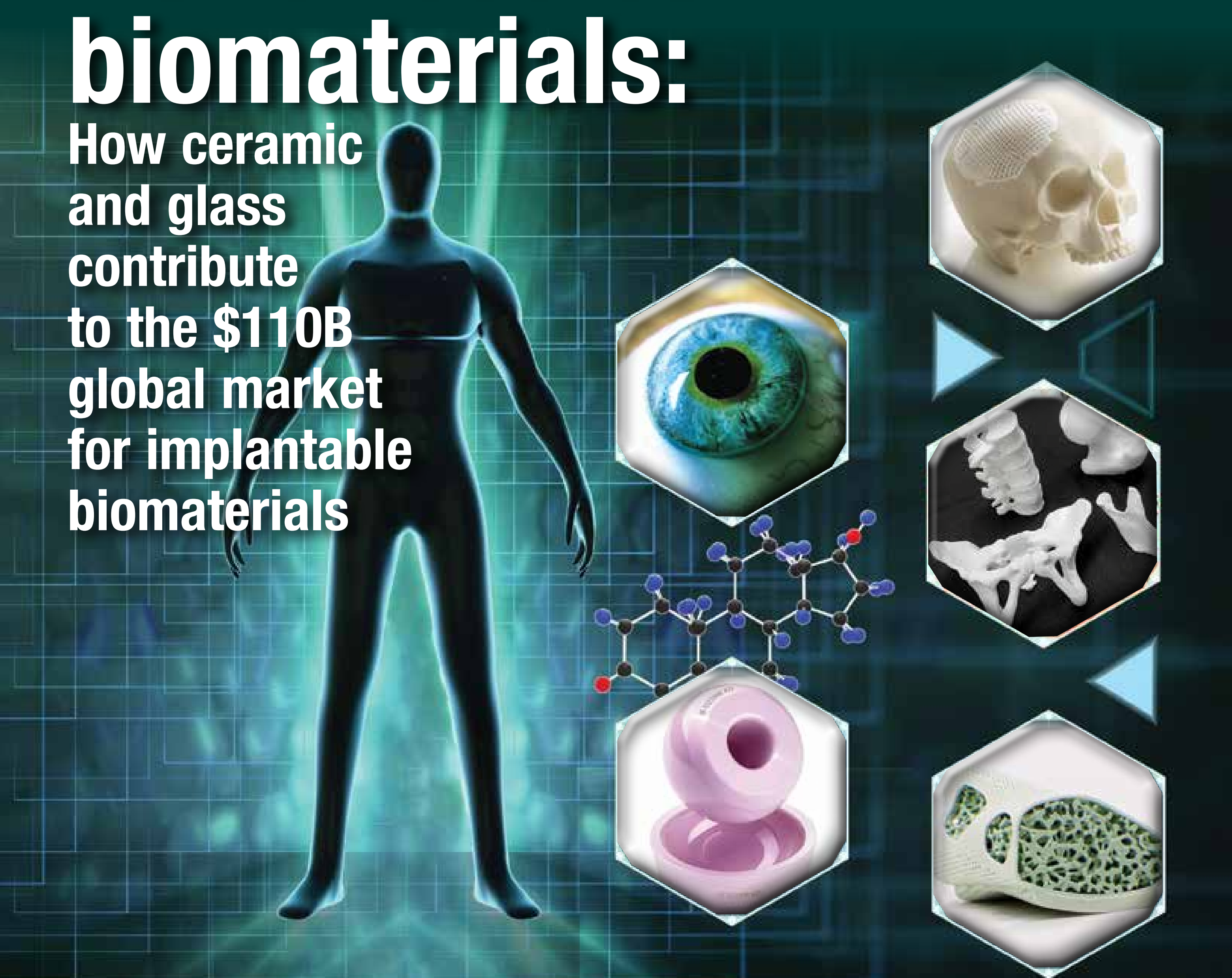
AMERICAN CERAMIC SOCIETY
bulletin
emerging ceramics & glass technology

DECEMBER 2020

Better bodies with biomaterials:

How ceramic and glass contribute to the $110B global market for implantable biomaterials



PLUS ceramicSOURCE Buyers Guide

AND Ceramic & Glass MANUFACTURING

EZG Refractory Mixers

[LEARN MORE]

GET IN LINE.

"the hog line"

Success at the end of the line begins with an EZG Refractory Mud Hog® at the front of the line. World-renowned for its longevity, customizable options, waste reduction and homogeneous mixing power.

- Full customization to suit unique applications
- Exclusive reversible vertical mixing paddle design prevents clogging and promotes uniform mixing
- Abrasion resistant bolt-in drum liners for maximum durability
- Low load, high dump ergonomic design for operator comfort

Want more efficient, safer and easier casting? ***Connect with our technical team to build your hog at ezgmfg.com.***

EZG® Manufacturing

1-800-417-9272 / ezgmfg.com / sales@ezgmfg.com
1833 N. Riverview Road, Malta, Ohio 43758

EZG Manufacturing is a division of EZ Grout Corporation. All EZG Manufacturing products are backed by our **two-year warranty** on parts unless otherwise stated and are now available for order.

MADE IN THE USA

contents

December 2020 • Vol. 99 No.9

feature articles

department

columns

meeting

resources

online
www.ceramics.org

December 2020 • Vol. 99 No.9

http://bit.ly/acerstwitter http://bit.ly/acerslink http://bit.ly/acersgplus http://bit.ly/acersfb http://bit.ly/acersrss

As seen on *Ceramic Tech Today*...

Credit: University of Oxford Press Office, Flickr (CC BY 2.0)

Pursuing the future of energy: A review on perovskite tandem solar cell development and fundamentals

Perovskite tandem solar cell technologies improved rapidly in the past six years, but there are still challenges keeping them from commercialization. A recent review article by two researchers at the University of Surrey in the U.K. provides an expansive look at this budding industry.

Read more at www.ceramics.org/perovskitereview

Also see our ACerS journals...

A review: Recent advances in sol-gel-derived hydroxyapatite nanocoatings for clinical applications
By G. Choi, A. H. Choi, L. A. Evans, et al.
Journal of the American Ceramic Society

Review on calcium silicate-based bioceramics in bone tissue engineering
By P. Srinath, P. Abdul Azeem, and K. Venugopal Reddy
International Journal of Applied Ceramic Technology

A review of acellular immersion tests on bioactive glasses—influence of medium on ion release and apatite formation
By A. Nommeots-Nomm, L. Hupa, D. Rohanová, D. S. Brauer
International Journal of Applied Glass Science

Sign up to get journal tables of contents and new content alerts. See this *CTT* post for more information: https://ceramics.org/August2020tips.

International Journal of Applied Ceramic Technology | International Journal of Applied Glass Science | International Journal of Ceramic Engineering & Science | Journal of the American Ceramic Society

Read more at www.ceramics.org/journals

American Ceramic Society Bulletin covers news and activities of the Society and its members, includes items of interest to the ceramics community, and provides the most current information concerning all aspects of ceramic technology, including R&D, manufacturing, engineering, and marketing. The American Ceramic Society is not responsible for the accuracy of information in the editorial, articles, and advertising sections of this publication. Readers should independently evaluate the accuracy of any statement in the editorial, articles, and advertising sections of this publication. *American Ceramic Society Bulletin* (ISSN No. 0002-7812). ©2020. Printed in the United States of America. *ACerS Bulletin* is published monthly, except for February, July, and November, as a "dual-media" magazine in print and electronic formats (www.ceramics.org). Editorial and Subscription Offices: 550 Polaris Parkway, Suite 510, Westerville, OH 43082-7045. Subscription included with The American Ceramic Society membership. Nonmember print subscription rates, including online access: United States and Canada, 1 year $135; international, 1 year $150.* Rates include shipping charges. International Remail Service is standard outside of the United States and Canada. *International nonmembers also may elect to receive an electronic-only, email delivery subscription for $100. Single issues, January–October/November: member $6 per issue; nonmember $15 per issue. December issue (*ceramicSOURCE*): member $20, nonmember $40. Postage/handling for single issues: United States and Canada, $3 per item; United States and Canada Expedited (UPS 2nd day air), $8 per item; International Standard, $6 per item.

POSTMASTER: Please send address changes to American Ceramic Society Bulletin, 550 Polaris Parkway, Suite 510, Westerville, OH 43082-7045. Periodical postage paid at Westerville, Ohio, and additional mailing offices. Allow six weeks for address changes.

ACSBA7, Vol. 99, No. 9, pp 1– 138. All feature articles are covered in Current Contents.

news & trends

Toward an International Year of Glass

Glass helps us live safer and more sustainable lives, from offering a sound disposal method for nuclear waste to improving osseointegration of biomedical implants to allowing for high-speed internet access. Yet this material, which is key to so many applications, is often underappreciated in society and viewed only in terms of windows and kitchenware.

Educating the public about the importance of glass in modern society is a goal for many materials science organizations, but individual efforts only go so far. What if we could bring people together in a global initiative to raise awareness of this influential material?

That is the driving force behind a recent initiative spearheaded by the International Commission on Glass (ICG) to have 2022 declared the International Year of Glass.

Since 1959, the General Assembly of the United Nations designated specific years as United Nations International Years to acknowledge fields of international endeavor and the importance of their contributions to global society. Usually, one or more Member States propose these observances, or on occasion, specialized agencies of the United Nations such as UNESCO and UNICEF may put forth a proposal. The proposal for the International Year of Glass, though, originated from a completely different source.

International Year of Glass: From conception to a thousand endorsements

The idea for an International Year of Glass was first discussed at the 2018 Fall Annual Meeting of ICG in Yokohama, Japan, per a suggestion by ACerS Distinguished Life Member David Pye. In May 2019, ICG, The Corning Museum of Glass, The American Ceramic Society, and The Glass Art Society endorsed the idea in a presentation to the Office of the United States Mission of the United Nations in New York City, which was well received.

Credit: International Year of Glass

ICG president Alicia Durán formally introduced the initiative to the ACerS community in a "Letter to the Editor" published in the September 2019 *Bulletin*. At the time, she noted that "Extensive planning is now underway to inform international art and scientific glass-themed societies and museums of this endeavor to secure the United Nations declaration of the 2022 International Year of Glass."

Since then, more than 1,100 organizations from over 70 countries have expressed support for the initiative. In an email, Durán says they are now forming an international steering committee to continue working and developing the initiative, and "Fundraising campaign, proposals of activities (international and national) and spreading these activities to the planet will be some of the tasks that we can face, and solve!!"

Coming next: November presentation to the United Nations

The next big task on the way to having 2022 designated the International Year of Glass is to receive formal approval from the UN. To do that, the International Year of Glass steering committee is preparing a presentation to be given in early November to the UN General Assembly.

Agustin Santos, the Spanish Ambassador to the UN, has guided the required resolution through the General Assembly, and he will present the proposal in November through a virtual presentation. The presentation will include introducing partner organizations and personalities in the International Year of Glass project, explaining the activities planned and concepts being developed, and how they link to the UN Agenda 2030.

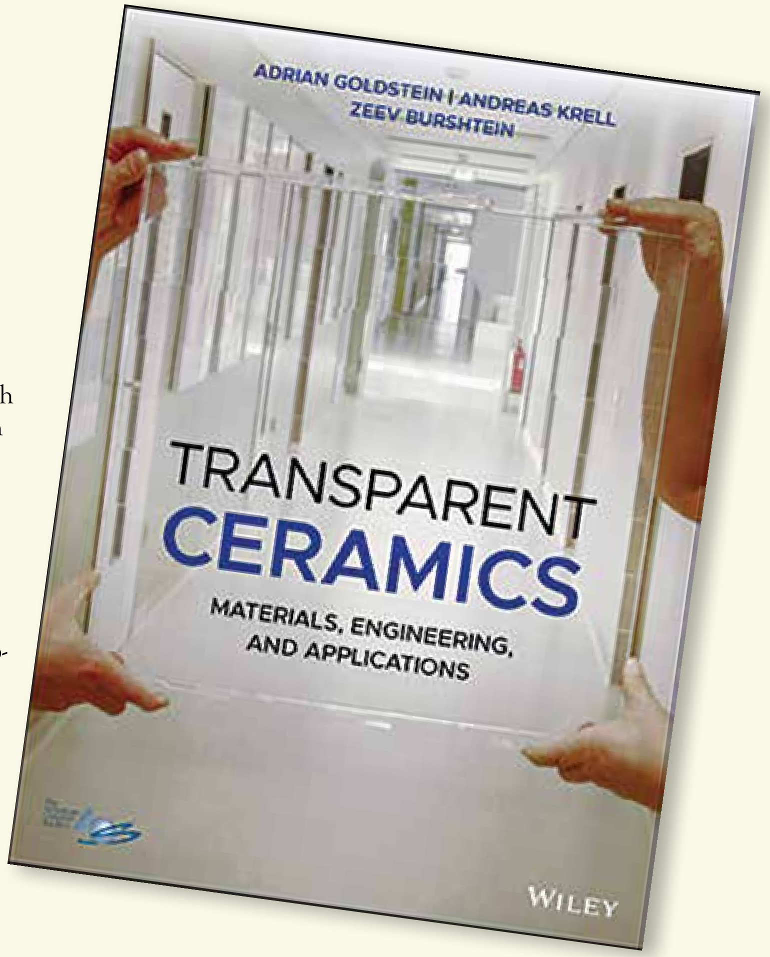
Volkan Bozkir, the Turkish Ambassador and recently installed President of the Assembly, has already expressed his support and will do so during the presentation as well.

After the presentation, the resolution for approving the International Year will be presented at the 75th UN General Assembly planned for December 2020.

If you wish to become a supporting institution, you can register your interest on the official International Year of Glass website at http://iyog2022.org or email the steering committee at manager@iyog2022.org. You can follow updates on the initiative on the official LinkedIn page at https://www.linkedin.com/company/international-year-of-glass-2022. ■

Roni Shneck
Guest columnist

Review of *"Transparent Ceramics: Materials, Engineering, and Applications"*



Over the last two decades and more, a considerable effort has been invested in development of optically transparent ceramic and glass-ceramic materials for functioning as various optical elements. Fabrication techniques of ceramic components has the potential of being highly cost-effective, and exhibit improved uniformity of optical properties compared to their crystalline counterparts. The prospected uses range from transparent optical military armour up to optical laser components.

The book addresses in detail that entire scope, starting with the underlying theoretical basis through technical production details, relevant materials, and current and future prospected applications. Especially, it provides a survey and analysis of currently used and studied materials, and points out some goals for near future developments.

Chapter 1 describes the book rational topic and aims in view of some historic progress, a definition of the spectral regions of interest, definition of transparency factors, and fabrication means and costs.

Chapter 2 describes the basic physics underlying the interaction of light with matter. Fundamental features of light like polarization, interference, and interaction with matter involving reflection, refraction, absorption and scattering are related to the relevant material properties like refractive indices, and acoustic and optical waves. Special attention is devoted to energy states spectroscopy of dopant rare earth and transition metal ions.

Chapter 3 surveys in detail the issue of ceramic materials processing, with attention on those mostly adequate to obtain transparent parts of optical equipment.

Chapter 4 surveys the multitude of materials used and proposed to be used for production of transparent ceramics, all in view of available production techniques and aimed-at applications.

Chapter 5 elaborates on various possible applications of transparent ceramics, mostly for security windows, optical lenses, and laser parts, but also for some, perhaps less appreciated ones like colour filters, scintillation elements, dental parts, and many more.

The book offers the thus-far broadest and deepest account of transparent ceramics. Individuals wishing acquaintance with this still emerging field, for either teaching or performing of scientific research, will definitely benefit from learning and consulting this new book.

Roni Shneck is professor in the Department of Materials Engineering at Ben-Gurion University of the Negev, Israel.

High-strength glass: Global markets

By Margareth Gagliardi

The global market for high-strength glass increased from $28.9 billion in 2018 to $30.9 billion in 2019, and is estimated to reach $31.9 billion in 2020, corresponding to a compound annual growth rate (CAGR) of 5.0% during the two-year period. The market is forecast to rise at a CAGR of 6.1% from 2020 to 2025, reaching global revenues of $42.9 billion in 2025.

High-strength glass is a category of glass characterized by high tensile or compressive strength. Its origins can be traced back to the 1660s, when German-English officer and scientist Prince Rupert of the Rhine, Duke of Cumberland presented the first tempered glass with the shape of a teardrop to King Charles II of England. However, almost 200 years went by before the first industrial process for producing tempered glass was developed.

There are seven main sectors in which high-strength glass finds current and potential applications: aerospace and defense, construction, electronics and optoelectronics, energy, life sciences, mechanical/chemical, and transportation. Applications within the transportation sector currently account for the largest share of the market, at an estimated 53.4% of the total in 2020. High-strength glass for the construction sector represents a relatively smaller share at 21.5%, while electronics and optoelectronics is estimated to account for 7.6%. All the remaining applications represent a combined share of 17.4%.

Laminated and tempered soda-lime-silica glass currently represent the largest segment (85.4%) of the high-strength glass market, with projected sales of $27.2 billion by the end of 2020.

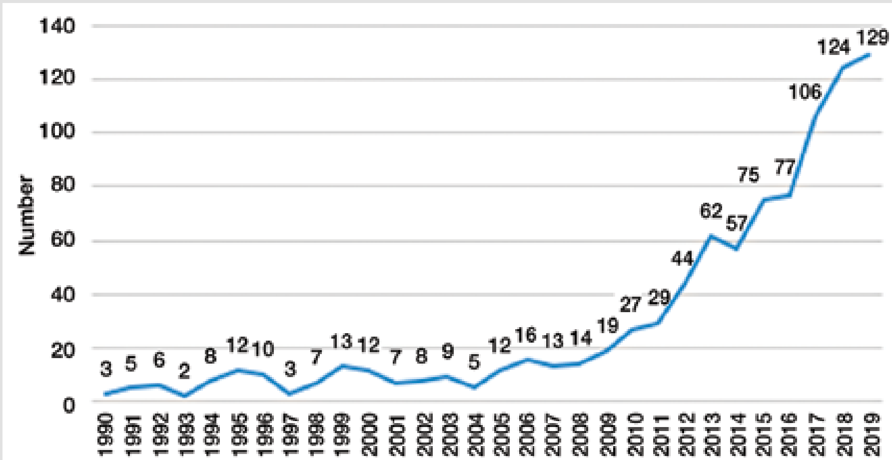


Figure 1. Number of global patent applications and patents issued related to high-strength glass, 1990–2019

Following that, aluminosilicate glass is estimated to be valued at $2.4 billion (7.5%), borosilicate glass at $1.6 billion (5.1%), and magnesium aluminosilicate glass at $632 million (2.0%).

Sales of high-strength glass are expected to continue rising at a single-digit rate during the next five years due to a number of relevant factors, including

- Expected general moderate growth for most industry sectors in which high-strength glass finds application,
- Higher unit price for high-strength glass compared to traditional glass,
- Stronger demand in the construction sector due to architectural trends aimed at emphasizing natural lighting and energy savings,
- Stronger demand in the electronics and optoelectronics sector due to on-going miniaturization and fabrication of devices with very thin profile,
- Larger use in the energy sector driven by the fabrication of solar cells and photothermal devices, and
- Emerging trends, such as higher demand for lightweight materials.

The Asia-Pacific region is currently the largest consumer of high-strength glass, with sales estimated to reach $13.1 billion by the end of 2020, corresponding to a share of 41.1% of the total. The United States represents the second-largest market (25.2%) with estimated sales of $8.0 billion while Europe is expected to reach slightly over $6.7 billion (21.1%).

About the author

Margareth Gagliardi is a research analyst for BCC Research. Contact Gagliardi at analysts@bccresearch.com.

Resource

M. Gagliardi, "High-strength glass: Global markets" BCC Research Report AVM199A, October 2020. www.bccresearch.com.

Table 1. Global market for high-strength glass, by end use, through 2025 ($ millions)

End Use	2018	2019	2020	2025	CAGR% 2020-2025
Transportation	15,692	16,547	17,043	21,855	5.1
Construction	6,121	6,667	6,863	9,671	7.1
Electronics and optoelectronics	2,198	2,329	2,436	3,546	7.8
Energy	2,019	2,266	2,380	3,713	9.3
Aerospace and defense	920	953	977	1,194	4.1
Mechanical/chemical	750	798	822	1,074	5.5
Life sciences	597	640	670	914	6.4
Others	652	690	711	890	4.6
Total	28,949	30,890	31,902	42,857	6.1

acers spotlight

SOCIETY, DIVISION, SECTION, AND CHAPTER NEWS

A Case for continuous membership

You were nominated to be an ACerS Fellow! ...but wait, you have not held continuous ACerS membership. I am sorry, you do not qualify for the Fellows distinction.

What if this situation happened to you? Do you count on renewing your ACerS membership only when you attend meetings? If you miss a meeting one year, you could experience a gap in membership and an interruption of important member benefits, such as the *Bulletin* and online access to ACerS' four peer-review journals and B*ulletin* archives.

It also makes you ineligible to receive distinctions that require continuous membership, such as becoming an ACerS Fellow (five continuous years) or Emeritus member (35 continuous years). To be eligible for Fellow and Emeritus status, ACerS encourages you to renew your membership each year. For more information about Fellows, Emeritus, or other awards eligibility, visit https://ceramics.org/members/awards. ■

Volunteer Spotlight

Brauer

ACerS Volunteer Spotlight profiles a member who demonstrates outstanding service to the Society.

Delia Brauer studied chemistry with environmental chemistry at Friedrich Schiller University Jena (Germany) and University of Northumbria at Newcastle (England) before executing a Ph.D. research project on degradable phosphate glasses and glass/polymer composites for medical applications at the Otto Schott Institute, Friedrich Schiller University Jena.

After postdoctoral research projects at the University of California, San Francisco; Imperial College London; Queen Mary University of London; and Nagoya Institute of Technology (Japan), Brauer returned to Friedrich Schiller University Jena as a junior professor in 2012. She was made a full professor of bioactive glasses in 2017.

Brauer leads an international group of students and postdoctoral researchers from various backgrounds. Her research focuses on inorganic glasses as biomaterials and on the interaction between glass and water.

She has edited one book and has contributed several chapters to publications. She is regularly invited to give talks at international conferences.

Brauer served as chair of Technical Committee 04 (Bioglasses) and member of Technical Committee 23 (Education) of the International Commission on Glass. The 2015 winner of the Gottardi Prize of the ICG, she was made a Fellow of the Society of Glass Technology (U.K.) in 2016. In 2020, together with Jessica Rimsza, she served as program co-chair of the first Virtual Glass Summit organized by ACerS.

We extend our deep appreciation to Brauer for her service to our Society! ■

In memoriam

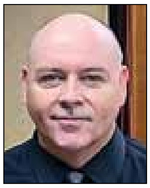
Edward Aitken
David J. Barber
Daniel Reardon
Willard Renner
John Roberts
Stuart Weinland

Some detailed obituaries can also be found on the ACerS website, www.ceramics.org/in-memoriam.

Names in the News

Jain

Himanshu Jain, Lehigh University's T.L. Diamond Distinguished Chair in Engineering and Applied Science and professor of materials science and engineering, was named winner of the 2020 *Journal of Non-Crystalline Solids* N.F. Mott Award, which recognizes a distinguished senior scientist with a history of outstanding contributions to the science of non-crystalline solids.



Wagner

Larry Wagner joined Du-Co Ceramics as automation engineer–electrical. ■

AWARDS AND DEADLINES

ACerS 2020 Award winners

This year's ACerS award winners can be seen on our YouTube channel https://youtu.be/7L9sRTTNVeI. Congratulations to all the winners! ■

Upcoming awards nomination deadlines

For more information about each award, visit www.ceramics.org/awards or contact Erica Zimmerman at ezimmerman@ceramics.org.

Society awards: January 15

ACerS runs a thriving awards program that recognizes the contributions of deserving individuals and companies in the ceramics and glass community. Nominations are encouraged for candidates from groups that are under-represented in ACerS awards relative to

Awards and deadlines (cont.)

their participation in the Society, including women, underrepresented minorities, industry scientists and engineers, and international members.

We urge you to submit nominations for our many Society and Division awards.

GOMD awards: January 21

The Glass & Optical Materials Division seeks nominations by **Jan. 21, 2021**, for the following awards:

- The Norbert J. Kreidl
- George W. Morey
- L. David Pye Lifetime Achievement
- Stookey Lecture of Discovery
- Varshneya-Mauro-Jain Guru-Chela Travel Fund

Bioceramics Division Awards

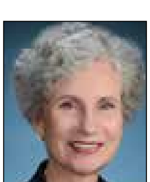
In 2020, the Bioceramics Division received ACerS Board approval for the creation of four awards with a **July 1** nomination deadline:

- Bioceramics Young Scholar
- Global Young Bioceramicist
- Larry L. Hench Lifetime Achievement
- Tadashi Kokubo (sponsored by Nippon Glass Co., Ltd.)

The Division announced the first recipients for two awards.

Lepry

2020 Global Young Bioceramicist Awardee: **William Lepry,** McGill University



Primus

2020 Larry L. Hench Lifetime Achievement Awardee: **Carolyn Primus,** Primus Consulting ■

STUDENTS AND OUTREACH

Register today for ACerS Annual Winter Workshop

ACerS Winter Workshop, hosted by the Ceramic and Glass Industry Foundation, will be held in conjunction with the ICACC 2021 virtual meeting on Thursday, Jan. 28 and Friday, Jan. 29, 2021. The Winter Workshop provides a combination of technical and professional development sessions designed specifically for students and young professionals. For more information and to register, visit https://ceramics.org/winter-workshop-2021. ■

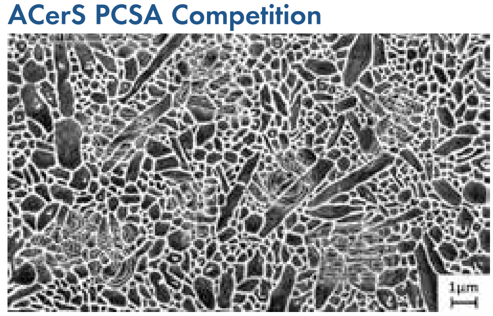
ACerS Global Distinguished Doctoral Dissertation Award

This award recognizes a distinguished doctoral dissertation in the ceramics and glass discipline. The awardee must have been a member of the Global Graduate Researcher Network and have completed a doctoral dissertation as well as all other graduation requirements set by their institution for a doctoral degree within 12 months prior to the application deadline. The nomination deadline is **Jan. 15, 2021**. For more information, visit www.ceramics.org/doctoraldissertationaward. ■

PCSA student competition awardees

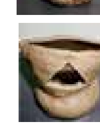
Congratulations to the following awardees from the 2020 PCSA student competitions:

ACerS PCSA Competition



◀ **2020 Artistic Creativity and Viewer's Choice Award**
Macro innovations from micro observations
by **Rachel Eckert,** Iowa State University






2020 Scientific Award ▶
Promethean Sierpinski
by **Zach Abrams,** Charles E. Smith Jewish Day School

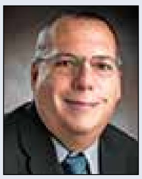
ACerS PCSA Lab Blooper Competition

◀ **2020 Artistic, Scientific, and Viewer's Choice Award**
Murphy's Law always obey
by **Anna De Marzi,** University of Padova

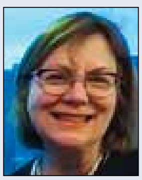
CERAMICANDGLASSINDUSTRY FOUNDATION

CGIF welcomes new board members

The Board of Trustees of the Ceramic and Glass Industry Foundation welcomed four new Board members at its recent meeting.



Alex Cozzi
Manager, applied materials research
Savannah River National LaboratoryAiken, S.C.



Leslie Fenwick Beiter
Regional account manager–ceramics
U.S. & Canada, Almatis, Inc.
Leetsdale, Pa.

Jeff Kohli
Director of glass research
Corning Incorporated
Painted Post, N.Y.

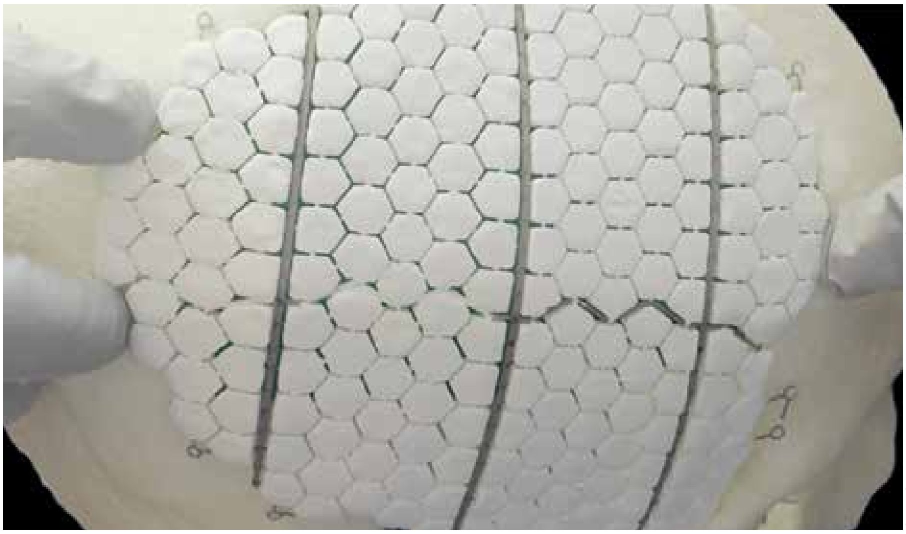
Nola K. Pearce
Vice president/Account executive
ETS Tech-Ops
Rochester, N.Y.

John Kieffer
Professor, University of Michigan
Ann Arbor, MI

CGIF Board of Trustee Officers for 2020–2021 are chair **Mary Stevenson**, president of Deltech, Inc.; chair-elect **Todd Steyer**, chief engineer for materials & technologies at The Boeing Company; immediate past chair **Thomas Arbanas**, president of Du-Co Ceramics; treasurer **Steve Houseman**, president of Harrop Industries; and secretary **Mark Mecklenborg**, executive director of The American Ceramic Society.

There can be no doubt that this year was a rough one for all of us. Despite that, the CGIF has remained diligent in finding new ways of reaching students—the future of our industry. Now more than ever, your gift to the Ceramic and Glass Industry Foundation is vital to our success in attracting students to the ceramics and glass fields as we fill the talent pipeline for industry. Please visit our website at https://foundation.ceramics.org/give or donate via your cell phone by texting the word “give” to 614-914-2685. ■

Titanium-reinforced bioceramic implant induces cranial regrowth in sheep



Researchers in Sweden developed this experimental bioceramic implant, which is composed of calcium phosphate tiles reinforced and interconnected by an additively manufactured titanium frame.

Researchers from several Swedish universities and institutes described in a recent paper a synthetic ceramic implant they created that could regenerate bone in large cranial defects in sheep.

Cranioplasty, or the surgical reconstruction of a defect in the skull, is a practice stretching back hundreds of years, but the technique only became common during the second half of the 20th century, due largely to warfare providing an impetus to improve our ability to cover large cranial defects.

To date, autologous bone grafts, or grafts made from bone obtained from other areas of the patient, are the standard for reconstructive treatment. Yet this approach is associated with frequent complications, in particular relatively high resorption, protrusion, and infection rates and a high rate of donor-site morbidities.

In the past few decades, researchers have extensively investigated alloplastic materials, or synthetic materials that substitute for tissue, as another option for cranioplasty grafts. Calcium phosphate ceramics are one group of materials that have played a central role in modern alloplastic cranioplasty research due to their biocompatibility and osteoconductivity, i.e., the ability of bone-forming cells in the grafting area to move across a scaffold and slowly replace it with new bone.

Calcium phosphate cements in particular have gained an edge over granular calcium phosphates because of advantages afforded by the cements' self-hardening properties, which make molding the brittle ceramic into a desired shape easier. Often, the cements are combined with or overlaid on other materials such as bioresorbable fibers or titanium mesh, respectively, to augment strength of the graft.

In recent years, several studies showed calcium phosphate ceramics that consist of several phases, such as beta-tricalcium phosphate (ß-TCP) and hydroxyapatite, exhibit improved or new properties compared to ceramics with a single phase. For example, high protein adsorption and osteoinduction, or the ability to stimulate cells to change into bone-forming cells. More researchers are now exploring mixed-phase calcium phosphate ceramics, such as the collaborative group of researchers in Sweden.

For their study, the researchers from the University of Gothenburg, Uppsala University, and Karolinska University Hospital and Karolinska Institutet chose a powder mixture of ß-TCP/dicalcium pyrophosphate and monocalcium phosphate monohydrate for their ceramic, which they mixed with glycerol to form a paste. They molded this bioceramic paste in the form of hexagonal tiles around an additively manufactured titanium frame and then left it to set overnight in sterile water, a process that also eliminated the glycerol.

The titanium-reinforced bioceramic implant and a control implant made only of titanium were placed in sheep skulls for testing. Following analysis of observations recorded at three months and 12 months, the researchers drew several notable conclusions, including

- **Soft tissue adaption:** The bioceramic implants revealed defect restoration and soft tissue adaptation in sheep cranial defects. In contrast, soft tissue contraction was apparent around titanium implants, with visible metal on the skin and dura sides.
- **Bone growth:** In the sheep skull, the bioceramic implant promoted a higher degree of bone formation, remodeling, and osseointegration compared to the titanium implant, leading to enhanced repair of the cranial defect. Outside the skeletal envelope, only the bioceramic implant promoted bone formation and maintained bone. Regardless of the location, the regenerated bone from the bioceramic had a composition similar to that of the native bone.

In the discussion section, the researchers note two main limitations of the study: the absence of a mechanical evaluation after bone regeneration, and the absence of cellular and molecular techniques to shed light on the underlying ceramic-to-bone transformation mechanisms. Despite these limitations, the researchers say the study provided proof-of-concept for this bioceramic's potential to promote in situ bone regeneration and osseointegration.

The open-access paper, published in *Proceedings of the National Academy of Sciences*, is "In situ bone regeneration of large cranial defects using synthetic ceramic implants with a tailored composition and design" (DOI: 10.1073/pnas.2007635117). ■

Thermal scanning probe lithography allows precise nanocutting of 2D materials

Researchers at École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland explored using thermal scanning probe lithography to fabricate nanostructures in 2D materials.

To date, top-down approaches to nanostructure construction are used extensively in the semiconductor industry to fabricate integrated circuits, among other things. Specifically, lithographic techniques—or techniques by which a pattern is transferred onto a surface—are typically used.

Common lithographic techniques involve using beams of light, electrons, or ions to etch patterns onto a surface. However, though these techniques work well for fabricating nanostructures on most surfaces, they run into some challenges when used to pattern 2D materials, such as causing structural damage.

Scanning probe lithography (SPL) is one type of lithography that holds potential for effectively fabricating nanostructures in 2D materials. Instead of using a focused beam of particles to etch patterns in a sample, SPL methods use a physical tip to modify the surface through various physical and chemical interactions, such as scratching, nanoindentation, or heating.

Among SPL methods, thermal scanning probe lithography (t-SPL) has gained much attention in recent years. This method involves using a heated nanotip to modify the surface of a sample, and it has now reached a high level of technical maturity, with several dedicated tools to perform reliable t-SPL.

In the recent open-access study on t-SPL, the researchers made a significant change to the setup of their experiment to fully harness the thermal component of t-SPL.

Instead of placing the 2D materials directly on an inelastic substrate, they placed a polymer layer between the 2D layer and substrate. "The polymer we use is polyphthalaldehyde (PPA) with a glass transition temperature of ≈150°C. Above this temperature, ... PPA does not melt but directly sublimates," they write in the paper.

When they pressed the heated tip into the 2D material, sublimation of the underlying polymer layer allowed the tip to achieve a deeper indention, thus making it easier to cut through the 2D material's chemical bonds.

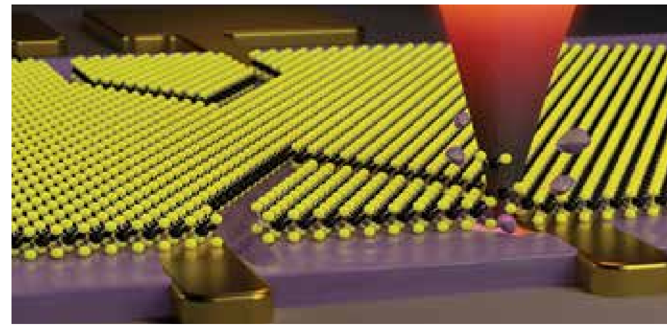
The researchers used the t-SPL method to create square patterns in a variety of molybdenum-based 2D materials, with pattern sizes ranging from 20 to 200 nm. "The smallest feature we were able to cut is about 20 nm, which is the smallest reported for a direct cutting method and is similar to the resolution in [electron beam lithography]," they write.

They also note their method is not limited to cutting monolayers but also can be used to cut certain multilayers and, "most interestingly," heterostructures. They acknowledge graphene, even at monolayer thickness, could not be fractured "as the intra-layer bonding exceeds the force that can be applied with the t-SPL tool," but they say this limitation "could be eventually overcome with a t-SPL cantilever that can apply larger contact forces."

In an EPFL press release, first author Xia Liu, researcher and postdoc in the School of Engineering's Microsystems Laboratory, says their technique could prove quite useful to the semiconductor industry.

"This generic technology will be very useful in nanoelectronics, nanophotonics, and nanobiotechnology, as it will help to make electronic components smaller and more efficient," she says.

The open-access paper, published in *Advanced Materials*, is "Thermomechanical nanocutting of 2D materials" (DOI: 10.1002/adma.202001232). ■



Credit: Case Western Reserve University

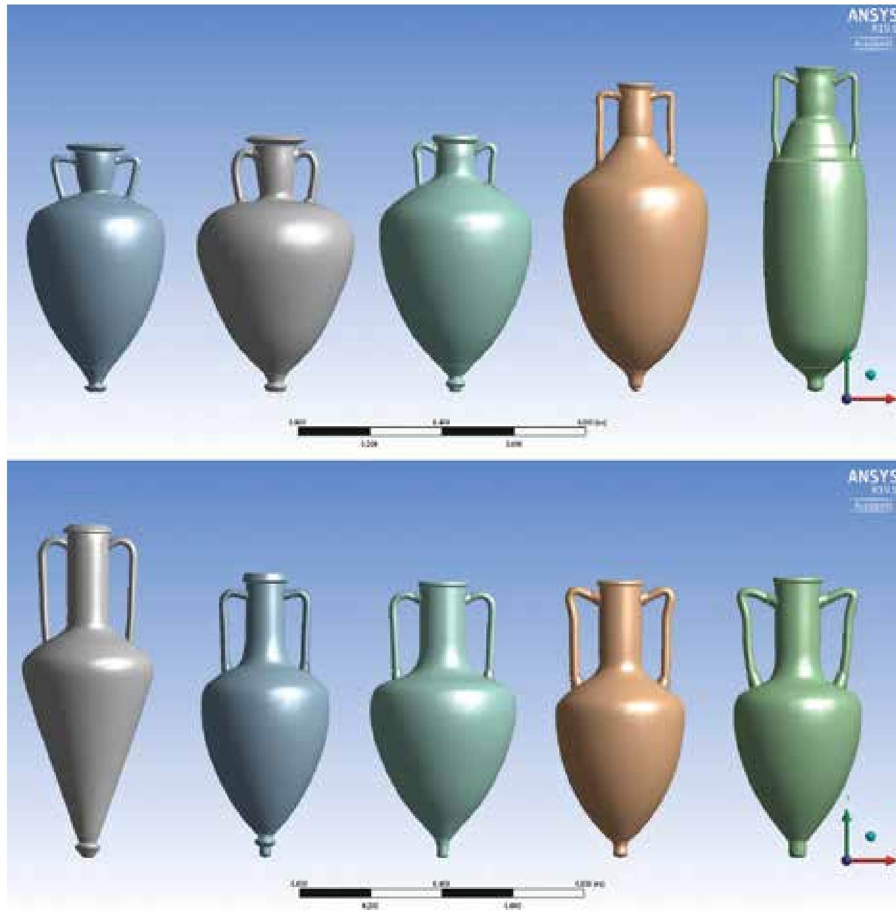
Researchers in the U.S. and Italy found infiltrating metalenses with liquid crystals may allow dynamic control of the lenses' optical properties.

Modeling illuminates properties of ancient ceramics

When master artisans passed down recipes for historic pottery from generation to generation, they determined correct firing and other processing conditions by relying on senses and experiences that could in no way be captured, even when records were kept. So it is no wonder some of the beauty and utility of historic pottery is difficult to replicate today, even by skilled artisans and engineers.

As archeologists find more artifacts, archeometrists seek to unlock the secrets of ancient civilizations and their engineers and artisans. But how can these scientists uncover key mechanical and chemical information from such priceless, irreplaceable items? How can they figure out how they were produced? Examining shards is helpful when the tests can be destructive, but it only goes so far. Instead, scientists use models to estimate and attempt to reproduce such items.

Two recent open-access articles in *International Journal of Ceramic Engineering & Science* discuss models that were used to better understand ceramics from different parts of the world designed for very different purposes: commerce and decoration.



3D models of amphorae from Kos (top) and Rhodes (bottom).

Amphorae: Understanding mechanical properties of standard transport containers

With the advent of regional trade, merchants needed containers in which to store and transport goods over long distances, especially by boat. And one type of ceramic container used often in antiquity for this purpose was amphorae.

Amphorae are bullet-shaped vessels, typically with long necks and handles that are affixed near the mouth of the vessel on one end and attached to the body at the other. They are specifically designed to be stacked inside cargo holds of ships in multiple layers.

While the amphorae itself had some value, the real value lay in the vessel's

Research News

Flash graphene rocks strategy for plastic waste

Rice University researchers advanced a new technique to make graphene from waste with a focus on plastic. Instead of raising the temperature of a carbon source with direct current, as in the original process, the lab first exposes plastic waste to around eight seconds of high-intensity alternating current, followed by the DC jolt. The products are high-quality turbostratic graphene, a valuable and soluble substance that can be used to enhance electronics, composites, concrete, and other materials. They estimate that at industrial scale, the process could produce graphene for about $125 in electricity costs per ton of plastic waste. For more information, visit https://news.rice.edu/category/news-releases.

Mini perovskite solar panels with 18.4% efficiency

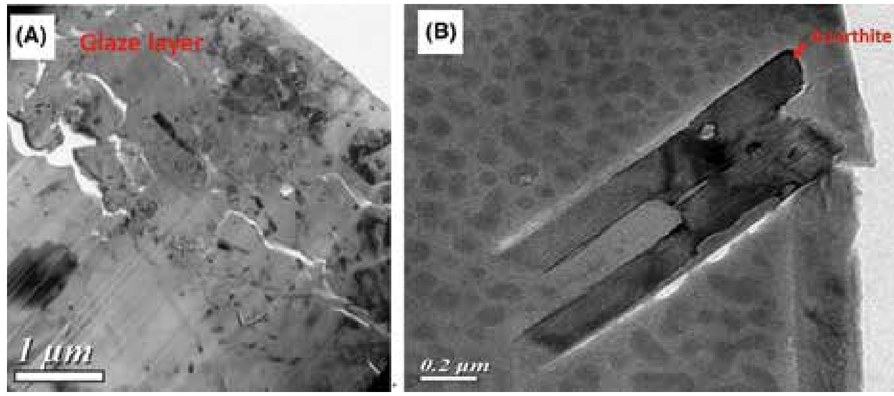
Researchers from Singapore's Energy Research Institute at Nanyang Technological University developed a mini solar module based on thermally evaporated perovskites with an efficiency of 18.4% and a geometric fill factor of around 91%. The module, which has an active area of 6.4 cm^2, is based on thermally evaporated methylammonium lead iodide with an optimized thickness of 750 nm. The perovskite films were used to build solar cells with an "n-i-p" layout on fluorine-doped tin oxide glass substrates. For more information, visit https://www.pv-magazine.com.

contents. As such, if the container broke and the contents of that vessel were lost—and potentially damaged other goods in the cargo hold as well—it could result in substantial losses to the producer and the ship owner.

In the first open-access paper, Anno Hein and Vassilis Kilikoglou from the Institute of Nanoscience and Nanotechnology in Greece assessed specific design features of different amphorae for their performance (e.g., failure potential), particularly during transport. Furthermore, they used simulations to provide information to help interpret typical damages observed in archaeological finds.

The researchers ran nondestructive testing such as X-ray tomography to determine wall thicknesses while performing mechanical testing on shards to get insights into mechanical strength, tangent moduli, and plastic deformation.

They used the limited experimental information as inputs and boundary conditions for finite element modeling of the stresses that build up at the contact points of the amphorae due to static vertical loading (e.g., the weight of one layer on the next), dynamic vertical loads (ships travel over waves), and dynamic horizontal loads (ships rocking side-to-side).



TEM micrographs of the shard of Ru celadon porcelain, including (A) the glaze layer of Ru celadon porcelain, and (B) anorthite surrounded by the dual-phasic glass matrix.

The results of the modeling include compressive and tensile stresses on the exterior and interior walls of the amphorae. Excessive compressive loads are found, but the authors surmise these loads result in elasto-plastic deformation, which is not catastrophic. Tensile stresses on the outer surfaces, on the other hand, can lead to crack initiation and eventual failure. Failed amphorae artifacts show damage in the areas predicted by the modeling.

The open-access paper, published in *International Journal of Ceramic Engineer-*

ing & Science, is "Digital modeling of function and performance of transport amphorae" (DOI: 10.1002/ces2.10056).

Ru celadon: Investigating the coloring of a masterwork of Chinese ceramics

Celadon is a pottery term that refers to both a transparent, greenish glaze and the wares to which the glaze is applied. Though the term is purely European, celadon originated in China, and today notable kilns such as the Longquan kiln in Zhejiang province are renowned for their celadon glazes.

Celadons come mostly in some shade of green, but shades of pale blue—notably Ru celadon—are highly valued, and in historical times were reserved more or less exclusively for use in the Chinese Imperial court.

In the second open-access paper, Yen-Yu Chen (Chinese Culture University) and Yi-Wun Bai and Wen-Cheng J. Wei (National Taiwan University) investigated methods to reproduce the unique color and milky opalescence of ancient Ru celadon glazed ceramics.

The color of celadon is generated by two mechanisms: chemical coloring by iron species in calcium aluminosilicate compositions; and structural coloring by inhomogeneities, specifically crystallites and voids in the celadon glass. While there is some information available about the material composition of ancient celadon—both from analysis of ancient shards and from prior studies—the fabrication methods are not well understood. For example, it is believed the porcelain was fired in a reducing environment, but there is no way of knowing the composition of the gases or their temperature—the technology simply did not exist for those measurements 1,000 years ago.

In this article, the researchers created their own celadon by varying a range of experimental conditions, including composition relative to phase stability data for the complex chemical system and firing temperatures, environments, and holding times. They measured the model systems they created against a shard of ancient celadon ceramic for color, microstructure, and chemical content of the glass and crystallites.

In the end they came close to the ancient celadon color and opalescence, giving insight into ancient firing protocols. Their work supports the combination of the chemical coloring and structural coloring mechanisms. Specifically, the dual-phase nature of the glass contributes to Rayleigh scattering while crystallites and voids contribute to the "milky" color, while the ratio of Fe^{2+} and Fe^{3+} oxidation states of iron contribute to chemical coloration.

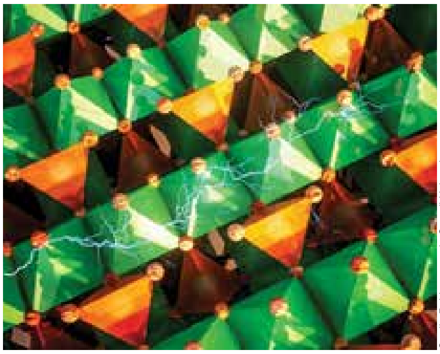
The open-access paper, published in *International Journal of Ceramic Engineering & Science*, is "Analysis of structural effects on coloring mechanism of Ru celadon porcelain" (DOI: 10.1002/ces2.10058).

Updated small-polaron transport model accounts for complex oxide systems

An interdisciplinary collaboration between Cornell University and Technion–Israel Institute of Technology (Israel) updated a model for ceramic conduction to more accurately calculate small-polaron transport in complex oxides.

For the past 60 years, researchers described the movement of polarons through a material using a small-polaron transport model developed by Heikes and Ure in the 1960s. However, Heikes and Ure developed the model based on binary compounds. When this model is used to describe conduction in higher-order oxides with multiple cations, it quickly runs into problems, as the researchers describe in their paper.

"For instance, in the binary spinel Fe_3O_4, all of the charge-conducting octahedral (Oh) sites are occupied by Fe cations, and charge transport occurs along pathways having an alternating arrangement of Fe^{2+}/Fe^{3+}," they explain. "On replacing an Fe^{2+} cation with a Mn^{2+} cation, although the donor/acceptor pair arrangement is still present, the



An updated ceramic conduction model may help researchers custom-tailor the properties of metal oxides in energy technologies such as lithium-ion batteries, fuel cells, and electrocatalysts.

charge transport may be affected by the differences introduced by the hopping barriers or different spinstates between the Fe^{3+}/Mn^{2+} cation pairs."

To update the conventional small-polaron transport model, the researchers investigated conduction in a tightly defined sample of epitaxial thin films of the spinel $Mn_xFe_{3-x}O_4$ grown by molecular-beam epitaxy.

Experiments on the $Mn_xFe_{3-x}O_4$ spinels confirmed what the researchers suspected—that charge cannot hop between manganese and iron cations. "This creates a requirement for a contiguous elemental path and leads to an additional condition for charge transport to occur: separate, decoupled percolation networks need to be formed by both Fe and Mn cations," they write.

They also observed a preference for polarons to travel along the manganese pathways rather than the iron pathways, and the presence of asymmetric hopping barriers between cross-hopping pairs. "To account for these observations, we introduce a percolation parameter, a polaron distribution parameter, and a cross-hopping parameter to the conventional electronic conductivity equation that correct the model for higher-order spinels," they write.

The updated model with these additional parameters showed "excellent overlap" with the experimental trends, thus "confirming the role of percolation pathways and cross-hopping in describing the charge transport in ternary spinels."

The paper, published in *Advanced Materials*, is "Breakdown of the small-polaron hopping model in higher-order spinels" (DOI: 10.1002/adma.202004490).

Ceramic matrix composites contain corrosive materials in thermal energy storage

In the recent September/October 2020 issue of the *International Journal of Applied Ceramic Technology*, two articles from different research groups in Germany explore creating carbon/carbon-silicon carbide (C/C–SiC) ceramic matrix composites (CMCs) for use as container materials in thermal energy storage systems.

Thermal energy storage systems offer an alternative to batteries and pumped hydro for storing energy generated from renewable sources. However, the molten salts and other closely related materials that are at the center of such systems are difficult to contain due to the highly corrosive nature of the liquid materials, moderately high operating temperatures, and substantial expansion during the transition from solid to liquid.

Producing container materials that can withstand the high temperatures, thermal expansion stresses, and corrosive materials for decades of operation are key to adoption of large-scale thermal energy storage. And as the research groups in Germany showed, C/C–SiC CMCs have the potential to serve as good container materials.

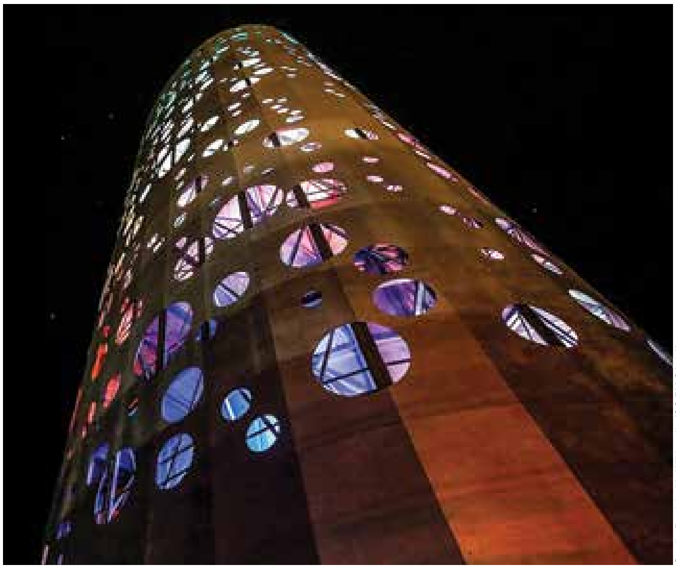
In the first open-access article, researchers from the German Aerospace Research Center and the University of Augsburg in Germany describe the design, fabrication, and characterization of a C/C–SiC container for an aluminum-silicon phase change alloy.

The first stages of their study focused on fabrication and compatibility testing of C/C–SiC test bars. They found the bars withstood the liquid aluminum-silicon alloy and maintained their physical properties with no discernable interactions, such as penetration of the alloy into the test bars. Though there are potential chemical reactions between the alloy and the CMC, the researchers found no evidence of substantial reactions, which echoes the findings of other researchers.

Following the test bars, they continued with the design and fabrication of the container. They decided on low-cost, scalable techniques for fabricating the four main components of their annular container and then used these techniques as boundary conditions for finite element analysis. They used finite element analysis to determine container wall thickness by balancing the strength needed to withstand stresses that arise during phase changes against heat conduction requirements to allow efficient energy transfer.

Unfortunately, pressure testing of the container revealed cracks at the interface of two of the parts, which most likely occurred during fabrication. Though the flaw prevented the full regimen of performance testing, and several issues require further experimentation, the researchers believe the container shows promise for thermal energy storage application.

The second article, by researchers from Chemnitz University of Technology in Germany, describes a different path to low-cost fabrication of C/C–SiC composites. The researchers prepared C/C–SiC using carbon fiber reinforced polymers as the starting material. The moldable precursor polymers are shaped and cross-linked, then pyrolyzed to C/C composites under argon atmosphere. Conversion to C/C–SiC is achieved by either liquid silicon infiltration or internal siliconization, the latter of which is accomplished by mixing silicon powder into the original polymer.



Thermal energy storage tower inaugurated in 2017 in Bozen-Bolzano, South Tyrol, Italy. Ceramic matrix composites hold promise as container materials for high-temperature and corrosive materials integral to thermal energy storage.

The researchers explored the effects of carbon fiber fraction (weight %), silicon fraction, and silicon loading method by measuring the processing parameters of mass loss, shrinkage, and porosity, and performance parameters of strength and elongation. The results are complex, but in short, the researchers concluded that the best mechanical properties were found to be at a fiber mass content of 40%, and a silicon amount higher than 14 wt% negatively influences the whole process.

Their results show that molding C/C–SiC composites from preceramic polymer-based mixtures has the potential to be a cost-effective method for fabrication of complex structures. Further research to optimize properties and processing parameters should improve the end-product performance and allow this method to compete with the more conventional fabrication methods, such as those employed by the authors of the first open-access paper.

The first open-access paper, published in *International Journal of Applied Ceramic Technology*, is "C/C–SiC component for metallic phase change materials" (DOI: 10.1111/ijac.13570).

The second paper, published in *International Journal of Applied Ceramic Technology*, is "Properties of C/C–SiC composites produced via transfer moulding and inner siliconization" (DOI: 10.1111/ijac.13548). ■

Polar rather than conductive battery cathodes lead to long-term cycling stability

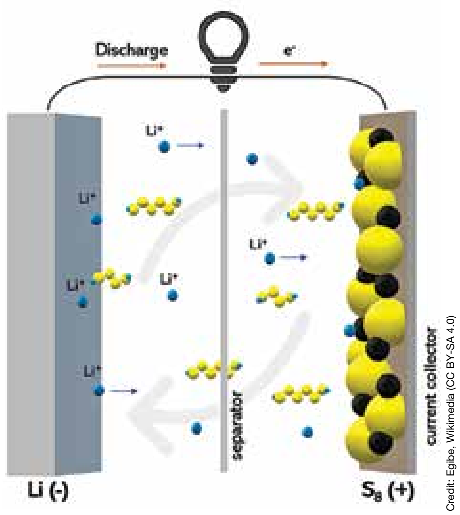
An international team led by Jong-Su Yu from Daegu Gyeongbuk Institute of Science & Technology (Korea) and Khalil Amine from Argonne National Laboratory conducted a recent study to determine the respective importance of two key properties—polarity and conductivity—in improving the cycling stability of lithium-sulfur batteries.

Li-S batteries have a theoretical specific energy of more than 2,500 Wh/kg, which is much higher than the average specific energy of 100–265 Wh/kg for current Li-ion batteries. However, to date the experimental values of Li-S battery specific energy have been far below theoretical values.

The main mechanisms hindering Li-S battery performance are irreversible loss of sulfur from the cathode (the polysulfide "shuttle" effect) and unstable lithium deposition on the anode. These mechanisms are not the only challenges, however. Sulfur also has low electrical conductivity (5×10^{-30} S/cm at room temperature), which hinders the cycling efficiency of Li-S batteries.

To improve conductivity, researchers have experimented extensively with placing the cathode's sulfur within highly conductive carbon host materials, such as hollow porous carbon, graphene, mesoporous carbon, and microporous carbon. Unfortunately, long-term cycling stability continues to be a problem because of the nonpolar covalent bonds that carbon forms with itself, which prevent polysulfides on the carbon surface from attaching strongly, and instead they diffuse away—leading to the notorious polysulfide "shuttle" effect.

Researchers have investigated employing oxide additives, polymers, or other inorganic materials on the carbon framework to enhance polysulfide confinement and mitigate the polysulfide shuttle effect. But these methods often require complicated and expensive synthesis processes, plus they limit the accommodation of sulfur by reducing available surface area.



Shuttling of polysulfide compounds (shown as yellow and blue chains) impairs the performance of lithium-sulfur batteries. Polar host materials for the cathode's sulfur can mitigate this effect, and researchers found this ability makes up for the materials' low conductivity.

Based on these challenges, the question of the best host material for sulfur in Li-S batteries remains wide open.

In the recent study, the researchers wanted to determine if it is better to pursue polarity or conductivity in the cathode to improve cycling if only one of these two properties can be maximized. To answer this question, they designed two cathodes, one made from platelet ordered mesoporous silica (pOMS) and one made from platelet ordered mesoporous carbon (pOMC).

"The two cathodes were designed to be exact replicas of one another apart from the use of either silica or carbon," Amine says in an Argonne press release. "This way, we could determine whether a more polar cathode or a more conductive cathode improved the longevity of the battery."

Upon testing, the researchers found that while the conductive carbon host with a higher specific surface area of 1,597 $m^2 g^{-1}$ showed better initial capacity, "the polar [silica host] with a lower surface area of 844 $m^2 g^{-1}$ reveals much more stable performance for long cycles and eventually outperforms the conductive counterpart after 500 cycles."

In addition, the silica host also demonstrated outstanding low fading rates, even at high current density, and comparable and improved areal and volumetric capacities, respectively, compared to carbon hosts.

"These outstanding areal and volumetric capacities, as well as cycle stability, which have not been achieved by even state-of-the-art carbon hosts, clearly indicate that the polar [silica] host, despite nonconductivity, has high promising potential for energy storage in [Li-S batteries]," the researchers write in the paper.

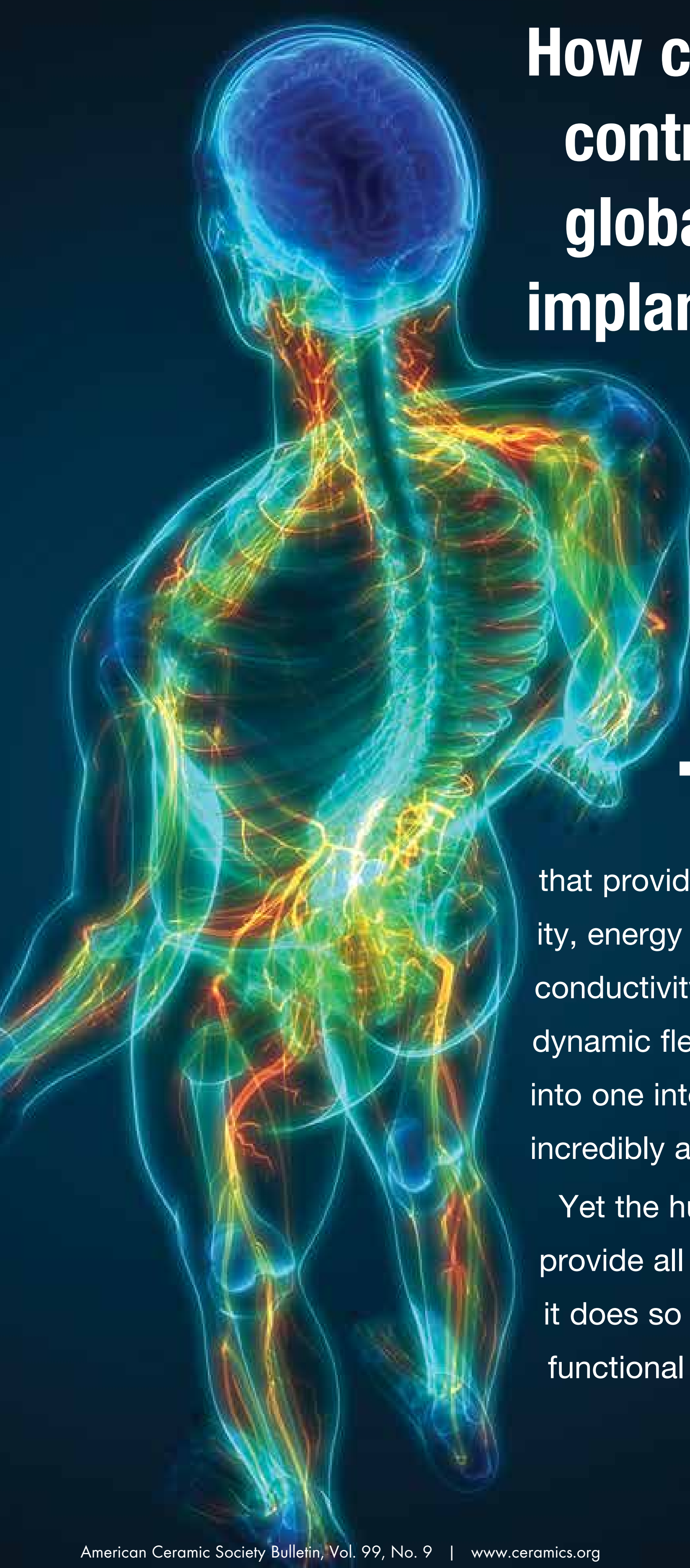
Of course, electrical conductivity is still necessary to achieve good electrochemical performance. "However, the conductivity is not a big issue in the host itself since the poor conductivity of the host can be compensated by the conducting agent involved as a required electrode material during electrode preparation," the researchers add.

In the conclusion, the researchers note they are currently investigating ways to improve electron pathways in the silica host while maintaining the high surface polar properties, such as by adding a thin conductive carbon coating to the silica to enhance conductivity.

The paper, published in *Advanced Energy Materials*, is "Revisiting the role of conductivity and polarity of host materials for long-life lithium–sulfur battery" (DOI: 10.1002/aenm.201903934).

BETTER BODIES WITH BIOMATERIALS:

How ceramic and glass contribute to the $110B global market for implantable biomaterials



By April Gocha and Lisa McDonald

Ceramic and glass biomaterials integrate with the human body in diverse ways to support human health. As aging populations and evolving healthcare approaches shift the medical landscape, increasing opportunities for both established and innovative technologies predict a strong future for ceramics and glass.

There are few systems that can efficiently incorporate materials that provide structural support, filtration capacity, energy generation, energy storage, electrical conductivity, gas exchange, processing power, dynamic flexibility, and regenerative potential into one integrated, highly functional, and incredibly adaptable self-contained system.

Yet the human body is a system that can provide all those functions and many more, and it does so through a unique collection of highly functional materials.

Collectively those materials enable everything our bodies do, and they often retain functionality throughout the human lifespan, which worldwide is an average of 73.2 years.[1] However, the materials are not always perfect and sometimes fail due to overuse, injury, disease, or genetics—circumstances that are becoming more common as worldwide populations age due to population dynamics and increasing life expectancies.

Globally, the number of individuals over 65 years old surpassed that of children under 5 years old for the first time in history in 2018. And while an estimated one in 11 individuals (9%) around the world were over 65 years old in 2019, the older population is expected to increase to one in six (16%) by 2050.[2]

These trends affect nearly every aspect of life, perhaps most notably healthcare. Individuals are living longer and are remaining active until later years of life, demanding enhanced strategies to maintain longer functionality of the body's materials.

Humans have long turned to biomaterials in diverse forms to repair, replace, or enhance bodily materials (Figure 1), establishing a global market for implantable biomaterials that was estimated to be worth nearly $110 billion in 2019.[3] While metals, polymers, ceramics, and glass all are used for biomaterial applications, ceramics and glass have a particular advantage, says Frank Anderson, vice president of Global Research and Development at CoorsTek (Golden, Colo.). "Many technical ceramics are inherently biocompatible, chemically-resistant, and inert, which gives them a unique advantage over other implantable materials," he says.

The global market for bioceramics was valued at $14.5 billion in 2016 and is predicted to reach a value of $20.2 billion by 2021, growing at a 6.9% compound annual growth rate (CAGR).[4] The market is mainly dominated by alumina and zirconia, which account for 75% of the market due to primary use of these materials in bone and dental implants. Other bioceramics frequently found in implantable devices include hydroxyapatite and tricalcium phosphate, and bioactive glass also has clini-

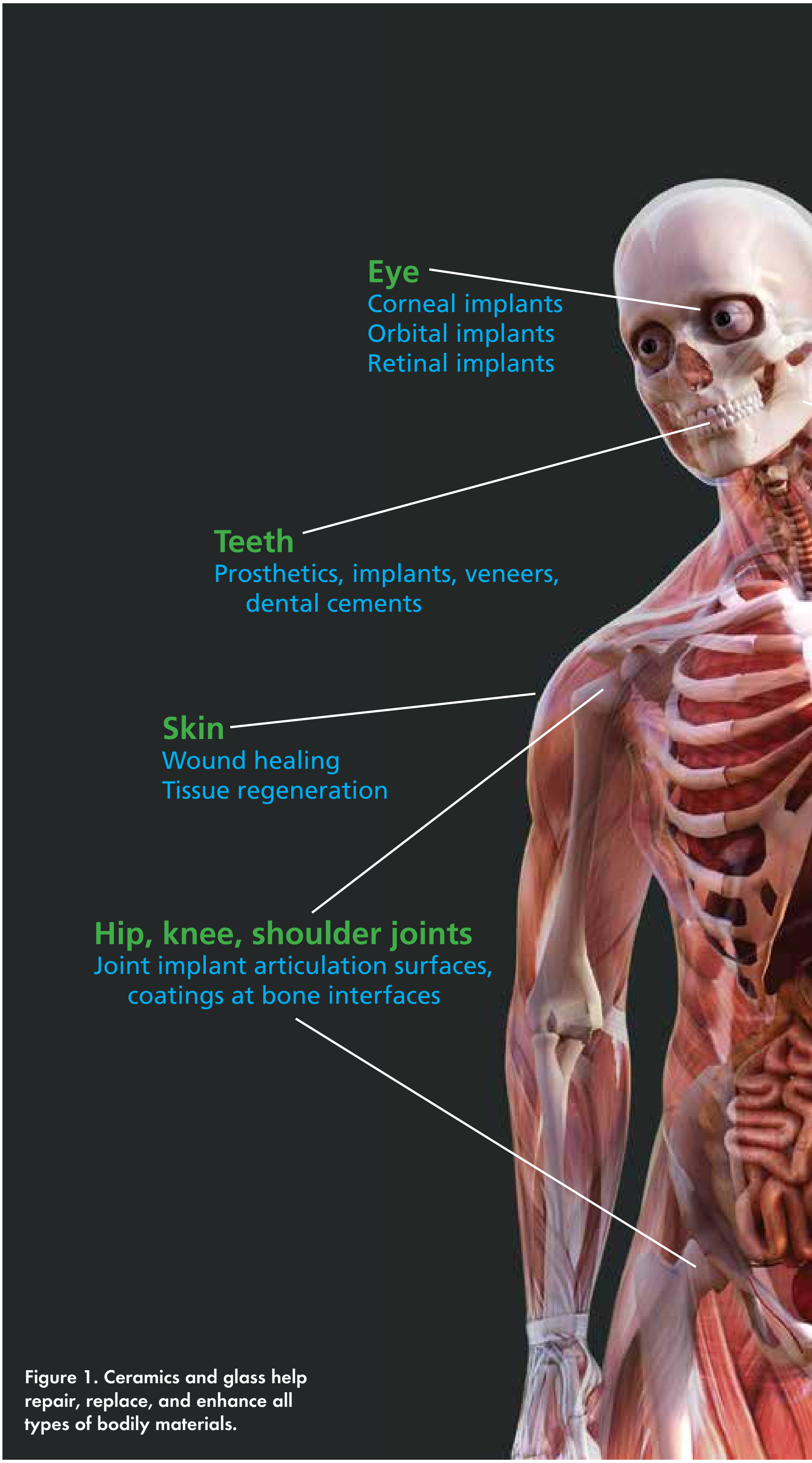
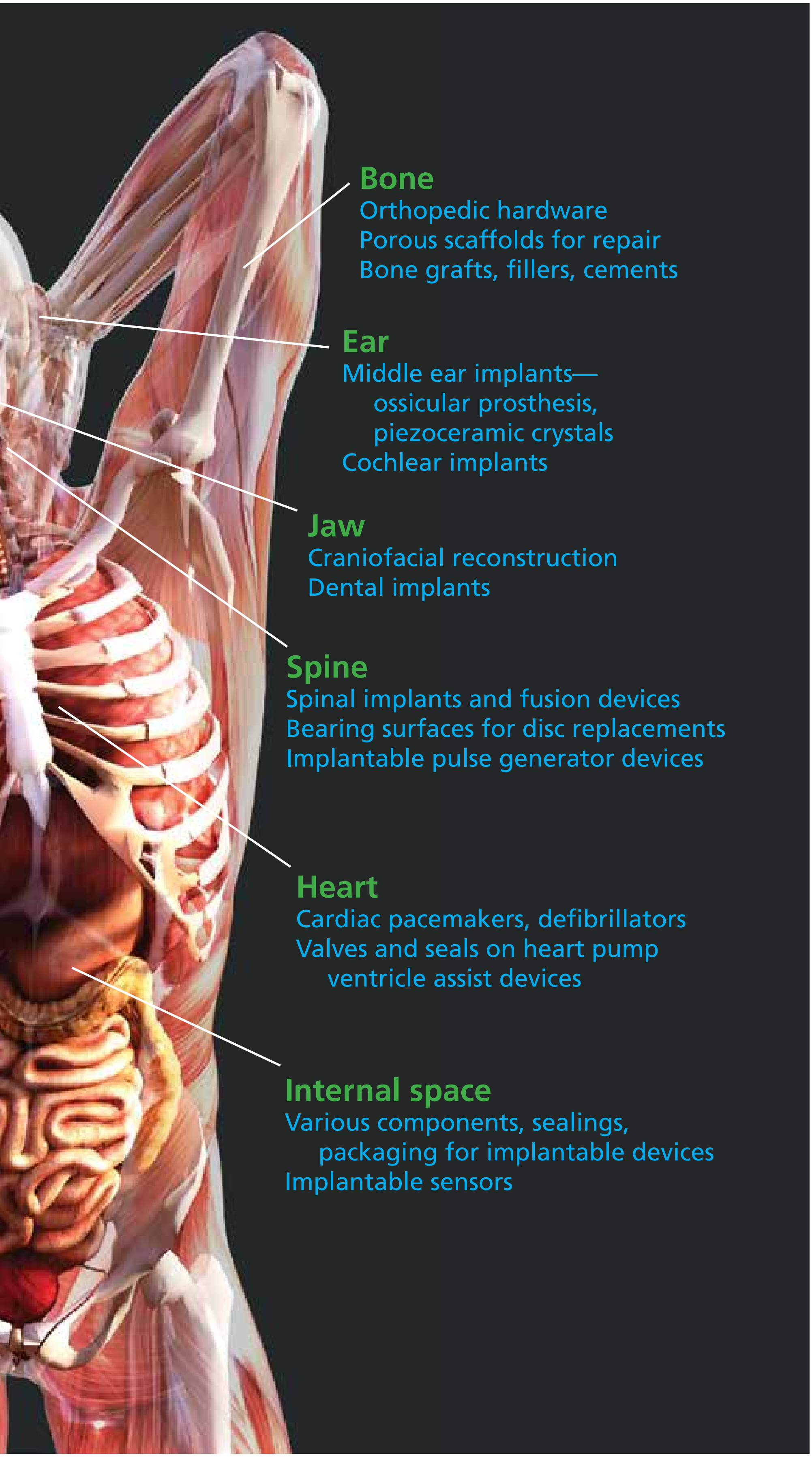


Figure 1. Ceramics and glass help repair, replace, and enhance all types of bodily materials.



cal applications with rapidly expanding potential throughout the human body.

It should be noted that while these materials predominate many implantable applications within the human body, mainly due to their acceptance and time on the market, other ceramic and glass compositions are also suitable for many of these applications, and we might expect their purview to expand in future markets.

Collectively, ceramic and glass materials enable many different kinds of implantable medical products that not only significantly contribute to human health but also constitute robust industries with rich economic impact. Table 1 provides a sample of some companies that manufacture ceramic and glass biomaterials or implantable products.

The following sections highlight a handful of applications for ceramics and glass in the human body. Although the listed applications are not exhaustive, the diversity highlighted here should provide a flavor of the vast potential of ceramics and glass within the human body.

PACKAGING: GLASS PROTECTS BOTH BODY AND DEVICE

Ceramic and glass materials are incorporated into or play supporting roles in many electronic devices implanted into the human body, such as neurostimulators and pacemakers. In these applications, a bioinert and long-lasting barrier between the device components and the harsh environment of the body is imperative to protect both—precisely a job for ceramics and glass.

For instance, glass-sealed feedthroughs and packaging often encase the batteries for implantable pacemakers, where a hermetic seal preserves both function of the device and safety of the patient.

"Glass is used to seal the terminals of pacemaker batteries. It acts as an electrical insulation material for the metal conductors. At the same time, glass creates a reliably gas-tight barrier when hermetically sealed with the electrical contact pins," says Jochen Herzberg, medical program manager of Schott's Electronic Packaging business unit (Landshut, Germany). "Specially selected glass types are resistant to the highly corrosive environment in the battery. And it doesn't deteriorate or get brittle over time like polymers or epoxies. It enables a higher reliability and a longer device lifetime."

To manufacture the glass-to-metal sealed packages and feedthroughs, Schott presses finely ground glass powder into a ring shape that is then sintered and assembled with the metal conductors inserted in the middle of the ring and an outer metal casing. The three components then undergo a sealing process in a belt furnace to bond the materials together.

Although this manufacturing technique provides a hermetic seal for battery feedthroughs, there is another glass technology that comes into play when miniaturization or encapsulation of heat-sensitive components is required. For those applications, Schott has another solution with its Primoceler glass micro-bonding technology. This wafer-scale technology uses a laser to precisely and locally bond glass to glass, creating a vacuum-tight bond with no additional materials.

"If you want to encapsulate, for example, a miniature sensor inside of a glass package, this is possible by stacking base wafers with spacer glass and cover or etched lid wafers, thereby creating a cavity in which the sensor device will be encapsulated," Herzberg says. "The stacked glass wafers are then laser-sealed, resulting in a gas-tight all-glass sensor package. One major advantage of Primoceler laser bonding technology is that it all happens at room temperature. So even if the sensor is very heat sensitive, which is usually the case, it can be packaged using the Schott Primoceler process. The extremely precise laser fuses

Table 1. Select companies that manufacture ceramic and glass implantable medical products or components*

Company (location)	Annual revenue (millions)*	Website	Role in value chain
Johnson & Johnson	$82,100	www.jnj.com	Develops, manufactures, and supplies diverse healthcare products, including medical devices such as orthopedic products
Stryker	$14,900	www.stryker.com	Develops, manufactures, and supplies diverse healthcare products, including medical devices such as orthopedic products
Kyocera Corp. (Kyoto, Japan) • Life & Environment Group, business segment that includes medical and healthcare	$15,404 $760	http://global.kyocera.com	Develops, manufactures, and supplies advanced materials to diverse markets; medical application is mainly ceramic hip implants
Zimmer Biomet (Warsaw, Ind.)	$7,982	www.biomet.com	Develops, manufactures, and supplies orthopedic products, including artificial joints and dental prostheses
Schott AG (Mainz, Germany)	$2,568	www.schott.com	Develops and manufactures diverse glass and ceramic products, including dental materials, medical device electronic components, implant packaging
The Straumann Group (Basel, Switzerland)	$1,746	www.straumann.com	Develops and manufactures diverse dental solutions, including implants, prostheses, technologies, and biomaterials
Morgan Advanced Materials Plc (Windsor, U.K.)	$1,356	www.morganadvancedmaterials.com	Develops and manufactures ceramic components for medical applications, such as feedthroughs for implantable devices
Wright Medical Group NV (Middlesex, U.K.)	$921	www.wright.com	Medical device, especially orthopedic surgical solutions and biologics
CoorsTek (Golden, Colo.)	$1,000‡	www.coorstek.com	Develops and manufactures technical ceramics for numerous industries, including orthopedic and implantable ceramics, (including ceramic hip implants), medical device components, and pharmaceutical components.
Ceramtec Gmbh (Plochingen, Germany) • Medical products	$727 $304	www.ceramtec.com	Develops and manufactures ceramic orthopedic components (including ceramic hip implants), dental implants, and medical engineering devices
Nobel Biocare (Zürich, Switzerland)	$629‡	www.nobelbiocare.com	Manufactures and supplies diverse dental solutions, including implants, prostheses, technologies, and biomaterials
Rauschert GmbH (Pressig, Germany)	$67‡	www.rauschert.com	Manufacturer of technical ceramics, including ceramic medical components
DSM Biomedical (Exton, Pa.)	$65‡	www.dsm.com/biomedical	Develops and manufactures biomaterials including bioceramics for diverse healthcare industries
Collagen Matrix Inc. (Oakland, N.J.)	$15‡	www.collagenmatrix.coc	Manufactures collagen and mineral-based medical products for dental and orthopedic applications, including ceramic and bioglass bone grafts
Mo-Sci (Rolla, Mo.)	$6‡	www.mo-sci.com	Develops and manufactures high-tech glass, including bioactive glass for medical applications
Lithoz GmbH (Vienna, Austria)	$5‡	www.lithoz.com	Develops and manufactures additive manufacturing technologies, particularly with ceramic materials, for diverse industries including medical applications
CAM Bioceramics (Leiden, The Netherlands)	$3.5‡	www.cambioceramics.cco	Develops and manufactures calcium phosphate biomaterials and coatings for orthopedic and dental applications
Berkeley Advanced Biomaterials Inc. (Berkeley, Calif.)	$0.6‡	www.hydroxyapatite.com	Develops and manufactures calcium-based biomaterials for medical industry, particularly bone grafts

*Conversions per Google as of October 16, 2020. All financial data obtained from company reports unless otherwise noted.

‡Private company or data not available; revenue estimated from dnb.com or google.com.

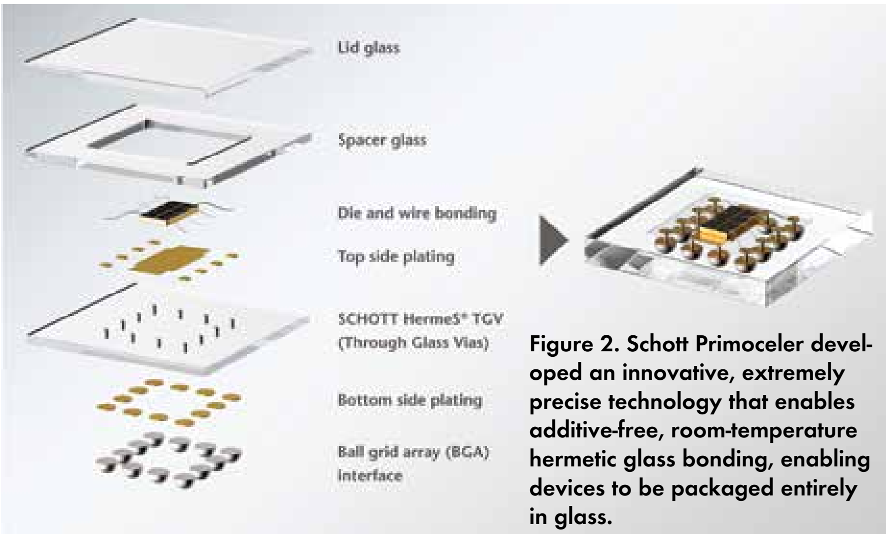


Figure 2. Schott Primoceler developed an innovative, extremely precise technology that enables additive-free, room-temperature hermetic glass bonding, enabling devices to be packaged entirely in glass.

Credit: Schott Primoceler Oy

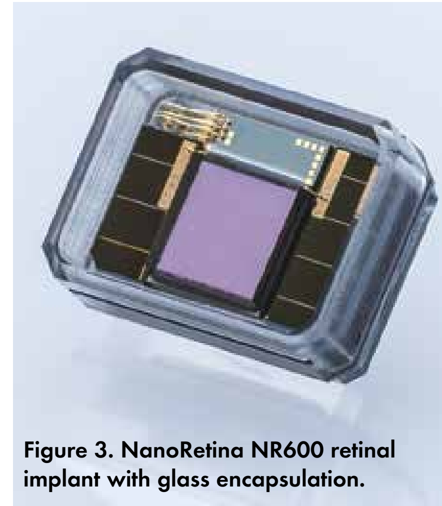


Figure 3. NanoRetina NR600 retinal implant with glass encapsulation.

Credit: Schott

and melts only the very small interface area where the glass wafers meet—an area of just some tens of microns—while leaving all other surfaces untouched." (Figure 2)

The possibilities of such technology are wide-reaching even within implantable device applications, but one of the first to see clinical application is in the eye.

For patients with reduced or lost sight due to retinal degradation, a company called NanoRetina (Herzliya, Israel) pioneered an artificial retina device. NanoRetina's NR600 implant, which is designed to mimic the functionality of the eye's highly sensitive photoreceptor cells, is a tiny chip containing an imager, 3D neural interface, and embedded photovoltaics to provide power. The device is completely encased in glass using Schott Primoceler technology (Figure 3).

"Without our glass-to-glass laser bonding technology, this would not have been possible because the encapsulated sensor inside is very heat sensitive. Only with our technology could we encapsulate it at room temperature," Herzberg says.

Enabled by glass, NanoRetina's NR600 implant entered a small clinical trial of 20 patients in Europe and Israel in early 2020 and already shows promising results. "The device was activated for the first time, and the result was amazing: this patient had been completely in the dark for five years, and she immediately reported seeing an image in the center of her visual field when the device was activated, and could show with her hands the size of the image that she saw," professor Peter Stalmans, who implanted the trial device and is one of Europe's leading retinal specialists, says in a Schott press release.[5] "I am very impressed by this experience. I have been working for more than 20 years as an ophthalmologist, but this is the first time I witnessed a completely blind patient being given back a visual perception."

Akin to maturation in the smartphone industry[6]—where shrinking of components has enabled enhanced functionality in smaller devices—miniaturization is an important reason why implantable devices such as NanoRetina's NR600 are possible today, and it can be traced back to advances in ceramics and glass, as well as other materials.

The consequences of miniaturization are not limited to better performing and more innovative devices, however—it also affects the ultimate bottom line in modern heathcare: cost.

"It starts with the surgery itself," Herzberg says. "Imagine the pacemaker—30 years ago it was very bulky, so hospitalization time of patients was really long, increasing healthcare costs. People cannot go to work, they are on sick leave,

THE SCIENCE AND ART OF GLASS OCULAR PROSTHESES

Credit: glasseyes view; Flickr CC BY-SA 2.0

Although ocular prostheses are often called "glass" eyes, many modern such prostheses are actually made of acrylic.

However, prosthetics fashioned from glass—true glass eyes—still exist and are especially prevalent in Germany, Austria, and Switzerland, where more than 90% of ocularists manufacture custom glass ocular prosthetics.

These glass ocular prosthetics are individual works of glass art, handmade by an ocularist to specifically match a patient's need. Ocularists train for about six years, gaining practical experience in addition to their education, to be able to master their art.[1]

Glass ocular prosthetics are uniquely made of cryolite glass, a silicate glass containing the mineral cryolite to provide a white hue that matches the look of a natural eye. The prosthetic is usually bowl or shell shaped.

Ocularists custom match a prosthetic to the patient's other eye, using colored class to embed details such as iris color and drawn blood vessels onto the eye, rather than painting them on, thus reducing the potential for reaction with the body. All details are part of the 100% glass prosthetic and are fired into the finished product.

Firing produces a very polished uniform surface on the prosthetic to prevent irritation within the eye socket. And unlike the hydrophobic surface of acrylic prosthetics, which can leave a feeling of dryness for the patient, glass's hydrophilic surface provides a uniform tear film that keeps the prosthetic moist.

A video of the custom manufacturing process is available at https://doi.org/10.3791/60016. ■

[1]Kunstaugen-Institut Leipold, http://www.augenprothesen-essen.de/en/wiki/augenprothese-aus-glas. Accessed Oct. 29, 2020.

and this is very costly for insurance companies. Today pacemakers are getting smaller and smaller because technology is getting better and better." Smaller devices allow more minimally invasive procedures, translating to faster recovery times and shorter hospital stays, which ultimately help reduce care-related costs.

Technologies and advances that continue to allow implantable devices to assume smaller forms with enhanced performance, as well as parallel medical developments that permit minimally invasive procedures and improved surgical outcomes, are critical components of future healthcare strategies to sustainably and effectively promote the health of growing, aging populations.

JOINT IMPLANTS: CERAMICS EXTEND IMPLANT LIFE

Our joints, the connections between the skeleton's more than 200 bones, provide our bodies with an incredible capacity for movement.

This ability is perhaps most appreciated in the face of reduced or lost mobility in the joints, often due to stiffening caused by conditions such as arthritis. Osteoarthritis, the most common form of arthritis, represents the single most common cause of disability in aging bodies, affecting an estimated 10%–15% of adults over 60 years old.[7]

As such, it is no surprise that the global market for joint replacement, implants, and regenerative product devices is expected to grow—reaching a value of $33.6 billion by 2023, growing at a CAGR of 4.8% during 2018–2023.[8]

Knee replacements constituted the largest share of the $26.5 billion joint replacement market (by value, not number) in 2018, accounting for 33% of the market, or $8.8 billion. Hip replacements were the next largest share, accounting for 28% of the market or $7.4 billion, followed by spinal implants (20%; $5.2 billion) and then extremities reconstruction, which comprises implant devices for the shoulder, elbow, wrist, digits, and ankle joints.

At all of these locations, ceramic implants compete with those made of polymers, metals, and combinations thereof. Due to length of time in the market, ceramics' successful infiltration into joint replacements is most notable for hip replacements.

"Though implantable ceramics have been in the market for decades, the adoption of these materials has really happened in the last 15 years," says Lucian Strong, vice president of CoorsTek Bioceramics (Grand Junction, Colo.), which manufactures ceramic femoral heads and acetabular liners for total hip arthroplasty, among other bioimplantable ceramic components. "The adoption is coming from the transition away from metals to ceramics due to the superior wear properties of ceramics, as well as patients' demands for longer and more active lifestyles after joint replacement."

Wear of polymer and metal joint implants can generate debris particles that cause inflammation around the joint, loosening the implant and potentially leading to its failure. Potential allergic reactions to metals as well as toxicity from release of metal ions from an implant into the body are also considerations.

These considerations are creating a favorable landscape for ceramic implants, and that shift is evident in data from the 2019 annual report of the American Joint Replacement Registry, a database of more than 1.5 million knee and hip arthroplasty procedures performed in the U.S. during 2012–2018. Registry data show that for total hip arthroplasty, the number of implants with ceramic heads is increasing and first surpassed those with cobalt chromium heads in 2015.[9]

This data, however, presents only a limited picture, as the registry captures an estimated 25%–30% of the volume of annual procedures in the U.S. Other estimates indicate that adoption of ceramic hip implants is already much higher in some parts of the world—more than 50% of hip implants performed in European countries like Austria, France, Germany, Italy, and Switzerland use a ceramic ball head, while 72% of total hip replacements in Asian countries such as South Korea have an alumina ball head.[10]

A large proportion of total hip replacement ceramic implants are historically alumina, although zirconia is used as well. Acceptance of zirconia was severely hindered by the 2001 recall of millions of Prozyr brand zirconia ball heads, prompted by high fracture rates in patient implants. Subsequent failure investigation of the manufacturer, Saint Gobain Ceramiques Desmarquest, determined that a switch in the type of furnace used to manufacture the implants caused an unanticipated change in temperature kinetics, resulting in insufficiently densified zirconia.[11] Although the problem was traced back to a manufacturing error, the recall significantly marred zirconia's reputation in the market.

Many modern ceramic hip joint implants now combine the best of both worlds with composites that offer improved properties of strength, toughness, and scratch resistance, for example, ones based on zirconia toughened alumina (Figure 4).

Beyond material-based considerations, additional factors also are coalescing to create a favorable landscape for ceramics implants. "Medical care has seen many transitions over time, but the latest big trend is the move to outpatient care due to rising costs," Strong says.

Similar to how miniaturization of components allowed pacemakers to shrink in size, resulting in shorter hospital stays and lower care-related costs, parallel evolu-

Credit: CoorsTek Bioceramics

Figure 4. Femoral head and acetabular liner cup for total hip arthroplasty, manufactured by CoorsTek Bioceramics. The implant is made of CeraSurf-p, an alumina zirconia matrix composite that incorporates advanced toughening mechanisms to improve the material's performance.

tions also occurred for joint replacements.

"Generally speaking, technical ceramics are a component of a larger medical implant. Modern ceramics are engineered to be so strong that they are allowing for design changes to the entire device," Strong explains. "They have been optimized to the point where they are impacting the surgical procedures, which are now quicker and more efficient. In total hip arthroplasty, ceramics are a critical part of the overall device, which has been designed around the next generation in surgery. With the current trend toward robotics, these designs allow for faster and more accurate outpatient surgical procedures that previously would require significant time in hospital recovery."

These advancements not only improve patient outcomes but also help reduce healthcare costs, factors that are intimately intertwined.

SPINAL IMPLANTS: SECURING WITH GLASS OR SILICON NITRIDE

Because the spine provides a critical balance of flexibility and stability to the body, any modifications to the spine ideally also must balance those same properties.

Spinal implant devices stabilize and strengthen the spine in various ways, often by securing vertebral elements and inserting implants to shore up the intervertebral space (Figure 5). But that need for flexibility and stability makes spinal devices challenging to design.

For instance, the articulation surface for a total disc arthroplasty must not only be functional, it must be designed to account for an estimated device life of more than 40 years. Considering the estimated number and amplitude of load cycles a lumbar disc undergoes annually—based on an average adult bending an estimated 125,000 times and taking 2 million steps in that year—a disc implant is expected to endure some 85 million cycles of loading during its lifetime without wearing down.[12]

So these devices demand incredibly high-performance and long-lasting materials. While the usual biomedical materials have long been used in spinal implant devices—metals such as stainless steel, titanium, and cobalt-based alloys offer strength; high-performance

Credit: Coorstek Bioceramics

Figure 5. Due to excellent their wear rates, ceramics can also be found in cervical disc bearing surfaces for spinal total disc replacements. This one, by CoorsTek Bioceramics, is made of alumina zirconia matrix.

polymers such as polyetheretherketone (PEEK) provide good value—these materials do not offer perfect solutions in the spine, where integration with existing tissue is particularly desirable for preserving functionality of the spine and maintaining longevity of the device.

"Overall, the need of the hour is to develop materials that demonstrate both biomechanical applicability and biocompatibility while being user friendly in a surgical environment," according to a 2017 article on trends in spinal surgery materials.[13] So it is not surprising that this field is also starting to realize the potential of ceramics and glass.

For instance, Mo-Sci (Rolla, Mo.) is developing multicomponent bioresorbable spinal bone grafts from bioactive glass—containing one bioactive glass formulation that dissolves more quickly and contains compounds to stimulate vasculature growth (e.g., copper and zinc elements) in early stages of healing, and another bioactive glass formulation that forms a porous silicate glass scaffold that dissolves more slowly to provide support while natural bone formation gradually replaces the graft.

"This bone graft has shown really nice improvements in spinal fusion rates, and it actually isn't even on the market yet," says Steve Jung, chief technology officer of Mo-Sci. "Mixing to get this benefit from this material and this benefit from this material is sometimes a better option than trying to find this one material that could do it all. Sometimes you have to accept that there are just two really great materials you can put together and get what you want from each."

Beyond bioactive glass, other materials also have their sights set on the spinal

Credit: SINTX

Figure 6. Silicon nitride spinal devices manufactured by SINTX.

market. Silicon nitride spinal fusion devices manufactured by SINTX (Salt Lake City, Utah)—the only FDA-registered and ISO-certified silicon nitride medical device manufacturer in the world—and sold through CTL Amedica are working their way into this market (Figure 6). Silicon nitride is not only bioactive, antiviral, and antibacterial but also promotes bone growth, providing an effective orthopedic solution.

Although the material currently constitutes a small portion of the overall market for spinal fusion devices, data indicates silicon nitride has significant potential, as the company reports there were fewer than 30 FDA-reported adverse events despite more than 35,000 human spine implantations over 10 years.[10]

SINTX anticipates many additional orthopedic applications for silicon nitride, such as dental and craniofacial applications as well as joint replacements. "There's a lot of concerns that metals corrode in the body. As you're putting hips into younger and younger patients who are going to live longer, you're not looking at 20-year outcomes. You're interested in 30- and 40-year outcomes, and there ceramics have a very special role," says Sonny Bal, president and CEO of SINTX.

For craniofacial applications, customized repair of defects with 3D-printed patient-specific implants is a possibility that SINTX has in mind, according to Don Bray, vice president of business development at SINTX. "If someone has a severe accident and you need to rebuild the facial bones and structure, you would want to do a CAT scan and make an exact fit. In the spine you can use some standard sizes. But because of the shape of the face, you can't—and we think 3D printing there with our silicon nitride is key," Bray says.

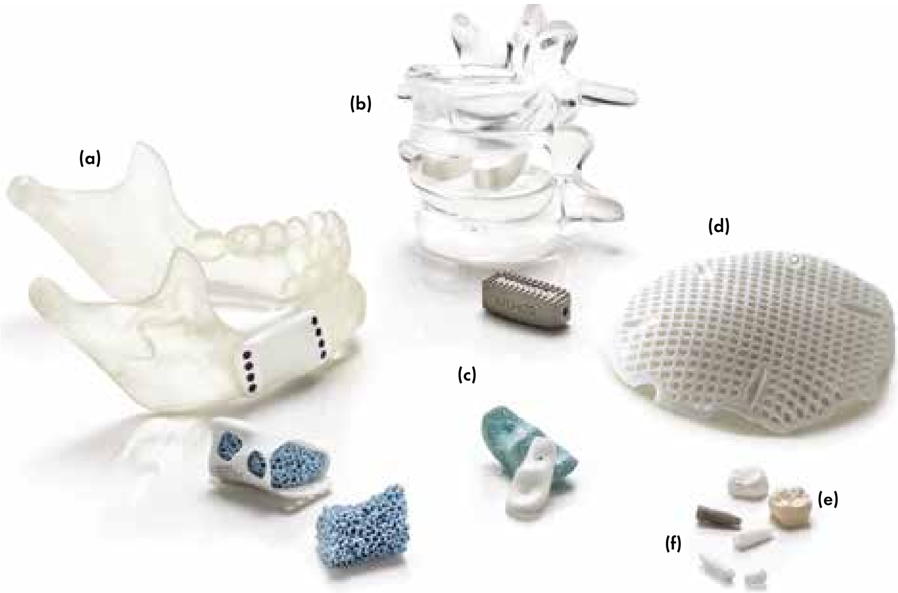


Figure 7. 3D-printed medical devices manufactured with Lithoz CeraFab System printers. From left to right: a) Mandibular implant (white: zirconia, blue: hydroxyapatite), b) spinal implants (grey: silicon nitride, white: tricalcium phosphate), c) front jaw bone augmentation (blue: hydroxyapatite, white: bioactive glass), d) cranial implant (tricalcium phosphate), e) zirconia crowns (native and colored), f) dental implants and abutment (grey: silicon nitride, white: zirconia).

"It's a very critical area, so having an antibacterial implant that would you could make exactly for the person is where we think this is going to go," Bray adds. "And we don't think it's that far off."

Because of silicon nitride's favorable antibacterial and biological properties, SINTX also is developing techniques to incorporate silicon nitride into devices and products made of other materials as well. For example, silicon nitride can be mixed into polymer-based products or coated onto titanium devices to enhance biocompatibility of those surfaces, promote healing, and prevent infection and spread of viral diseases, according to Bal. "We are looking at 3D processing procedures that we can commercialize, in which we put a very tenacious micron-level coating of silicon nitride that supercharges the metal and makes it antibacterial," he says.

3D PRINTING: A TECHNOLOGY WITH LAYERED MEDICAL POTENTIAL

Multimaterial implants

At the intersection of medical care and additive manufacturing lies tremendous promise to completely change how we approach health strategies to replace, enhance, and restore function of the human body.

According to the annual Wohler's report, the 2019 additive manufacturing industry was worth some $11.867 billion. Medical and dental applications account for about 11% of that market, and dental in particular represents a large growth segment in the latest report.[14]

Additive manufacturing company Lithoz GmbH (Vienna, Austria) is familiar with the potential of the technology for medical and dental applications. Lithoz's lithography-based ceramic manufacturing technology 3D prints complex structures layer-by-layer using a photocurable polymer–ceramic slurry. After printing, green parts are debinded and sintered to remove the polymer, leaving fully dense ceramic parts.

Lithoz developed both the expertise and the custom printers to additively manufacture a diverse array of ceramic materials, everything from piezoceramics to regolith, and certainly including ceramics with medical applications such as alumina, zirconia, silicon nitride, hydroxyapatite, and tricalcium phosphate. Daniel Bomze, head of the Lithoz's medical business unit, says the company also has success printing with bioactive glass. "We have produced several parts and some slurries already successfully with bioglass. So we know it works," he says. Now, Bomze says Lithoz is waiting for a commercial partner who is interested in making the investment to further develop applications for additively manufactured bioactive glass.

Lithoz's technologies can print complex geometries such as high-resolution lattice structures with openings just several hundred microns wide—optimal scaffolds to promote interaction and integration with living tissues—so medical applications are one promising direction (Figure 7). For instance, such bioceramic scaffolds could be used to repair bone defects due to injury or disease.

While ceramic and bone are a perfect match materially speaking, design of bioceramic scaffold structures is challenging because they must provide both porosity and mechanical strength, properties that often come at a tradeoff. Fortunately, natural bone can provide some inspiration. Bone's structure consists of an outer layer of dense cortical bone filled with porous and spongy inner trabecular bone, a multimaterial strategy that uses two different forms to provide two different components of bone's function.

Lithoz is developing multimaterial 3D-printed implants that provide both porosity to promote tissue regeneration and mechanical stability to support a bone defect. These multimaterial implants incorporate a strong outer layer for structural support during the initial healing phase, composed of a ceramic material with good mechanical stability such as zirconia, with a porous inner scaffold of bioresorbable ceramic substrate such as tricalcium phosphate or hydroxyapatite. The inner material more closely matches the inorganic component of bone, and its porosity permits cell attachment and penetration of blood vessels, allowing the body to heal and replace the bioresorbable substrate with natural tissues over time.

Such multimaterial implants could be used to repair many types of bone defects, such as those in the jawbone. Critically, Bomze says, the material's resorption rate can be tuned to the area of the body being targeted. "The ideal would be that the regrowth, the new tissue forms at the same speed as the implant is being resorbed. So you have the overall volume and stability, and the whole healing time is the same by tuning this artificial material and the natural material," he says.

Although the individual components of these implants were implanted into a small number of human patients, with good results so far, the multimaterial implant is currently a proof-of-concept. And although the current design is printed into two separate steps, Lithoz has bigger plans for the future.

"The future will be printing it simultaneously, in one single step—you could print the cage and the inner part at the same time and then sinter them together," Bomze says. "You can probably make even more sophisticated materials, for example a sandwich structure with an inner part of hydroxyapatite, then a shell of zirconia, and then a tiny outer coating or a third layer again of hydroxyapatite to facilitate ingrowth of the of implant. And here we're making really rapid progress."

In that vein, Lithoz released in September 2020 a new multimaterials 3D printer called the CeraFab Multi 2M30. The printer is similar to the company's other offerings but now includes two vats to provide the ability to simultaneously print with two different raw materials (Figure 8). This ability affords new functional applications, such as printing multiple materials in a single layer and allowing gradual compositional variation from one material to the next.[15]

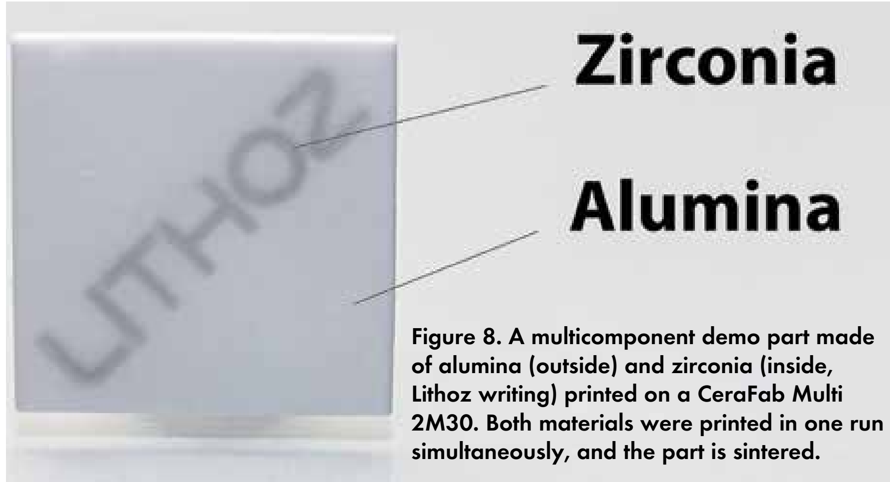


Figure 8. A multicomponent demo part made of alumina (outside) and zirconia (inside, Lithoz writing) printed on a CeraFab Multi 2M30. Both materials were printed in one run simultaneously, and the part is sintered.

Credit: Lithoz

3D-painting

Additive manufacturing is a diverse technology, so Lithoz's lithography-based technique is one of many different approaches.

Another company, Dimension Inx (Chicago, Ill.), is innovating with printing ceramic-based biomaterials at room temperature, with no additional post-processing sintering steps required—affording the ability to incorporate organic molecules such as proteins, drugs, and antibiotics into the materials themselves before printing.

As noted in a May 2019 *Bulletin* article,[16] "3D-painting is a materials-centric advanced manufacturing technology that permits nearly any material to be transformed into a 3D-printable '3D-paint' via simple, room-temperature extrusion without the need for support materials,

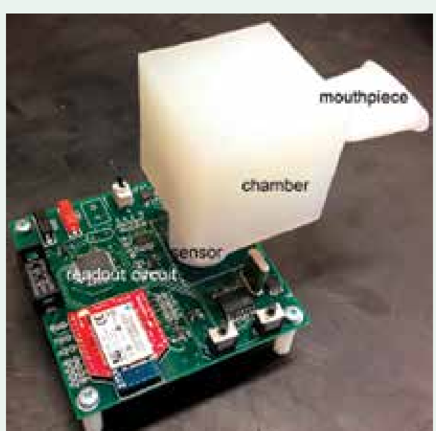
BREATHALYZERS: ANOTHER WAY TO DETECT COVID-19

In the fight against COVID-19, the main technique used to collect samples is a deep nasal swab, a procedure doctors describe as moderately uncomfortable but some patients describe as "being stabbed in the brain."

Testing methods that are more comfortable and more easily administered would certainly be appreciated by patients and physicians alike, and researchers have explored saliva testing as an alternative, with some promising results. However, according to Edward Orton, Jr., Chair in Ceramic Engineering Pelagia-Iren (Perena) Gouma at The Ohio State University, breathalyzers may be an even easier and readily accessible way to administer tests.

Breathalyzers use selective gas sensing elements to detect certain biomarkers in breath that signal disease. Compared to swab-based testing methods, breathalyzers are noninvasive, nonintrusive, and can deliver a result in dozens of seconds.

Gouma has explored the use of breathalyzers for medical diagnostics since 2003. She started investigating the development of breathalyzers aimed specifically at detecting infectious diseases a few years ago, and she has worked extensively the past few months to use that knowledge to design a breathalyzer that detects COVID-19.



Credit: Perena Gouma and M. Stanacevic.

The portable, battery-operated breathalyzer prototype to detect COVID-19 developed at The Ohio State University.

The in-development COVID-19 breathalyzer uses ceramic sensors to target biomarkers that give a response specific to that infection, and it includes advances on nanomaterials for detecting specific breath gases at concentrations that can make a diagnosis.

Gouma says her team initially tested the new breathalyzer by using gas canisters that were mixed to simulate the breath gas mixture as a result of COVID-19 infection. However, they have since moved to conducting human testing and have been testing at various COVID-19 testing sites around Columbus, Ohio.

In mid-September, they reported initial results from the ICU-focused human testing at the Ohio State Wexner Medical Center. The results showed the breathalyzer could detect acute cases of COVID-19 and can monitor the severity of the disease.

The researchers currently are seeking FDA emergency-use authorization for the breathalyzer.

For more information on Gouma's study, as well as other breathalyzer studies taking place at Northeastern University, check out a recent *Wired* story on the topic at https://www.wired.com/story/could-breathalyzers-make-covid-testing-quicker-and-easier. ■

Figure 9. Anatomical structures display a handful of possible structures that were 3D printed by Dimension Inx with Hyperelastic Bone: (clockwise, from top left) spine, femoral head, mandible, and pelvis.

Figure 10. A sheet of Dimension Inx's 3D-printed Hyperelastic Bone, which is flexible despite being 90% ceramic.

powder-beds, resin-baths, cross-linking, or curing."

In the 3D-painting technique, a powder-based material is mixed with elastomer and solvents; after extrusion through a nozzle, the finished printed product requires only rinsing and sterilizing. The flexibility of the technique means that in addition to 3D printing structures out of 3D-paints, the same strategy could also be used to coat products manufactured via other techniques and out of other materials.

Importantly, 3D-painting can be applied to almost any material, including ceramics. "3D-painting is materials agnostic. It's not dependent on what you're making or what material you're using," says Adam Jakus, cofounder and chief technology officer at Dimension Inx.

As one example of the 3D-painting technology, Dimension Inx's bone-specific 3D-paint formulation, called Hyperelastic Bone®, is primarily ceramic yet still incredibly flexible, offering significant potential for bone implants. Hyperelastic Bone can be printed in specific structures (Figure 9) as well as porous scaffolds and sheets that could be cut and custom-fit in the operating room (Figure 10).

"The really interesting thing about Hyperelastic Bone is that it's 90% ceramic, which is technically more ceramic than is in our actual bones," Jakus explains. Human bones contain 60%–70% dry weight of crystalline hydroxyapatite, bound by collagen and other structural and functional proteins. "But the end result is actually flexible and cuttable and shapeable, which you wouldn't really expect for a something that's mostly ceramic."

That flexibility is because of Hyperelastic Bone's unique microstructure, which forms as evaporants vaporize from the printed material after it is extruded through a printer nozzle. The rate of evaporation tunes precipitation of the elastomer, forming an optimized structure in the printed material.[17]

"A very specific microstructure really allows the different components of the composite, the ceramic and the resorbable polymer, to play off each other and move around and then return to their original form without breaking," Jakus says.

Hyperelastic Bone also is microporous, which provides excellent osteoconductivity and biocompatibility. "If it's intended to regrow bone, the body tissue needs to be able to access that material on the microstructure level and transform it," Jakus says, although the porosity can have a drawback. "But it's a balance if you want structural integrity and you want bioactivity. Those things are in conflict all the time."

Since the technology is relatively well-established at this point, Jakus says Dimension Inx is now working on quality control aspects of the process, showing that it can demonstrate consistent results. "So a lot of our efforts throughout 2020 have been establishing new quality control systems and quality manufacturing systems around design and synthesis of these new materials as well as the 3D-painting process itself," he says.

That includes establishing consistent and detailed manufacturing processes and identifying and mitigating risks—all part of the company's preparations toward seeking FDA approval for Hyperelastic Bone devices.

3D printing inherently conjures ideas of patient-specific printed implants. And while that is an eventual direction for Dimension Inx, the company is starting with a more practical pathway—and one common for biomedical innovations—by targeting mass-produced implants of Hyperelastic Bone, a collection of standard shapes like "strips or squares or blocks," Jakus says. "We are introducing a new material in a new manufacturing process. So I think it's important to get the regulatory agencies, the FDA, surgeons, everybody comfortable with the material and the process first so they are then willing to take that next step to patient-matched implants."

That acceptance is a considerable issue in the medical industry—you not only have to prove that a device or technology works (see sidebar: *Regulating the pace of medical innovation*), but you also have to convince medical professionals to use it as well. And that can be a major barrier, especially for new medical innovations.

"The technology is the easy part," Jakus says. "And even after you identify a technology that addresses an actual need, getting surgeons to venture out their comfort zone is very hard." If an existing clinical solution is trusted and works relatively well, medical professionals often are not keen to change a process, especially if the solution does not offer additional profit or patient benefit or it requires the professional to master a new technique. Introducing a new product also comes with some inherent risk, which medical care is designed to minimize, for good reason.

One sector, however, where medical professionals are often more willing to take modest risks is the craniofacial space—which is why medical innovations often target this site.

In particular, additively manufactured medical technologies often focus on craniofacial applications because these defects are non-load bearing and highly individualized. In addition, there are few existing off-the-shelf products to treat craniofacial defects, so these medical professionals are often more willing to take a slight risk with innovative new solutions.

Infiltrating a site like the craniofacial space can then be a strategic initial target application of a new technology to gain acceptance before expanding to additional sites and applications.

Another consideration that makes the craniofacial segment attractive for innovation in additive manufacturing, especially with bioresorbable materials, is that these surgeons treat many pediatric defects. "So they're most excited to use new materials, ceramic or not, that transform over time and grow with the patient," Jakus says.

TISSUE REGENERATION: THE SOFTER SIDE OF BIOMATERIALS

In terms of the body's natural materials, ceramics and glass are most analogous to bone and tooth enamel—so it is not surprising that there are so many orthopedic and dental applications for ceramics and glass (see sidebar: *Ceramics used in dentistry*).

But modern developments in nanotechnology, particularly the ability to engineer nanosurfaces, nanoparticles, and nanoscaffolds, as well as more nuanced understanding of cell biology are together reshaping how we think about the potential of biomaterials.

Biomaterials were once designed to minimize interactions with the body and to eliminate any potential adverse reactions. But starting with Larry Hench's discovery of bioactive glass 50 years ago,[18] a more modern perspective for biomaterials no longer attempts to eschew cell biology.

"Design of a new biomaterial should always consider the need of the cells, because the cells are the engineers of our body," says Aldo Boccaccini, professor of biomaterials and head of the Institute of Biomaterials in the Department of Materials Science and Engineering at University of Erlangen-Nuremberg (Erlangen, Germany).

Many biomaterials now aim to not only stand in for living tissues when they need to be repaired or replaced, but the materials play a more supportive role in actually helping the body perform its own healing—more like an assist rather than a complete substitution. That guidance can be used to mediate processes such as wound healing and to rebuild damaged or missing tissues, broadly contributing to the overall field of tissue engineering, or regenerative medicine.

In terms of the future of healthcare, regenerative medicine is a big business. The global market for tissue engineering

REGULATING THE PACE OF MEDICAL INNOVATION

While there is no shortage of innovative ideas for medical applications, bringing such innovations to the market is a whole different story.

"The medical market is slow and steady in terms of innovation," says Lucian Strong, vice president of CoorsTek Bioceramics (Grand Junction, Colo.). "While new applications or processes may demand new materials, there is a well-defined process that is governed through the regulatory bodies around the globe. There is no simple introduction of a new material that will be implanted into a patient. Clinical data, proven over numerous years and multiple patients, is necessary for any new material to gain acceptance."

Collecting such data takes considerable time, but it is a critical component of the regulatory processes to ensure that biomaterials and devices are safe and effective once implanted into human patients. And even before the clinical data, much additional time must be first devoted to testing and documenting effectiveness and safety in both lab settings and in animal models.

In the U.S., where the FDA regulates the approval process, bringing a medical device to market takes on average 3–7 years.[1] Although this process unavoidably slows the pace of innovation, these pathways are critical to maintain safety and minimize potential harm to human health.

Yet even once clinical data does provide acceptance for a material, the story is still not over.

"The increasing longevity of the human race, younger patients undergoing surgical interventions, all points to a future in which we as scientists need to understand the long-term interaction of the implant with the body," says B. Sonny Bal, president and CEO of SINTX.

Of course, it is not feasible to wait decades while collecting long-term outcomes for every new device—such observation trials would completely stifle innovation and prohibit entrance of any new product on the market.

Instead, to develop materials for the future, we need robust short-term outcome proxies that can predict long-term behavior, Bal says. "That's the Holy Grail."

Bal made the analogy to how NASA uses algorithms and modeling to predict the outcomes of its missions. There are no practice runs when sending a rocket to Mars—NASA incorporates knowledge and modeling to maximally reduce the margin of error. And that, he envisions, is where biomaterials need to go.

"Instead of experimenting with humans, we need to be able to predict how a biomaterial will behave in the body just like NASA does—because there's no room for mistakes. You do it once, and that patient has to live with it. You can't have failures," he says. ■

[1]G. A. Van Norman, "Drugs, devices, and the FDA: Part 2: An overview of approval processes: FDA approval of medical devices," *JACC: Basic to Translational Science*, **1**[4] 277–87 (2016). DOI: 10.1016/j.jacbts.2016.03.009

and regeneration was valued at $24.7 billion in 2018 and is predicted to reach $109.9 billion by 2023, representing an impressive CAGR of 34.8%.[19] While bone is a significant focus of this market, it encompasses soft tissues as well, such as strategies to repair damaged cardiac and gastrointestinal tissues or engineer vascular, muscle, neural, and skin tissues.

Likewise, there is potential for many different types of materials in this broad field. "In the field of regenerative medicine and tissue engineering, there is no one material that is going to tackle all the problems," Boccaccini says. And many of the ceramic- or glass-based strategies to heal tissues actually combine them with organic materials, in polymer composites or hydrogels, for example.

Although bioactive glasses were discovered half a century ago, their potential within regenerative medicine is still being realized today. When in contact with body fluids, bioactive glasses dissolve and release ionic dissolution products such as biologically active ions within the body. Cells, in turn, respond to these ionic products, some of which stimulate growth of new blood vessels in the tissue, a process called angiogenesis. Blood vessels nourish developing tissue with oxygen and nutrients and remove waste products, so the angiogenic response is part of what makes bioactive glass so attractive for tissue repair.[20]

But ionic dissolution products also do more than stimulate angiogenesis—these products alter gene expression patterns in nearby cells, shifting signaling pathways that orchestrate every cellular function, such as cell migration, proliferation, and differentiation.

Although we are just beginning to unravel some of these biomolecular mechanisms, the potential exists for bioactive glass compositions and properties to catalyze a diverse array of cellular responses, precisely tuned to the target tissue and the desired effect in that tissue—whether that is modulating an immune reaction, prompting tissue regeneration, or stimulating release of growth factors to guide stem cell differentiation.

"Understanding genetic upregulation and activation by ionic stimuli released from bioactive glasses offers the possibility of developing patient-specific therapies, a huge challenge for the aging population," per a 2015 *Bulletin* article on bioactive glasses.[21]

One of the more familiar and clinically approved applications of bioactive glasses for soft tissues is in wound repair, with products such as a cotton candy-like borate bioactive glass fiber matrix to heal advanced wounds.[22]

CERAMICS USED IN DENTISTRY

Ceramics are ubiquitous in the $10.7 billion U.S. dental industry,[1] with applications in prosthetics, fillings, orthodontic appliances, cosmetic products, process materials, preventive products, toothpaste, and more. Below are some highlights of the roles that ceramics play in this industry.

Dental caries: From prevention to treatment

Dental caries, commonly known as tooth decay, is the most common bacterial disease of children and adults worldwide.[2] Formerly, tooth loss due to bacteria attacking the tooth enamel was inevitable, but advances in dental materials and techniques during the last few decades have greatly reduced chances of this outcome.

Plaque removal and teeth cleaning at home and by hygienists is the first line of defense against these bacteria. Toothpastes contain many ceramic powders ranging from stannous fluoride, potassium nitrate, and several calcium phosphate compounds. Bioactive glass is also present in some toothpastes, to promote remineralization of the enamel. Sodium bicarbonate is often used by hygienists to more thoroughly remove plaque, and pumice is sometimes used as well.

When bacterial attack progresses into the enamel, a dentist will seek to remove the softened tissue and restore tooth anatomy. Small to medium bacterial lesions (cavities) are treated with ceramic composite filling[a] material or glass polyalkenoate cement[b] material to restore the tooth form.

When the disease progresses into the pulp, a medication that induces the pulp tissue to build a protective barrier of reparative dentine is needed. Calcium hydroxide-containing materials used to be the standard material used for this purpose, but now tricalcium silicate cements, which are based on the same materials as white Portland cement, are the "gold standard." (These cements are set with a matrix that includes calcium hydroxide.)

If the pulp becomes irreversibly infected, a root canal procedure is required. In this procedure, the pulp is removed and is replaced by a combination of rubber points shaped like a root canal and sealed with another material. The trans-polyisoprene rubber points are usually filled with zinc oxide and barium sulfate. The sealing material comes in a variety of polymer and ceramic matrices, ranging from epoxy to zinc oxide–eugenol. The newest sealers are based on tricalcium silicate powders. Sometimes, glass fiber-reinforced composite posts are inserted in a root canal after a root canal procedure to help restore tooth function.

When a majority of the anatomy of a tooth is lost, the anatomy is restored with a crown. Gold foil and its alloys were the materials traditionally used for crowns, but in the 1950s, porcelain enameled crowns and bridges became the standard tooth restoration for severely damage teeth because of their greater durability and more natural aesthetic. Today, all-ceramic crowns—such as alumina, lithium disilicate, and yttria-stabilized tetragonal zirconia—are the most common crown type because of their strength, ease of fabrication, and aesthetics. Tetragonal zirconia with 3% yttria dominates this market due to its high strength, but zirconia with higher yttria formula are also in use due to better aesthetics, despite their diminished strength.

Whenever a temporary or permanent crown or bridge is placed, dental cements are needed. Numerous ceramic- and glass-containing dental cements are used in dentistry, but the original cements were all based on zinc oxide. More recently, glass-ionomer cements evolved from the original silicate filling materials in the mid 20th century and remain popular because of their temporary fluoride release, which deters caries from forming under a crown. Resin-modified glass-ionomer cements and compomers are also advantageous, by combining light-curable polymers from composites with limited fluoride ion release from the glass ionomers.

Tooth extractions: Replacing the missing teeth

Periodontal diseases and tooth fractures may lead to tooth extraction. Dental implants, or posts surgically placed into the jawbone, are increas-

[a] Urethane polymers filled with about 40–70% by weight of ceramic powders, which may include radiopaque glasses, fumed silica, or quartz in combination. Requires bonding agents such as silane and a polymer primer to induce adhesion.

[b] In other words, glass-ionomer, composed of fluoroaluminosilicate glass powder reacted with a polyacrylic acid liquid, which bonds to tooth structure. Used for restoring tooth anatomy plus permanent cementation of crowns, bridges, inlays, onlays, posts, and orthodontic appliances.

"But you can also think of internal wounds, such as adhesives with hemostatic ability for coating internal wounds where there is a lot of bleeding," Boccaccini says. "Here I think yet is an open area for the applications of [bioactive glass], either as a fiber or mesh or in composites."

As research continues to characterize how cells respond to the unique materials as well as the underlying biomechanisms of these responses, soft tissue applications of bioactive glass will also continue to expand.

Mo-Sci's Steve Jung says that bioactive glass is experiencing increasing integration in medical products due to the material's recognition as a "premium material" and its ability to intimately interact with tissues. Bioactive glasses are being combined with other materials to make new products as well as being integrated into existing products already on the market. "They're making these products better by the addition of bioactive glass," Jung says.

Jung says that in veterinary medicine, there also have been some indications that bioactive glass can also repair tendons and ligaments. "To me, that kind of outcome is really what gets you thinking about sports injury-type situations—if you blow a ligament, could we develop a technology to help to heal that back together?" he says.

Beyond being implanted within the human body to aid tissue regeneration, ceramic and glass materials can also be similarly used to grow tissues outside of the body, with the vision that these tissues could eventually be harvested and implanted into or on the body as appropriate.

"The possibilities for ceramic technologies for improving the health and wellbeing of mankind are vast," says Randel Mercer, chief technology officer at CoorsTek. "One exciting avenue CoorsTek has been working on is the use of engineered ceramic cell culturing devices. Our product, Cerahive, is used to grow human tissue cells in an environment that mimics the growth environment in the human body." These porous ceramic substrates line the bottom of a cell culture dish to support 3D cell cultivation, allowing in vitro growth of cell spheres (Figure 11). "The future potential to 'manufacture' specific tissues in the laboratory could be used as a source for repairing damaged tissue in humans," Mercer says.

LOOKING FORWARD—A GLIMPSE OF FUTURE HEALTHCARE

So what does the future of medical care look like, and how do biomaterials fit into that future?

---

ingly used to replace single teeth and to support bridges and dentures. Implants used to be exclusively titanium, sometimes with a hydroxyapatite (ceramic) coating. However, tetragonal zirconia is gaining popularity despite its higher cost due to its improved biocompatibility.

When implants are not possible, a partial or full denture may be made for a patient. Today, most dentures are composed of pressure formed acrylic base with injection molded acrylic teeth. However, in some regions of the world, porcelain teeth in an acrylic base remain popular. (Porcelain was the standard denture material in the early 20th century.)

Other applications: Brackets, abrasives, equipment

Orthodontic brackets are commonly made of stainless steel, but sapphire, tetragonal zirconia, and polycrystalline alumina (with no glass bonding) are also used to manufacture orthodontic brackets because of their aesthetic appeal (they make the brackets less obvious). Ceramic coatings such as rhodium oxide are also used on orthodontic wires to disguise the orthodontic device.

Diamonds, tungsten carbide, and alumina and silica abrasives are essential for dentistry to remove tooth structure and to polish or adjust any dental restorative or denture. Some abrasives are bound in rubber; others are used in paste form.

"Of course, most of the equipment used in dentistry would not be possible without ceramics, from microscopes and cameras to curing lights to air turbines handpieces; from piezoelectric devices, to general electronic devices, to office scheduling and case record software and computers," says Carolyn Primus, medical device consultant and the 2020 Larry Hench awardee for Bioceramics.

Future of dental ceramics

Biocompatibility is a top priority for medical devices, and ceramics excel in biocompatibility compared to polymers and metals. On the other hand, durability is a key concern for ceramic restoratives in dentistry, particularly composite ceramics. Current research on zirconia, for example, looks to optimize the strength and appearance of zirconia by exploring variations in the stabilizers for the tetragonal phase. Ceramic nanoparticles are another subject of much research, as nanoparticles offer a way to provide unique biological responses. Nanoparticles are not new in dentistry, however—silica nanoparticles have been used for decades in composites and toothpastes.

Compared to other fields, manufacturing in dentistry happens at a small scale. As such, "Dentistry often follows the innovations in other industries or adopts materials used in other fields," Primus says.

For example, computer-aided design and computer-aided manufacturing (CAD/CAM) are examples of innovations from other industries adopted for dental applications beginning in the 1980s.[3] CAD/CAM dentistry is becoming a widespread method for making ceramic dental crowns in a dental office.

Additive manufacturing is also being adopted for dentistry. Fabrication of dentures and temporary restorations are leading the way for additive manufacturing. Lithoz GmbH (Vienna, Austria) is helping to lead the adoption of additive manufacturing for dental purposes with their lithography-based CeraFab 7500 Dental and CeraFab System Series ceramic manufacturing machines. Ivoclar Vivadent (Schaan, Liechtenstein) is also exploring additive manufacturing with their PrograPrint PR5, a digital light processing-based stereolithography printer.

As these technical innovations allow people to retain more teeth, the dentistry field will continue to grow, and the opportunities for ceramic and glass materials along with it. ■

[1]Dental products & materials." *Freedonia Group*, January 2016. https://www.freedoniagroup.com/industry-study/dental-products-materials-3359.htm

[2]Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJ, Marcenes W, "Global burden of untreated caries: a systematic review and metaregression," *Journal of Dental Research*, **94**(5): 650–658 (May 2015). doi: 10.1177/0022034515573272

[3]Klim J and Corrales E. (2008). "Innovation in dentistry: CAD/CAM restorative procedures." https://www.semanticscholar.org/paper/Innovation-in-Dentistry-%3A-CAD-%2F-CAM-Restorative-Corrales/f80ede5fc034b50afe972b7b7e15435108c7c8d5#paper-header. Accessed on Oct. 29, 2020.

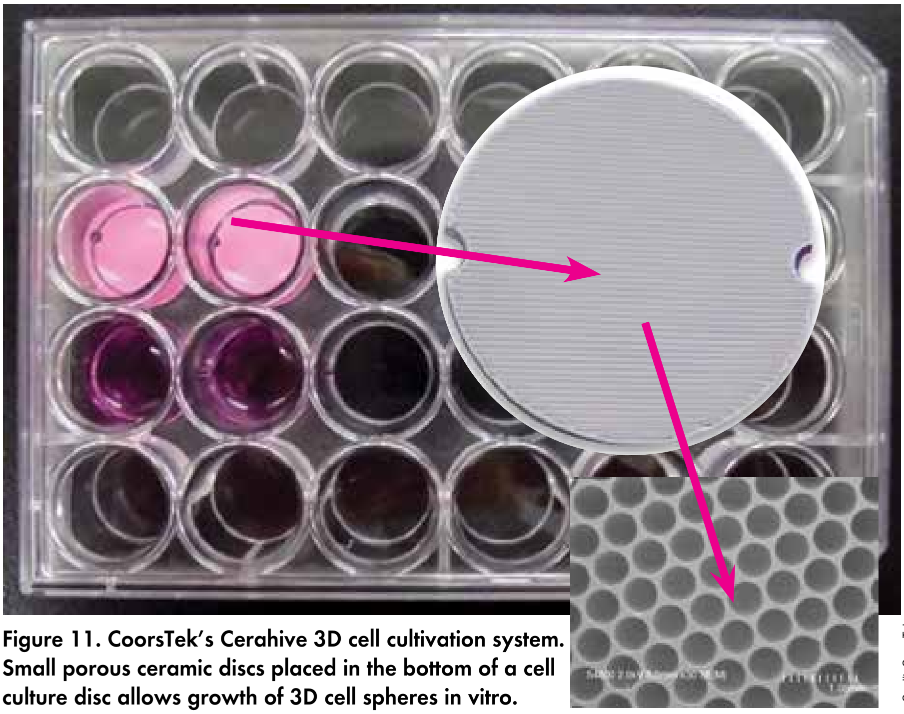


Figure 11. CoorsTek's Cerahive 3D cell cultivation system. Small porous ceramic discs placed in the bottom of a cell culture disc allows growth of 3D cell spheres in vitro.

Credit: CoorsTek

"The medical industry is constantly searching for new, better, and more cost-effective solutions, and advancements in the medical industry are moving at a pace so much faster than just a few years ago due to the introduction of advanced materials. With climbing healthcare costs combined with the move from inpatient to outpatient procedures, there is a pull from the market for better materials," says CoorsTek's Lucian Strong.

Ceramics and glass clearly fit into that future vision not only because of the role of established products such as joint implants but also due to entirely new forms and functionalities of the materials that are just starting to be discovered, realized, and matured.

"I absolutely believe that ceramics and bioactive glass have a really strong future, and their areas of use are going to diversify in a big way," says Mo-Sci's Steve Jung. "Bioactive glass is 50 years old, but we're still finding new ways to use it all the time. Old materials used in new ways or in combination with new techniques I think is the wave of the future."

Some of those new ways, combinations, and techniques are highlighted in this article, but potential extends much, much further as well.

One particular area ripe for future innovation is technologies that address multiple different tissues simultaneously. Although an isolated tissue-specific approach often guides biomaterial developments, components of the human body operate together in systems on several different scales.

"If you look at everything in isolation, there are solutions that already exist. They may not be the best solutions, but there are ways to treat individual tissues," says Dimension Inx's Adam Jakus. However, most injuries or conditions involve multiple tissues, so more complex solutions are often required.

"This has been a driving force for our technology for a long time, and we set up a manufacturing technology where all the materials are complementary to each other," Jakus says about Dimension Inx's 3D-painting platform. "So we can manufacture a bone material with a muscle material and with a ligament material, so that in the future you could make a multitissue implant."

Such strategies will inevitably need to leverage properties and strengths from multiple different materials. "This could be partially ceramic, partially polymer, partially biological, even partially things like graphene and graphite for electrical conductivity," Jakus adds. "So manufacturing different material types together to match the really different material types in the body."

Another systems-level approach that will certainly shape the future of healthcare is smart implants.

Miniaturization of devices, enabled by advances in the materials themselves, provided the feasibility for tiny sensors that can be implanted within the body to track an array of biological parameters on-demand. Such sensors provide the ability to track those parameters continuously, rather than sporadic measures taken at a doctor's office or hospital, and monitor for any changes that could signal a potential health problem. Such rich data provides a more comprehensive view of a patient's health as well as the ability to respond immediately to a potential disturbance in that health.

According to Schott's Jochen Herzberg, smart implants have a prominent place in the future of medical care not only because they provide better monitoring but also in terms of reducing healthcare spending, by reducing trips to the doctor or hospital and by informing more strategic medical intervention when necessary.

"A trend that is very visible right now is smart implants and remote monitoring of patients to reduce hospitalization. For example, in-line measurements of vital signs like blood pressure inside of your body, with smart computers inside your body communicating with your doctor without being hospitalized," Herzberg says.

Glass is already used in several different components of such devices, including hermetic seals, but its optical transmissivity offers compatibility in terms of data transmission (see sidebar: *Could future bandages not only be smart, but also made of glass?*).

Yet tiny implantable devices also can do more than just sense and monitor—they can also be designed with the capability to intervene as well, for instance by delivering a therapeutic.

"This is very fast moving technology. The idea is to replace conventional medical therapies with active implants so that you avoid overmedicating your whole body, for example by replacing

COULD FUTURE BANDAGES NOT ONLY BE SMART, BUT ALSO MADE OF GLASS?

Credit: Schott North America; YouTube

"The materials of the future must be smarter than ever," states a video from Schott's Opportunity lab.

The company is clearly giving top marks to ultrathin glass, as the video depicts a transparent glass bandage being directly applied to a cut in the skin.

In this concept, thin-film sensors are integrated into a small sheet of ultrathin glass, which can be applied directly to a wound to not only treat the wound and help it heal but also to transmit health data in real time.

Although the smart bandage is a concept idea, it plays into current medical trends toward connected devices and data-driven monitoring of health, with increasing use of sensors in and on the body to continuously measure diverse health parameters.

Yet although thin glass is flexible, it is still breakable—meaning that damaging this bandage could result in additional wounds beyond what the bandage was originally intended to treat.

However, according to Schott's website,[1] the company is not discounting the concept's potential. "Sounds utopian perhaps, but due to the special properties of glass, it could soon be a reality," the website says.

Watch the video at https://youtu.be/aSiJsGchvbw. ■

[1]Schott, https://www.us.schott.com/innovation/smart-glass

chronic pain relievers with very smart implants that are active only where the pain is created rather than influencing the whole body," Herzberg says.

Smart implants play into an overall health ecosystem increasingly focused on early detection and proactive intervention, before health conditions because problems and require more involved treatment.

These data-based monitoring strategies extend beyond implants as well, according to a Deloitte Insights report on the future of health.[23] "Medical products might no longer be limited to pharmaceuticals and medical devices. They could also include software, applications, wellness products, even health-focused foods. The home bathroom of the future, for example, might include a smart toilet that uses always-on sensors to test for nitrites, glucose, protein, and pH to detect infections, disease, even pregnancy. A smart mirror equipped with facial recognition might be able to distinguish a mole from melanoma," the report says.

Ultimately, the entire landscape of how we approach, monitor, manage, and mitigate human health is shifting. While these changes will not come without challenges to the market for biomaterials, they also offer incredible opportunity—and ceramics and glass are certainly well-positioned to capitalize on such opportunities as well as integrate critical function into the human body. ■

ACKNOWLEDGEMENTS

We thank Carolyn Primus for her review of and detailed suggestions for the section "Ceramics used in dentistry."

REFERENCES

[1] WorldoMeter, "Life expectancy of the world population." https://www.worldometers.info/demographics/life-expectancy. Accessed on Oct. 29, 2020

[2] United Nations, "Global issues: Ageing." https://www.un.org/en/sections/issues-depth/ageing

[3] BCC Research, "Global markets for implantable biomaterials (AVM118A)," January 2015.

[4] BCC Research, "Bioceramics: Technologies and global markets (AVM143A)," June 2017.

[5] Schott, "Enabling vision restoration with glass encapsulation," April 28, 2020. https://www.us.schott.com/english/news/press.html?NID=com5769

[6] A. Gocha, "Smart materials make smartphones: How ceramics and glass contribute to the $479B smartphone market," *American Ceramic Society Bulletin*, **97**(9): 11–23 (2018).

[7] World Health Organization, "Chapter 6: Priority diseases and reasons for inclusion – Osteoarthritis," In: Priority Medicines for Europe and the World Update Report, 2013. Available at: https://www.who.int/medicines/areas/priority_medicines/Ch6_12Osteo.pdf

[8] BCC Research, "Advanced orthopedic technologies, implants and regenerative products (HLC052D)," August 2018.

[9] American Academy of Orthopaedic Surgeons, "American Joint Replacement Registry Annual Report 2019," 2019.

[10] I. V. Antoniac (Ed.), "Handbook of bioceramics and biocomposites," Springer, 2016.

[11] "The Prozyr Femoral Ball Recall," *All Things Biomaterials*, September 23, 2017. http://allthings-biomaterials.org/archives/170#more-170

[12] M. Marcolongo, S. Sarkar, and N. Ganesh, "Trends in materials for spine surgery," *Comprehensive Biomaterials II*, **7**: 175–98 (2017). DOI: 10.1016/B978-0-08-100691-7.00269-X

[13] D. Bray, and B. McEntire "Silicon nitride—A ceramic surgical implant material," *American Ceramic Society Bulletin*, **99**(3): 32–5 (2020).

[14] T. J. McCue, "Additive manufacturing industry grows to almost $12 billion in 2019," *Forbes*, May 8, 2020. https://www.forbes.com/sites/tjmccue/2020/05/08/additive-manufacturing-industry-grows-to-almost-12-billion-in-2019/#36c737545678

[15] S. Geier, and I. Potestio, "3D-printing: From multi-material to functionally-graded ceramic," *Ceramic Applications* **8**: 32–4 (2020).

[16] A. E. Jakus, "Tissue engineering and additively manufactured ceramic-based biomaterials," *American Ceramic Society Bulletin*, **98**(4): 23–30 (2019).

[17] A. E. Jakus, A. L. Rutz, S. W. Jordan, A. Kannan, S. M. Mitchell, C. Yun, K. D. Koube, S. C. Yoo, H. E. Whiteley, C.-P. Richter, R. D. Galiano, W. K. Hsu, S. R. Stock, E. L. Hsu, and R. N. Shah, "Hyperelastic 'bone': A highly versatile, growth factor–free, osteoregenerative, scalable, and surgically friendly biomaterial," *Science Translational Medicine*, **8**[358], 358ra127 (2016). DOI: 10.1126/scitranslmed.aaf7704

[18] L. L. Hench, "The story of Bioglass®," *Journal of Materials Science: Materials in Medicine*, **17**: 967–978 (2006).

[19] BCC Research, "Tissue engineering and regeneration: Technologies and global markets (HLC101D)," June 2019.

[20] A. A. Gorustovich, J. A. Roether, and A. R. Boccaccini, "Effect of bioactive glasses on angiogenesis: A review of in vitro and in vivo evidences," *Tissue Engineering Part B Reviews*, **16**: 199–207 (2010).

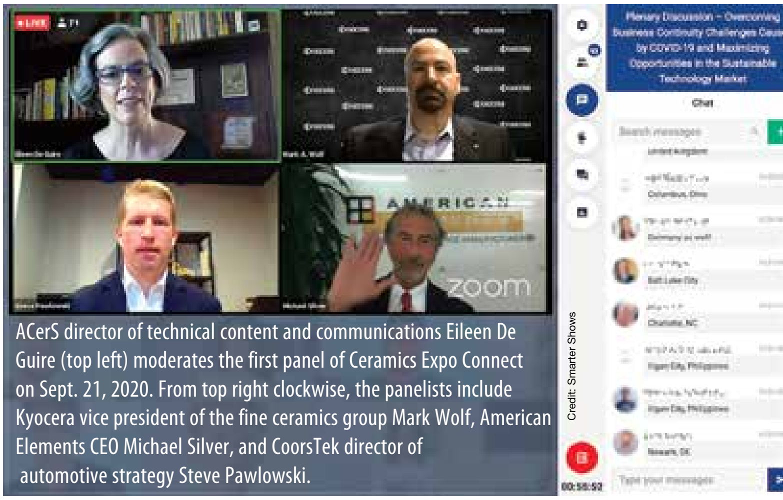
[21] V. Miguez-Pacheco, D. Greenspan, L. L. Hench, and A. R. Boccaccini, "Bioactive glasses in soft tissue repair," *American Ceramic Society Bulletin*, **94**(6): 27–31 (2015).

[22] P. Wray, "Cotton candy that heals? Borate glass nanofibers look promising," *American Ceramic Society Bulletin*, **90**(4): 25–9 (2011).

[23] Deloitte Center for Health Solutions, "Deloitte Insights: The future of aging," 2019. Available at: https://www2.deloitte.com/us/en/insights/industry/health-care/future-of-aging-aging-population-and-healthcare-industry.html

ceramics expo

Connect covers wide range of new and emerging ceramic applications



ACerS director of technical content and communications Eileen De Guire (top left) moderates the first panel of Ceramics Expo Connect on Sept. 21, 2020. From top right clockwise, the panelists include Kyocera vice president of the fine ceramics group Mark Wolf, American Elements CEO Michael Silver, and CoorsTek director of automotive strategy Steve Pawlowski.

Credit: Smarter Shows

How are manufacturers handling business during the COVID-19 pandemic? That question was at the core of many discussions during Ceramics Expo Connect, the virtual version of Ceramics Expo. The industry exposition, which typically takes place in the spring, took place instead from Sept. 21–25, 2020, and it welcomed more than 1,500 virtual event attendees and more than 150 exhibitors.

Each day of the exposition featured panels, interviews, and roundtables focused on different themes, including clean and electrified technology (Monday), additive manufacturing (Tuesday), aerospace applications (Wednesday), and quality and testing (Thursday).

The exposition kicked off Monday with a panel on overcoming business continuity challenges caused by COVID-19. The manufacturers on the panel say while there are still difficulties, overall some of the necessary workarounds enacted to handle the pandemic could prove useful in the future, such as facilitating business electronically and working from home.

On Tuesday, manufacturers again were future focused in their discussions of additive manufacturing. However, they did caution that additive manufacturing should not be treated as a solution to all processing challenges but rather as just another forming process.

With all the talk of future potential, Wednesday discussions focused on one area in which ceramics are already making a difference: aerospace. The first jet engines based on ceramic matrix composites were commercially deployed in 2016, and panelists suggested more aerospace opportunities for ceramic materials in the future, including in shrouds, liners, nozzles, and blades.

In contrast to the other three days, Thursday wrapped up the exposition with a focus on current processes and how to ensure material quality and testing. Experts from multiple fields offered their expertise, including representatives from vehicle manufacturing, scientific instruments for molecular research, and clay brick making. ■

First-ever

Ceramic Manufacturing Solutions Conference looks at latest trends in ceramic manufacturing industry

Andrea Ross (above) presents Dana Goski and Matthew Lambert (below) with this year's John E. Marquis Memorial Award.

Credit: ACerS

Current trends, applications, and processes in the ceramic manufacturing industry were the focus of the first-ever Ceramic Manufacturing Solutions Conference, which took place on Sept. 29, 2020. Originally scheduled to take place alongside Ceramics Expo in the spring, CMSC was rescheduled as a virtual event for the week after Ceramics Expo Connect in light of the ongoing pandemic.

Sixty-nine registrants from 13 countries, including 10 students, registered to attend the one-day event, which was organized into three main sessions: Testing, Quality, and Health & Safety; Ceramic Processing; and Raw Materials.

The day kicked off with a keynote presentation by Doug Freitag, technical director for government affairs at the United States Advanced Ceramics Association. Freitag spent time describing the history and current status of research on transparent ceramic armor and ceramic fiber reinforced ceramic matrix composites for gas turbines.

Following Freitag's presentation, ACerS director of meetings and marketing Andrea Ross presented Allied Mineral Products vice president of research & development Dana Goski and manager of special projects Matthew Lambert with this year's John E. Marquis Memorial Award, in recognition of their paper "Engineering resilience with precast monolithic refractory articles."

During the three main sessions, several topics were discussed in regard to each theme, including

• Occupational Safety and Health Administration citations and ASTM test methods for powder characterization under **Testing, Quality, and Health & Safety**.

• Failure modes & effects analysis, additive manufacturing considerations, silicon nitride production, and specific volume diagrams under **Ceramic Processing**.

• Electric arc fusion of mullite ceramics and the role of alumina in various applications under **Raw Materials**.

"Working in the manufacturing environment, the CMSC event exceeded expectations; the speakers and the content of their talks were both excellent. I'm excited for this event to continue," says coorganizer Keith DeCarlo of Blasch Precision Ceramics. ■

REGISTER TODAY!

VIRTUAL MEETING

ELECTRONIC MATERIALS AND APPLICATIONS (EMA 2021)

JAN. 19– 22, 2021

ceramics.org/ema2021

Organized by the ACerS Electronics and Basic Science Divisions

Electronic Materials and Applications 2021 (EMA 2021) is an international conference focused on electroceramic materials and their applications in electronic, electrochemical, electromechanical, magnetic, dielectric, biological and optical components, devices, and systems. Jointly programmed by the Electronics Division and Basic Science Division of The American Ceramic Society, EMA 2021 will be a virtual event on the same planned dates, Jan. 19–22, 2021.

EMA 2021 is designed for scientists, engineers, technologists, and students interested in basic science, engineering, and applications of electroceramic materials. Participants from across the world in academia, industry, and national laboratories exchange information and ideas on the latest developments in theory, experimental investigation, and applications of electroceramic materials.

Students are highly encouraged to participate in the meeting. Prizes will be awarded for the best oral and poster student presentations.

ORGANIZING COMMITTEE

ELECTRONICS DIVISION

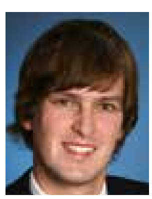
Xiong

Hui (Claire) Xiong
Boise State University
clairexiong@boisestate.edu

Andrew

Jennifer Andrew
University of Florida
jandrew@mse.ufl.edu

BASIC SCIENCE DIVISION



Rheinheimer

Wolfgang Rheinheimer
Technische Universität Darmstadt, Germany
wolfgang.rheinheimer@gmail.com

Garcia

Edwin Garcia
Purdue University
redwing@purdue.edu

SCHEDULE OF EVENTS

WEDNESDAY, JANUARY 20, 2021

Plenary session 1	9:45 – 11 a.m.
Concurrent technical sessions	11 a.m. – 4 p.m.
Networking session	4 – 5 p.m.

THURSDAY, JANUARY 21, 2021

Plenary session 2	10 – 11 a.m.
Concurrent technical sessions	11 a.m. – 5 p.m.
Student & Young Professionals networking session	5:30 – 6:30 p.m.

FRIDAY, JANUARY 22, 2021

Concurrent technical sessions	11 a.m. – 5 p.m.
Failure: The greatest teacher	5 – 6 p.m.

TECHNICAL PROGRAM

S1 – Characterization of Structure-Property Relationships in Functional Ceramics

S2 – Advanced Electronic Materials: Processing Structures, Properties, and Applications

S3 – Frontiers in Ferroic Oxides: Synthesis, Structure, Properties, and Applications

S4 – Complex Oxide Thin Films and Heterostructures: From Synthesis to Strain/Interface-engineered Emergent Properties

S5 – Mesoscale Phenomena in Ferroic Nanostructures: From Patterns to Functionalities

S6 – Emerging Semiconductor Materials and Interfaces

S7 – Superconducting and Magnetic Materials: From Basic Science to Applications

S8 – Structure-Property Relationships in Relaxor Ceramics

S9 – Ion-Conducting Ceramics

S10 – Point Defects and Transport in Ceramics

S11 – Dislocations in Ceramics: Processing, Structure, Plasticity, and Functionality

S12 – Evolution of Structure and Chemistry of Grain Boundaries and Their Networks as a Function of Material Processing

S13 – 5G Materials and Applications Telecommunications

S14 – Agile Design of Electronic Materials: Aligned Computational and Experimental Approaches and Materials Informatics

S15 – Functional Materials for Biological Applications

OFFICIAL NEWS SOURCES

REGISTER TODAY!

45TH INTERNATIONAL CONFERENCE AND EXPOSITION ON ADVANCED CERAMICS AND COMPOSITES

VIRTUAL MEETING

FEB. 8–12, 2021

ceramics.org/icacc2021

Organized by the Engineering Ceramics Division of The American Ceramic Society

The American Ceramic Society www.ceramics.org

Engineering Ceramics Division The American Ceramic Society

Due to uncertainty surrounding the current global pandemic, meeting organizers, along with the meetings team at The American Ceramic Society, have decided to move the 45th International Conference & Exposition on Advanced Ceramics & Composites meeting to a fully virtual format for 2021, running live sessions containing pre-recorded talks on a new date: Feb. 8–12, 2021. This conference will be the first-ever Virtual ICACC organized by ACerS Engineering Ceramics Division, and we would like for you to be a part of it.

This conference has a strong history of being the preeminent international meeting on advanced structural and functional ceramics, composites, and other emerging ceramic materials and technologies, and this year is no different.

The technical program will reflect the growth and success of ICACC by featuring 18 symposia, five focused sessions, one special focused session, and the 10th Global Young Investigator Forum. These technical sessions, consisting of both oral and poster presentations, will provide an open forum for scientists, researchers, and engineers from around the world to present and exchange findings on recent advances on various aspects related to ceramic science and technology. The technical program reflects critical areas of interest within ceramics and advanced composites, with a particular emphasis on current trends in research, development, engineering, and application of advanced ceramics.

Hisayuki Suematsu
Program chair, ICACC 2020
Nagaoka University of Technology, Japan
E-mail: suematsu@nagaokaut.ac.jp

Focused Sessions

- ❖ Special Focused Session on Diversity, Entrepreneurship, and Commercialization
- ❖ 10th Global Young Investigator Forum

FS1: Bio-Inspired, Green Processing, and Related Technologies of Advanced Materials

FS2: Materials for Thermoelectrics

FS3: Molecular-level Processing and Chemical Engineering of Functional Materials

FS4: Ceramic/Carbon Reinforced Polymers

FS5: Fractography of Ceramics

Symposia

S1: Mechanical Behavior and Performance of Ceramics and Composites

S2: Advanced Ceramic Coatings for Structural, Environmental, and Functional Applications

S3: 18th International Symposium on Solid Oxide Cells (SOC): Materials, Science, andTechnology

S4: Armor Ceramics – Challenges and New Developments

S5: Next Generation Bioceramics and Biocomposites

S6: Advanced Materials and Technologies for Rechargeable Energy Storage

S7: 15th International Symposium on Functional Nanomaterials and Thin Films for Sustainable Energy Harvesting, Environmental, and Health Applications

S8: 15th International Symposium on Advanced Processing and Manufacturing Technologies for Structural and Multifunctional Materials and Systems (APMT15)

S9: Porous Ceramics: Novel Developments and Applications

S10: Modeling and Design of Ceramics and Composites

S11: Advanced Materials and Innovative Processing Ideas for Production Root Technologies

S12: On the Design of Nano-laminated Ternary Transition Metal Carbides/Nitrides (MAX Phases) and Borides (MAB Phases), and Their 2D Counterparts (MXenes, MBenes)

S13: Development and Applications of Advanced Ceramics and Composites for Nuclear Fission and Fusion Energy Systems

S14: Crystalline Materials for Electrical, Optical, and Medical Applications

S15: 4th International Symposium on Additive Manufacturing and 3D Printing Technologies

S16: Geopolymers, Inorganic Polymers, and Sustainable Materials

S17: Advanced Ceramic Materials and Processing for Photonics and Energy

S18: Ultra-High Temperature Ceramics

Antonia Ressler
Guest columnist

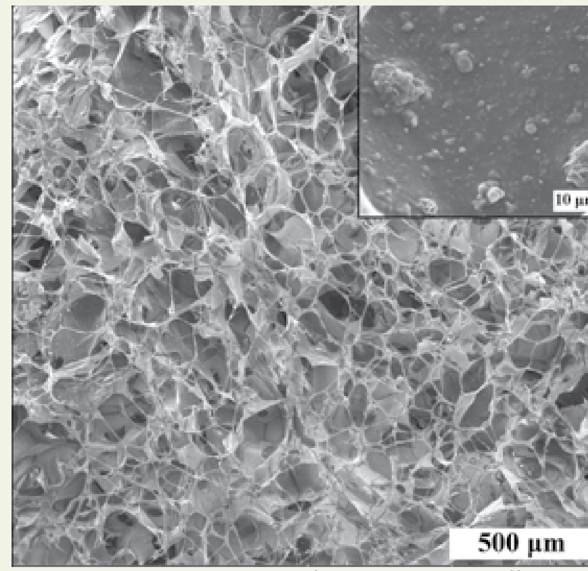
Biomimetic approach—the role of ions in bone regeneration

The challenge of bone tissue engineering (BTE) is to develop bone scaffolds that allow good integration with the surrounding tissues. Systems of particular interest are scaffolds based on calcium phosphates (CaP), mainly hydroxyapatite (HAp), due to its chemical and structural similarity to the inorganic matrix of natural bone and its excellent bioactivity.

Scientists have used growth factors in combination with CaP to enhance bone regeneration, but negative side effects such as ectopic or unwanted bone formation throw the safety of this approach into question.[1] An alternative way to adjust properties of synthetic materials is a biomimetic approach, in which various trace elements with a beneficial effect for bone formation are incorporated in CaPs.[1] The introduction of even small quantities of these ions may cause changes or improvements in the biological, physicochemical, or mechanical properties of scaffolds.

Researchers have extensively investigated CaPs substituted with strontium, magnesium, zinc, selenium, and carbonate ions.[1,2] Findings concerning each of these ions include

- **Strontium** (Sr^{2+}) stimulates bone formation by decreasing resorption activity and differentiation of osteoclasts, while at the same time increasing osteoblast proliferation and differentiation.
- **Magnesium** (Mg^{2+}) acts as a growth factor, especially in the early stage of bone formation, where it plays a key role in bone metabolism. It influences the osteoblast and osteoclast activity.
- **Zinc** (Zn^{2+}) is thought to have the same influence on osteoblast and osteoclast activity as strontium and magnesium. Furthermore, it has antimicrobial and anti-inflammatory properties. Due to that, zinc-substituted CaPs could be used as a coating for metal implants to reduce inflammatory response.[1,2]
- **B-type carbonate** (CO_3^{2-}) substitution is characteristic for biological apatite and thus is a highly interesting substitution in synthetic HAp. Furthermore, the CO_3-substitution enhances bioresorption and therefore osteogenic performance of synthetic material.[3]
- **Selenium** is an essential element for the proper functioning of bone tissue, with strong antioxidant properties. Selenium can induce tumor cell apoptosis while at the same time enhance the proliferation of healthy bone cells.[4] As such, many experiments involve selenium oxyanions (SeO_3^{2-} or SeO_4^{2-}), especially in bone cancer studies.



Credit: Antonia Ressler

Figure 1. SEM micrographs of highly porous scaffold based on biopolymer chitosan and hydroxyapatite multisubstituted with Sr^{2+}, Mg^{2+}, Zn^{2+}, Na+, CO_3^{2-}, and SeO_3^{2-} ions.

Though these results show the benefits of introducing trace elements in CaPs, scaffolds based on HAp still face some disadvantages, such as poor mechanical properties. To overcome these disadvantages, HAp has been combined with polymers to obtain composite scaffolds for bone regeneration.

The ongoing University of Zagreb research project "Development of biocompatible hydroxyapatite-based materials for bone tissue engineering applications" supported by the Croatian Science Foundation investigates highly porous scaffolds based on biopolymer chitosan and multisubstituted HAp (Figure 1). Initial results show multisubstituted scaffolds have better osteogenic properties compared to nonsubstituted scaffolds, confirming the importance of trace elements in BTE.

Currently, I am one of the researchers involved with this research project. In the future, we plan to investigate the efficacy of selective laser sintered bioinspired scaffolds for bone tissue engineering as well.

References

[1]S. Bose, G. Fielding, S. Tarafder, A. Bandyopadhyay. "Understanding of dopand-induced osteogenesis and angiogenesis in calcium phosphate ceramics," *Trends in Biotechnology*, Vol. 31, pp. 594–605, Oct. 2010.

[2]E. Boanini, M. Gazzano, A. Bigi. "Ionic substitutions in calcium phosphates synthesized at low temperature," *Acta Biomaterialia*, Vol. 6, pp. 1882–1894, June 2010.

[3]D. L. Goloshchapov, V. M. Kashkarov, N. A. Rumyantseva, P. V. Seredin, A. S. Lenshin, B. L. Agapov, E. P. Domashevskaya. "Synthesis of nanocrystalline hydroxyapatite by precipitation using hen's eggshell," *Ceramics International*, Vol. 39, pp. 4539–4549, May 2013.

[4]V. Uskoković, M. Adiraj Iyer, V.M. Wu. "One ion to rule them all: the combined antibacterial, osteoinductive and anticancer properties of selenite-incorporated hydroxyapatite," *Journal of Materials Chemistry B*, Vol. 5, pp. 1430–1445, Jan. 2017.

Antonia Ressler is a recent doctoral graduate from and now researcher in the Faculty of Chemical Engineering and Technology at the University of Zagreb, Croatia. Her research focuses on biomimetic scaffolds for bone tissue regeneration. She is currently a committee member of the Young Ceramists Network, an initiative of the European Ceramic Society sponsored by the JECS Trust.

Ceramic & Glass MANUFACTURING

DECEMBER 2020 • VOLUME 1 • ISSUE 5

www.ceramics.org/ceramicandglassmanufacturing

SETTING THE STANDARDS: HOW STANDARDS ENHANCE QUALITY AND PROMOTE RELIABILITY

JAPAN FINE CERAMICS ASSOCIATION AND ITS INTERNATIONAL STANDARDIZATION ACTIVITIES FOR FINE CERAMICS

A SHORT LIST OF STANDARDS-DEVELOPING ORGANIZATIONS

CONTENTS

Ceramic & Glass MANUFACTURING

Vol. 1, No. 5

Executive Director & Publisher
Mark Mecklenborg

Editorial & Production
Eileen De Guire
Director of Technical Content and Communications
edeguire@ceramics.org

David Holthaus
Content Editor
dholthaus@ceramics.org

Lisa McDonald
Associate Managing Editor

Tess Speakman
Senior Graphic Designer

Kerry Burgdorfer
Graphic Designer

Michelle Martin
Production Editor

Customer Service & Circulation
ph: 866-721-3322 **fx:** 240-396-5637
customerservice@ceramics.org

Advertising Sales
National Sales
Mona Thiel, National Sales Director
mthiel@ceramics.org
ph: 614-794-5834 **fx:** 614-794-5822

Europe
Richard Rozelaar
media@alaincharles.com
ph: 44-(0)-20-7834-7676 **fx:** 44-(0)-20-7973-0076

Editorial & Advertising Offices
The American Ceramic Society
550 Polaris Pkwy., Suite 510
Westerville, OH 43082

Ceramic & Glass Manufacturing is published four times per year by The American Ceramic Society. The American Ceramic Society is not responsible for the accuracy of information in the editorial, articles, and advertising sections of this publication. Publication of articles does not comprise endorsement, acceptance, or approval of the data, opinions, or conclusions of the authors on the part of the Society or its editors. Readers should independently evaluate the accuracy of any statement in the editorial, articles, and advertising sections of this publications. Vol. 1, No. 5, pp 1–18.

INDUSTRY NEWS

ENPRO AGREES TO BUY OPTICAL FILTER AND COATINGS MAKER

Charlotte, N.C.-based EnPro Industries, Inc. agreed to acquire Alluxa, Inc., a privately held, Santa Rosa, Calif.-based company. Alluxa is an industrial technology firm that provides optical filters and thin-film coatings for applications in the industrial technology, life sciences, and semiconductor markets. EnPro is financing the transaction with cash and rollover equity from Alluxa executives. The purchase price is $255 million, including rollover equity. EnPro says it has a strategy to grow by acquisition in attractive markets.

North Carolina-based EnPro employs about 6,000 people.

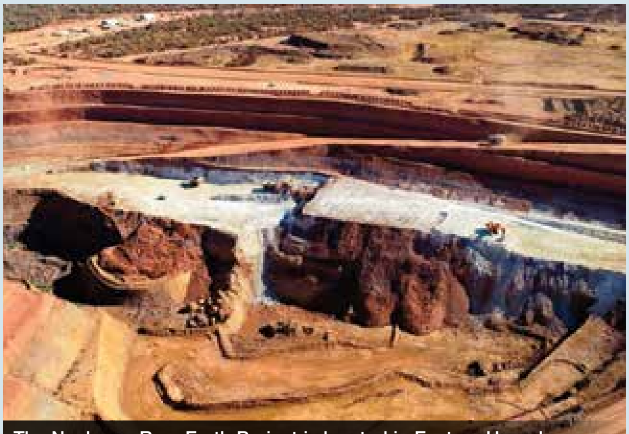
The latest transaction follows two agreements Total signed in February to develop nearly two gigawatts of solar projects in Spain.

TOTAL AGREES TO BUILD SOLAR PROJECTS IN SPAIN

French energy company Total SE reached an agreement with Spanish developer Ignis to build 3.3 gigawatts of solar projects in Spain. The first projects are scheduled to start in 2022, with the rest expected to be in production by 2025. The transaction will bring Total's portfolio of solar projects under development in Spain to more than five gigawatts by 2025, contributing to Spain's goal of generating 70% of its electricity from renewables by 2030 and 100% by the middle of the century.

ALTONA ENERGY ACQUIRES MAJORITY STAKE IN RARE EARTH PROJECT

Australia-based Altona Energy, a mining exploration company with a focus on rare earth element projects in Africa, signed an agreement with Leadway Group Ltd. to acquire a 70% interest in a greenfield project in Uganda, the Nankoma Rare Earth Project. Altona says it wants to build a portfolio of rare-earth sites in Eastern and Central Africa. When the agreement is final, Altona will be responsible for completing a feasibility study on establishing a commercial-scale, rare-earth mining and processing operation at the site. Altona will also be the manager and operator of the project.



The Nankoma Rare Earth Project is located in Eastern Uganda.

SIEMENS, UNIVERSITY OF NEW MEXICO COLLABORATE ON RENEWABLE ENERGY

Siemens Industry and the University of New Mexico signed an agreement to collaborate on integrating renewable energy systems and microgrids. The agreement is centered around a University-owned microgrid. The microgrid assets include facilities such as a cooling tower, thermal storage tank, battery energy storage system, fuel cell, photovoltaic system, and a natural gas generator. The university is part of a statewide consortium that received a five-year, $20 million grant in 2018 to modernize the electrical grid. Its microgrid facilitates research into power system modernization, renewable energy systems, smart grids, and smart cities.

The university's microgrid was built partly to test new smart-grid technologies.

MORE INDUSTRY NEWS

BERLIN PACKAGING ACQUIRES NETHERLANDS-BASED COMPANY

Berlin Packaging announced the acquisition of Vinkova B.V., a Netherlands-based glass packaging supplier with expertise in the food and beverage sectors. The transaction is Berlin's eighth acquisition in Europe since 2016. "Continued expansion in Europe is a central tenant of Berlin Packaging's overall growth strategy," says Bill Hayes, CEO and president of the Chicago-based company. The company says all Vinkova employees and locations would be retained. Financial details were not disclosed.

Berlin Packaging maintains more than 130 sales and warehouse locations, and design and innovation centers on two continents.

SANDVIK JOINS GE ADDITIVE BETA PROGRAM

GE Additive announced that Sandvik Additive Manufacturing joined its Binder Jet beta partner program. Sandvik has a broad alloy program for additive manufacturing on the market, marketed under the Osprey brand. The GE program uses its industrialized additive technology with technical partners to grow its Binder Jet technology. GE says the first phase involves developing the beta system into pilot lines, and eventually into a commercially available factory solution in 2021.

Sandvik is a Stockholm, Sweden-based company with about 40,000 employees.

GUARDIAN GLASS COMPLETES STARTUP OF PLANT IN POLAND

Guardian Glass completed starting up its second float glass facility in Częstochowa, Poland, to help meet the demand for high-performance coated and fabricated glass products in Eastern Europe. The plant hosts two float lines, two coater lines, and a lamination line. Headquartered in Auburn Hills, Mich., Guardian Glass has six float glass plants in the United States and one in Mexico, as well as many fabrication facilities and warehouses. Guardian Glass companies also operate ten float glass plants across Europe and Russia.

The Częstochowa plant represents Guardian's biggest greenfield capital investment in its history, the company says.

The Made In Space ceramics manufacturing module team.

CERAMIC MANUFACTURING MODULE HEADED TO SPACE STATION

Made In Space plans to launch a ceramic manufacturing module to the International Space Station. The technology is a commercial, in-space manufacturing device designed to provide proof-of-potential for single-piece, ceramic turbine blisk (blade and disk) manufacturing in microgravity for terrestrial use. This project marks the first ceramic facility on the ISS. Made in Space says the module will demonstrate the viability of manufacturing with preceramic resins in an additive, stereolithography environment. Made In Space is developing the technology with technical partners HRL Laboratories of Malibu, Calif., and Sierra Turbines of San Jose, Calif.

SETTING THE STANDARDS: HOW STANDARDS ENHANCE QUALITY AND PROMOTE RELIABILITY

By David Holthaus

Standards in manufacturing are essential to ensuring quality products and to improving the accuracy and reliability of the materials used to make them.

They are also critical to promoting the safety of those who use the products, and sometimes it can literally be a matter of life and death.

In 2018, after two years of work, a committee of ASTM International, one of the world's largest standards-developing organizations, published requirements for bullet-resistant doors on police vehicles.

The standard called for door panels to be made from a combination of ceramic and fabric, with the ceramic material acting as the strike face to break bullets that were made with steel cores. Such ammunition was increasingly being used in the high-powered weaponry that police were encountering on the streets, according to ASTM. Panels made with basic, armored steel often would not stop bullets with steel cores.

The new specification standardized protection levels and included language to help public safety agencies retrofit their vehicles or buy new ones with the safer ceramic-fabric panels.

It was a dramatic example of how standards evolve to keep up with new technology, materials, and processes.

Perhaps not as dramatic, but equally important in terms of safety and reliability, is the development and evolution of standards used to make refractories, the materials used to build structures routinely subjected to high temperatures.

The ASTM International Committee C08 on Refractories was founded in 1914. Over its history, the committee has defined what a refractory is, clas-


ASTM International's headquarters in West Conshohocken, Pa.
Credit: ASTM International

sified them by type and function, and defined tests to determine their suitability for specific applications.

In the early decades of the committee's existence, refractories were used to build the linings of fireplaces, kilns, and stills, among other applications. By the end of the 20th century, refractories were used to line nuclear reactors and in the manufacturing of reentry heat shields for space shuttles.

The new uses demanded standardized tests to benchmark performance and to help evaluate and develop new materials.

Bill Headrick has been involved with creating and refining ASTM standards for more than 30 years, and he is currently working with Committee C08 as the chair of the technical subcommittee on monolithics.


Standards for the production of refractories have evolved since 1914. *Credit: RHI Magnesita*

Headrick is head of research and development for aluminosilicate products for the Americas at RHI Magnesita, the world's largest refractories company.

There are more than 100 standards relating to refractories alone, and the manual on refractory standards is nearly an inch thick, Headrick says. Committee members are engaged in a continuous process of evaluating and reviewing the standards to make sure they are up to date. In August alone, Headrick says the committee reevaluated six standards.

"The biggest thing is making sure we're using the best available methods," he adds.

For example, for years, the only method for determining the chemistry of materials was wet chemistry, and the relevant standards only addressed those methods. "Now, we have X-ray fluorescence, X-ray diffraction, mass spectroscopy, and we've had to rewrite our standards to take into account these better methods that give better results," he says.

The committee is currently doing a lot of work to make standards safer, Headrick says, and to have them align with the health and safety requirements of employers.


Bill Headrick
RHI Magnesita

Some of the standards for measuring chemistry use materials that are considered hazardous to health, leading the committee to look for alternative materials that are safer and can produce similar results.

"That's the biggest evolution going on," he says. "We're going through all the standards and making sure they're as safe as possible."

It is a deliberative process.

Every five years, ASTM standards must be reviewed and reapproved by the appropriate subcommittee and then by the main committee. Any negative comment about the proposed standard must be resolved before the standard can be approved.

"To pass a standard, you have to eliminate every single negative," Headrick says. "Once everyone is in full, 100 percent agreement, then the standard is published. That can take a matter of months to a number of years."

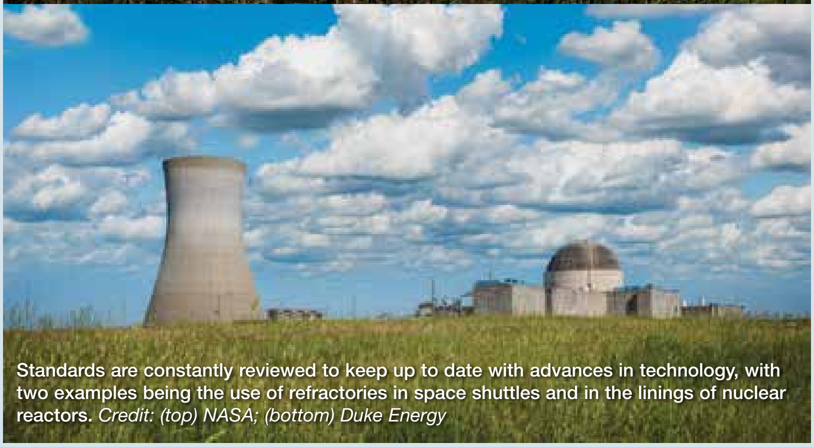
For several years now, ASTM committees and subcommittees have worked on the standardization of the growing and developing field of additive manufacturing, the process of fabricating parts and components layer by layer using computer-aided design rather than traditional manufacturing methods.

Improved technology, advanced equipment and sensors, and more suitable materials are driving the productivity and reliability of additive manufacturing production, yet the rapid change has pointed up the need for standardization, says Mohsen Seifi.

Seifi is ASTM's director of global additive manufacturing programs, responsible for additive manufacturing programs that support standards development and other products and services at the organization. He also oversees its Additive Manufacturing Center of Excellence, which has the mission to bridge the gap between standardization to research and development.

By 2008, the nascent additive manufacturing industry had reached the point where standards were needed.

"Without standards, it's going to be the Wild West," Seifi says. "Industry needs standards for rapid implementation of this technology for critical applications."



Standards are constantly reviewed to keep up to date with advances in technology, with two examples being the use of refractories in space shuttles and in the linings of nuclear reactors. *Credit: (top) NASA; (bottom) Duke Energy*

Additive manufacturing's shortened development cycle and more efficient process means products can be designed and produced more quickly, but standardization is necessary to create consistency and reliability, and to serve as a foundation for continued growth.

"Innovation is inevitable, but without having standards in place, you can't really drive this technology forward in terms of full implementation and adoption to satisfy regulation," Seifi says.

"The reason is very clear," he adds. "You need to make sure we're all communicating the same language and making products in a repeatable and reliable fashion."

Mohsen Seifi, ASTM International

ASTM's committee on additive manufacturing technologies has met since 2009 and now has more than a thousand members from more than 35 countries who have developed standards that support the application and adoption of additive manufacturing for diverse materials and processes across various industry sectors.

In 2011, ASTM International and the International Organization for Standardization (ISO) signed an agreement paving the way to create joint additive manufacturing standards in order to increase collaboration and minimize duplication of efforts.

"If you are a user of this technology interested in fabricating parts and components, are you going to receive the same results if you produce a part at a service provider in the U.S. versus Europe versus Asia?" Seifi says. "That's where standards play a critical role to make sure we manufacture products in a consistent, reliable, and repeatable manner."

Another key reason for standards is to facilitate certification of additively manufactured parts from regulatory bodies such as the Federal Aviation Administration, NASA, Department of Defense, Food and Drug Administration, and many others.

"Once a standard is out, it has the potential to become part of regulatory frameworks and can get into federal codes and referred to in federal contracts," Seifi says.

One of the key trends on additive manufacturing standardization is understanding the challenges the technology brings in regard to data management and schema, Seifi says. The 3D printers and their sensors can generate gigabytes, sometimes terabytes, of data. "The question is, what data to collect according to what standard and format and why?" he says. "Is that data you collect findable, accessible, and reusable? Does it make sense to capture that data, and using what standard method? What kind of intelligence can we generate from the data to improve the process?"

"There are major standard gaps in this space that ASTM is trying to fill," he adds.

In the cases of newer technologies such as additive manufacturing, and older processes such as refractory production, standards have helped advance processes, improve quality, and enable those production methods to be used reliably in a growing range of industries and applications.

A short list of standards-developing organizations

There are many organizations in the U.S. and around the world that work to develop standards for their industries. Here are some that apply to manufacturing:

- **The Association for Manufacturing Technology**
Based in McLean, Va., the association promotes the interests of American manufacturing machinery and equipment, including the standardization of technology used to run machines. www.amtonline.org

- **The American Nuclear Society**
Based in LaGrange Park, Ill., the Society advances the development of nuclear science, engineering, and technology, and maintains a standards committee and board. www.ans.org

- **The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)**
Based in Atlanta, Ga., the Society focuses on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability through research, standards writing, publishing, and continuing education. www.ashrae.org

- **American Society of Mechanical Engineers**
Based in New York City, N.Y., the Society enables collaboration and skills development across engineering disciplines through programs in continuing education, training and professional development, codes and standards, research, and conferences and publications. www.asme.org

- **ASTM International**
Formerly known as American Society for Testing and Materials, ASTM International is an international standards organization that develops and publishes consensus technical standards for a range of materials, products, systems, and services. It is headquartered in West Conshohocken, Pa., outside of Philadelphia. www.astm.org

- **International Code Council**
Based in Washington, D.C., the Council is an association of building safety professionals and a source of model codes and standards that establish baselines for building safety. www.iccsage.org

- **The International Organization for Standardization (ISO)**
Headquartered in Geneva, Switzerland, ISO is an international standard-setting body composed of representatives from various national standards organizations. It promotes worldwide proprietary, industrial, and commercial standards. www.iso.org

- **The International Committee for Information Technology Standards (INCITS)**
Based in Washington, D.C., this committee is a standards development organization composed of information technology developers. www.incits.org

- **The International Society of Automation**
Based in Research Triangle Park, N.C., the Society is a technical society for engineers, technicians, businesspeople, educators, and students, and it sets standards for industry professionals in automation. www.isa.org

- **National Institute of Standards and Technology (NIST)**
Headquartered in Gaithersburg, Md., NIST is a nonregulatory federal agency within the U.S. Department of Commerce that develops and disseminates standards that allow technology to work seamlessly and business to operate smoothly. www.nist.gov

- **NSF International**
Based in Ann Arbor, Mich., NSF International has developed more than 80 public health and safety standards, and tests and certifies products to verify they meet those standards. www.nsf.org

- **SAE International**
Previously known as the Society of Automotive Engineers, Warrendale, Pa.-based SAE International is a standards-developing organization for engineering professionals in various industries. Its principal emphasis is on global transport industries, such as aerospace, automotive, and commercial vehicles. www.sae.org

- **UL**
Formerly known as Underwriters Laboratories, UL is a global safety certification company headquartered in Northbrook, Ill. It is approved to perform product safety testing by the U.S Occupational Safety and Health Administration. www.ul.com

JAPAN FINE CERAMICS ASSOCIATION AND ITS INTERNATIONAL STANDARDIZATION ACTIVITIES FOR FINE CERAMICS

By Hirofumi Takemura

Japan Fine Ceramics Association (JFCA) was established in 1986 with a mission to promote the development of the fine ceramics/advanced ceramics industry. To take advantage of the most advanced technologies of fine ceramics, overall collaboration of manufacturers, users, universities, and research laboratories is required, together with the fusion of other materials.

The members of JFCA are 104 companies from different industries, such as ceramics, chemicals, metals, automobiles, electronics, power supply, and service. Through various activities, JFCA brings together and promotes cooperation among government, industry, academia, and overseas countries for the further expansion of the fine ceramics industry. The United States Advanced Ceramics Association (USACA), European Ceramics Center (PEC), and Ceramics Application are cooperating members of JFCA.

There are technical committees and consortiums in JFCA. Committees operate research groups such as Solid Oxide Fuel Cells, Power Electronics, GaN, LED, Bioceramics, Optical Ceramics, Material Function Predictive Simulation, Advanced Coating Alliance, and Ceramics Matrix Composites Consortium. In September, Fine Ceramics Roadmap 2050 Study Group was launched, which will publish the latest Roadmap in both Japanese and English versions in December 2021.

Figure 1. Fine ceramics production in Japan.
Credit: Japan Fine Ceramics Association

Figure 1 shows the amount of fine ceramics production in Japan, which reached $30 billion in 2018.[1]

The benefits of standards for worldwide industries are extensive.[2] Standards help manufacturers reduce costs, anticipate technical requirements, and increase productive and innovative efficiency. Standards make trade across international borders easier and promote global competition, having a positive impact on economies.

Standards provide consumers with confidence in the quality and safety of products and services. In a global economy of rapidly emerging new technologies and markets, standards help set the rules and establish the frameworks, making it easier to innovate successfully.

ISO international standards help businesses of any size and sector reduce costs, increase productivity, and access new markets. Standards can help to

- Build customer confidence that the products are safe and reliable;
- Meet regulation requirements, at a lower cost;
- Reduce costs across all aspects of a business;
- Gain market access across the world;
- Improve quality, safety, and lead time of products and services;
- Lower research and development costs and improve speed to market by building on previously standardized technology or systems; and
- Provide uniformity of units measurement, enabling accuracy and confidence in commercial transactions locally and globally.

THE ROLE OF JFCA

JFCA conducts surveys and research to promote the international standardization of fine ceramics. JFCA, as a drafting organization in the field of fine ceramics, is making international standards for high-quality, safe, secure, and highly reliable fine ceramic materials.

JFCA holds the secretariat of ISO/TC206 (Fine Ceramics) and ISO/TC150/SC7 (Tissue-engineered Medical Products) under the Japanese Industrial Standards Committee. In addition, as a national committee for ISO/TC206 and ISO/TC150 (Implants for Surgery) in Japan, we are engaged in deliberating proposals for new work items, development of projects in Japan and other countries, and maintenance and management of issued ISO standards.

Figure 2. Conventional standardization model. *Credit: Japan Fine Ceramics Association*

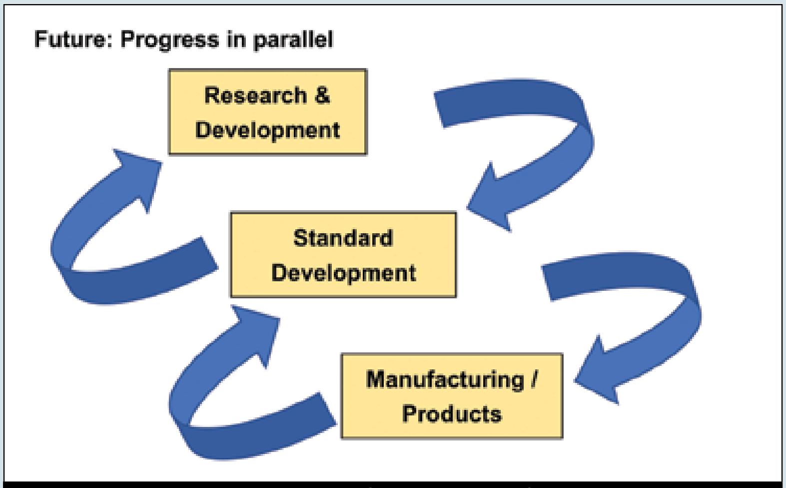


Figure 3. Future standardization model. *Credit: Japan Fine Ceramics Association*

ACCELERATION OF STANDARDIZATION SPEED

The speed of technological development increases to popularize new technologies globally. The conventional model shown in Figure 2, "Research & Development-Standard Development-Manufacturing / Products," cannot catch up with its speed.

It is necessary to proceed with R&D and standard development at the same time and connect it to global manufacturing.

As shown in Figure 3, loop-shaped parallel development becomes the most effective way to establish standardization.[3]

ABOUT INTERNATIONAL STANDARDS ORGANIZATION

International standards are published by international standardization bodies; three organizations are the representative. International Organization for Standardization (ISO) establishes international standards in a wide range of fields, except the fields of electricity, electronics, and communications. International Electrotechnical Commission (IEC) establishes international standards in the fields of electricity and electronics, and International Telecommunication Union (ITU) establishes international standards in the fields of communication, broadcasting, and information technology.

ISO is currently divided into 333 technical committees that deliberate and manage international standardization. The international standards for fine ceramic materials mainly belong to two committees: ISO/TC206 (Fine Ceramics) and ISO/TC150 (Implants for Surgery).

ISO/TC206 standardizes various forms and functions of fine ceramics. Japan is the secretariat of this committee and has a committee manager. The chair is from South Korea. The ISO/TC206 scope states as follows[4]: Standardization in the field of fine ceramics materials and products in all forms: powders, monoliths, coatings and composites, intended for specific functional applications including mechanical, thermal, chemical, electrical, magnetic, optical, and combinations thereof. The term "fine ceramics" is defined as "a highly engineered, high performance, predominantly non-metallic, inorganic material having specific functional attributes."

Note: Alternative terms for fine ceramics are advanced ceramics, engineered ceramics, technical ceramics, or high-performance ceramics.

The ISO/TC206 strategic business plan has the following description[4]:

World demand for fine ceramics is projected to expand to $75 billion in the year 2020.

In order for the fine ceramics industry to further grow to contribute to the 21st century as a new materials industry, the following issues have to be overcome.

- Further promotion of research and development in terms of the material itself, development of new uses and application technologies.
- Research on manufacturing processes, and cost-reduction through corporate efforts.
- Establishment of testing and evaluation methods and standardization of the methods to prepare a basis for research and development, application, and utilization.
- Promoting international cooperation in the fields of research and development, and standardization.

Table 1 shows the composition of ISO/TC206, the number of ISO registrations, and the number under development. ISO/TC206 is divided into more specialized working groups (WGs) from WG1 to WG12. Since the committee's inception in 1992, 136 standards have been issued. In recent years, about 10 new standards were published each year. In addition, there are 18 items under development.

WG	Title	Published Standards	Standards under development
WG1	Terminology/Classification	2	1
WG2	Powders	16	0
WG3	Chemical analysis	4	3
WG4	Composites	22	2
WG5	Porous ceramics	4	0
WG6	Monolithic ceramics/Mechanical properties	20	0
WG7	Monolithic ceramics/Physical and thermal properties	10	1
WG8	Joining	4	0
WG9	Photocatalysis	28	3
WG10	Coatings	16	2
WG11	Electrical and optical applications	6	3
WG12	Engineering applications	4	3
ISO/TC206		136	18

Table 1. ISO / TC206 structure, number of published standards and standards under development

SC/WG	Title	Published Standards	Standards under development
SC1	Materials	37	7
SC2	Cardiovascular implants and extracorporeal systems	33	11
SC4	Bone and joint replacements	36	5
SC5	Osteosynthesis and spinal devices	26	9
SC6	Active implants	16	2
SC7	Tissue-engineered medical products	4	0
WG1-15		14	5
ISO/TC150		166	39

Table 2. ISO/TC150 structure, number of published standards and standards under development

New work-item proposals are deliberated by experts in the relevant working groups depending on the technical field. After approval of new business-item proposals, deliberation and approval proceed by passing through the stages of working draft, committee draft, draft international standard, and final draft international standard, to the goal of being published. It takes about three years to complete the process.

ISO/TC206 is currently composed of Participating Members from 14 countries (nine countries in Europe; five countries in Asia) and Observer Members from 20 countries. Participating Members have the right to vote and can elect experts to actively participate in the proposed project.

ISO/TC206 holds a plenary meeting once a year where member countries can participate. This year, it was scheduled to be held in Brussels, Belgium, but due to the COVID-19 pandemic, the face-to-face conference was canceled, and a web conference was held by Japan. The plenary meeting is a valuable opportunity for experts on global standardization to gather once a year, but it was a shame it was canceled. It is scheduled to be held in France in 2021 and in Belgium in 2022. Japan took the role as host country in the first, tenth, and twentieth plenary meetings. 2023 will be the thirtieth meeting, and we would like to hold the meeting in Kyoto, Japan.

ISO/TC150 is a committee related to surgical implants. It includes bioceramics such as artificial bones and dental implants, which overlap with the field of fine ceramics. Germany is the chair of TC150, and Japan holds the secretariat of TC150/SC7.

The ISO/TC150 scope states as follows[5]:

Standardization in the field of implants for surgery and their required instrumentation, covering terminology, specifications, and methods of tests for all types of implants, and for the materials both basic and composite used in their manufacture and application.

The ISO/TC150 configuration is divided into specialized fields: subcommittee (SC) from SC1 to SC7, and working groups from WG1 to WG15. Since its inception in 1971, the technical committee has issued 166 standards, and 39 standards are under development.

ISO/TC150 currently consists of Participating Members from 29 countries, and Observer Members from 17 countries.

RECENT INTERNATIONAL STANDARDIZATION ACTIVITIES

New work-item proposals were made from Japan to ISO/TC206 in 2020. Two proposals were made regarding the thermal characteristics evaluation method for ceramic substrates for power modules, and one proposal was made regarding the evaluation method for power generation characteristics of piezoelectric materials. One new work-item proposal was approved for a ceramic substrate for a power module, and it is currently at working draft stage.

The market size of power modules was 420 billion yen in 2019, and it is projected to be 570 billion yen in 2025 (140% of 2019). The core technology for ensuring the long-term reliability of power modules is the high-temperature resistance of power semiconductors. More specifically, it is heat that controls the change over time, and the ambient temperature and heat generated by driving the element contribute as heat sources.

We have strategically promoted the world's first international standardization of the method for measuring the thermal properties of ceramic substrates for power electronics, which is a key element of next-generation power semiconductors.

In addition, JFCA is promoting a research project to develop international standardization of fine ceramics as a preliminary step to propose new work-item proposals to ISO. We are working on about six projects a year. Each project takes three years to research, prepare a standardization draft, and make a new proposal to ISO.

The following projects are underway as ongoing research and research projects.

- Test method for GaN crystal surface defects.
- Strength reliability test method for ceramic materials for solid oxide fuel cells (SOFC).
- Corrosion-resistant test method for fine ceramic thin films.
- Optical characteristic evaluation method for ceramic phosphors for white LEDs.
- Test method for thermal characteristics of insulating substrates for power electronics.
- Mechanical property test method for bioceramics.

All of these projects cover advanced technological fields where the market for fine ceramic materials is expected to expand, and they are developments for standardization related to property test methods for fine ceramic materials. We are aiming for international standardization to ensure high-quality, safe, secure, and highly reliable fine ceramic materials.

To secure the competitiveness of the fine ceramics industry and to develop the industry, it is necessary to differentiate products by improving functionality, strengthen price competitiveness by innovation in manufacturing processes, enhance product revolution by innovation of materials, develop new markets, and lead with speed. We hope that the international standardization promoted by JFCA will contribute to the further expansion of the fine ceramics industry.

OTHER JFCA ACTIVITIES

CMC International Cooperation: CMC International Cooperation was established in 2020 for developing reliability assurance technology for ceramic matrix composites. This consortium consists of the CMC center at Tokyo University of Technology, Ultra High Temperature Materials Research Center, and JFCA.

CMC International initiated development of the international standard inspection method that can overcome the problems of the conventional test method for ceramic matrix composite reliability. The method of guaranteeing reliability for use by taking advantage of the "damage tolerance" is not established yet. The first step is to prepare SiC/SiC test pieces that are damaged and defective inside. Then, we will conduct an evaluation test (round robin test) using common test pieces by overseas joint research partners of the University of Birmingham and the University of California, Los Angeles.

Giant Micro-photonics Research: The Giant Micro-photonics Project was established in 2020 by RIKEN Spring-8 Center (RSC), National Institute for Materials Science (NIMS), Mitsubishi Electric Co., Kounoshima Chemical, and JFCA to achieve dramatic sophistication of extremely high-power, solid-state lasers and terahertz generation by new transparent ceramic materials, or so called giant micro-photonics. Based on these research results, the project is expected to prototype and develop a compact ultrahigh output, power density laser and develop wavelength conversion technology, which was difficult until now. It is also designed to convert to other important wavelengths and apply laser driven particle accelerators.

Japan Ceramics Expo: JFCA is the coorganizer of Japan Ceramics Expo, which is one of the world's largest exhibitions alongside Ceramitec in Munich and Ceramics Expo in Cleveland, Ohio. Japan Ceramics Expo is organized by the Reed Exhibitions Japan and gathers all kinds of highly functional ceramics, materials, forming/processing equipment, burning/heating equipment, evaluation/testing/analysis equipment. It is held every year in Osaka and Tokyo.

Japan Ceramics Expo is chosen by advanced materials industry players worldwide as the best gateway to the Japanese and Asian markets. For more information, please go to

https://www.ceramics-japan.jp/en-gb.html.

Osaka Expo
Dates: Wednesday, June 23 to Friday, June 25, 2021
Venue: INTEX Osaka, Japan

Tokyo Expo
Dates: Wednesday, December 8 to Friday, December 10, 2021
Venue: Makuhari Messe, Japan

ABOUT THE AUTHOR

Hirofumi Takemura is director of Japan Fine Ceramics Association.

REFERENCES

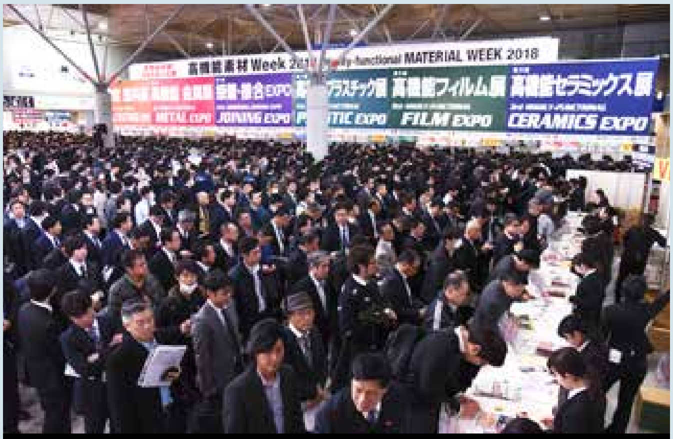
[1] JFCA Fine Ceramics Industrial Trend Survey (2019)

[2] ISO-Benefits of standards (https://www.iso.org/benefits-of-standards.html)

[3] METI Standardization Seminar (2020)

[4] ISO/TC206-Fine ceramics (https://www.iso.org/committee/54756.html)

[5] ISO/TC150-Implants for surgery (https://www.iso.org/committee/53058.html)



Japan Ceramics Expo in 2018. *Credit: Japan Fine Ceramics Association*

ADVERTISERS INDEX

DECEMBER 2020 • VOLUME 1 • ISSUE 5

ADVERTISERS

VOLUME 1

Ceramic & Glass MANUFACTURING

Issue	Theme
December 2019	Globalization: Doing business in China, Vietnam, and India
April 2020	Breaking in: A small company guide to working with big companies
June/July 2020	Smart manufacturing: Good business practices for manufacturers
September 2020	Workforce development
December 2020	Standards: Guideposts to quality

Ensure you get every issue!
Sign up today for your **free** copy at
www.ceramics.org/ceramicandglassmanufacturing

Calendar of events

November–December 2020

29–Dec 3 2020 MRS Fall Meeting & Exhibit – VIRTUAL EVENT ONLY; www.mrs.org/fall2020

January 2021

19–22 Electronic Materials and Applications (EMA2021) – VIRTUAL EVENT ONLY; www.ceramics.org/ema2021

February 2021

8–12 45th International Conference and Expo on Advanced Ceramics and Composites (ICACC2021) – VIRTUAL EVENT ONLY; www.ceramics.org/icacc2021

March 2021

15–17 China Refractory Minerals Forum 2021 – InterContinental Dalian, Liaoning, China; http://imformed.com/get-imformed/forums/china-refractory-minerals-forum-2020

24–25 56th Annual St. Louis Section/Refractory Ceramics Division Symposium on Refractories – Hilton St. Louis Airport Hotel, St. Louis, Mo. www.ceramics.org

24–29 ➨ 2nd Global Forum on Smart Additive Manufacturing, Design and Evaluation (SmartMADE) – Osaka University, Nakanoshima Center, Japan; http://www.jwri.osaka-u.ac.jp/~conf/Smart-MADE2021

27–31 ➨ The Int'l Conference on Sintering 2022 – Nagaragwa Convention Center, Gifu, Japan; https://www.sintering2021.org

April 2021

25–30 ➨ International Congress on Ceramics (ICC8) – Bexco, Busan, Korea; www.iccs.org

May 2021

1–4 6th Ceramics Expo – Cleveland, Ohio; https://ceramics.org/event/6th-ceramics-expo

3–7 6th International Conference on Competitive Materials and Technology Processes (ic-cmtp6) – Hunguest Hotel Palota, Miskolc-Lillafüred, Hungary; www.ic-cmtp6.eu

16–19 ➨ Ultra-high Temperature Ceramics: Materials for Extreme Environment Applications V – The Lodge at Snowbird, Snowbird, Utah; http://bit.ly/5thUHTC

17–20 China Ceramitec 2021 – Messe München, Germany; https://www.ceramitec.com/en

23–28 14th Pacific Rim Conference on Ceramic and Glass Technology (PACRIM 14) – Hyatt Regency Vancouver, Vancouver, British Columbia, Canada; www.ceramics.org/PACRIM14

June 2021

7–9 ACerS 2021 Structural Clay Products Division & Southwest Section Meeting in conjunction with the National Brick Research Center Meeting – Omni Austin Hotel Downtown, Austin, Texas; www.ceramics.org

28–30 MagForum 2021: Magnesium Minerals and Markets Conference – Grand Hotel Huis ter Duin, Noordwijk, Amsterdam; http://imformed.com/get-imformed/forums/magforum-2020

July 2021

18–23 Materials Challenges in Alternative & Renewable Energy 2020 (MCARE 2020) combined with the 4th Annual Energy Harvesting Society Meeting (EHS 2020) – RESCHEDULED-Hyatt Regency Bellevue Bellevue, Wash.; www.ceramics.org

September 2021

14–17 20th Biennial Worldwide Congress Unified International Technical Conference on Refractories – Hilton Chicago, Chicago, Ill.; www.ceramics.org

October 2021

NEW DATE

12-15 ➨ International Research Conference on Structure and thermodynamics of Oxides/carbides/nitrides/borides at High Temperature (STOHT) – Arizona State University, Ariz.; https://mccormacklab.engineering.ucdavis.edu/events/structure-and-thermodynamics-oxidescarbidesnitridesborides-high-temperatures-stoht2020

17–21 ACerS 123rd Annual Meeting with Materials Science & Technology 2021 – Greater Columbus Convention Center, Columbus, Ohio; www.ceramics.org

January 2022

18–21 Electronic Materials and Applications 2022 (EMA 2022) – DoubleTree by Hilton Orlando at Sea World Conference Hotel, Orlando, Fla; www.ceramics.org

23–28 46th International Conference and Expo on Advanced Ceramics and Composites (ICACC2022) – Hilton Daytona Beach Oceanfront Resort, Daytona Beach, Fla.; www.ceramics.org

Dates in **RED** denote new entry in this issue.

Entries in **BLUE** denote ACerS events.

➨ denotes meetings that ACerS cosponsors, endorses, or otherwise cooperates in organizing.

denotes virtual meeting

classified advertising

Career Opportunities

Statement of Ownership

Ownership, Management and Circulation Statement per 39 U.S. Code 3685 for *American Ceramic Society Bulletin* as filed Sept. 29, 2020, with the U.S. Postal Service.

American Ceramic Society Bulletin is published nine times per year (monthly except February, July and November) by The American Ceramic Society, 550 Polaris Parkway, Suite 510, Westerville, Ohio 43082. Publisher is Mark Mecklenborg, and editor is Eileen De Guire.

	Avg. each issue during previous 12 months	Actual no. of single issue nearest filing date
A. Total number of copies (net press run)	7,523	8,078
B. Paid and/or requested circulation		
1. Paid/requested outside-county mail subscriptions	2,972	2,850
2. Paid in-county subscriptions	none	none
3. Sales through dealers and carriers, street vendors, counter sales and other non-USPS paid distribution	1,674	1,478
4. Other classes mailed through the USPS	none	none
C. Total paid and/or requested circulation	4,646	4,328
D. Free distribution by mail (samples, complimentary and other free)		
1. Outside-county	2,337	3,390
2. In-county	none	none
3. Other classes mailed through the USPS	none	none
4. Free or Nominal Rate Distribution Outside the Mail (Carriers or other means)	227	152
E. Total Free or Nominal Rate Distribution	2,564	3,542
F. Total distribution	7,210	7,870
G. Copies not distributed	255	194
H. **Total**	7,465	8,064
I. Percent paid and/or requested circulation	64.44%	54.99%

Call for contributing editors for ACerS-NIST Phase Equilibria Diagrams Program

Professors, researchers, retirees, post-docs, and graduate students ...

The general editors of the reference series *Phase Equilibria Diagrams* are in need of individuals from the ceramics community to critically evaluate published articles containing phase equilibria diagrams. Additional contributing editors are needed to edit new phase diagrams and write short commentaries to accompany each phase diagram being added to the reference series. Especially needed are persons knowledgeable in foreign languages including German, French, Russian, Azerbaijani, Chinese, and Japanese.

RECOGNITION:
The Contributing Editor's name will be given at the end of each PED Figure that is published.

QUALIFICATIONS:
General understanding of the Gibbs phase rule and experimental procedures for determination of phase equilibria diagrams and/or knowledge of theoretical methods to calculate phase diagrams.

COMPENSATION for papers covering one chemical system:
$150 for the commentary, plus $10 for each diagram.

COMPENSATION for papers covering multiple chemical systems:
$150 for the first commentary, plus $10 for each diagram.

$50 for each additional commentary, plus $10 for each diagram.

FOR DETAILS PLEASE CONTACT:
Mrs. Kimberly Hill
NIST MS 8520
Gaithersburg, Md. 20899-8524, USA
301-975-6009 | phase2@nist.gov

The American Ceramic Society www.ceramics.org

NIST

ceramicSOURCE

TABLE OF CONTENTS

Directories

ADVERTISER INDEX

ADDITIVES

Acids
Arkema Inc PA
Ferro-Ceramic Grinding Inc MA
Heraeus Quartz UK Ltd UK
Hexion Inc OH

Adhesives
Aremco Products Inc NY
Arkema Inc PA
Dow Corning Corp MI
Empower Materials Inc DE
Gwent Electronic Materials Ltd UK
Hexion Inc OH
Master Bond Inc NJ
Peter Pugger Mfg Inc CA
Starfire Systems Inc NY
Vanderbilt Minerals, LLC CT
Zibo Guangtong Chemical Co Ltd China

Binders
Arkema Inc PA
BassTech Intl NJ
Borregaard LignoTech WI
Empower Materials Inc DE
Fusion Ceramics Inc OH
Gwent Electronic Materials Ltd UK
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Hexion Inc OH
Nyacol Nano Technologies Inc MA
Peter Pugger Mfg Inc CA
Polymer Innovations Inc CA
Refractory Minerals Co Inc PA
Shamrock Technologies Inc NJ
Tethon 3D NE
Trinity Ceramic Supply Inc TX
Vanderbilt Minerals, LLC CT
Wesbond Corp DE
Zschimmer & Schwarz GA

Colorants
American Chemet Corp IL
Arlimin Industries CO
Cancarb Limited Canada
Ceramic Color & Chemical Mfg Co PA
Fusion Ceramics Inc OH
Hunter Chemical LLC PA
Imerys Refractory Minerals GA
Laguna Clay Co CA
Mason Color Works Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden
Sauereisen Inc PA
Wistra GmbH Germany

Conditioners
Borregaard LignoTech WI
Vanderbilt Minerals, LLC CT

Deflocculants
BassTech Intl NJ
Borregaard LignoTech WI
Fusion Ceramics Inc OH
Zschimmer & Schwarz GA

Defoaming Agents
Arkema Inc PA
Ferro-Ceramic Grinding Inc MA
Momentive Performance Materials Inc NY
Polymer Innovations Inc CA
Zschimmer & Schwarz GA

Fillers
Arkema Inc PA
Baikowski Malakoff Inc NC
Dow Corning Corp MI
Fusion Ceramics Inc OH
Hexion Inc OH
Imerys Refractory Minerals GA
Maryland Refractories Co OH
Momentive Performance Materials Inc NY
RE Carroll Inc PA
Sauereisen Inc PA
Vanderbilt Minerals, LLC CT

Flocculants
Hexion Inc OH
Wesbond Corp DE
Zschimmer & Schwarz GA

Fluxes
Fusion Ceramics Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden

Foaming Agents
Arkema Inc PA
Hexion Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden
Zschimmer & Schwarz GA

Fungicides
Vanderbilt Minerals, LLC CT

Gelling Agents
Trinity Ceramic Supply Inc TX
Vanderbilt Minerals, LLC CT

Glaze Additives
BassTech Intl NJ
Fusion Ceramics Inc OH
Hexion Inc OH
Hunter Chemical LLC PA
RISE Research Institutes of Sweden, RISE Glass Sweden
Vanderbilt Minerals, LLC CT
Zschimmer & Schwarz GA

Glaze Hardeners
Fusion Ceramics Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden
Vanderbilt Minerals, LLC CT

Lubricants
Arkema Inc PA
Boca Bearing Company FL
Borregaard LignoTech WI
Momentive Performance Materials Inc NY
RE Carroll Inc PA
Shamrock Technologies Inc NJ
Superior Graphite Co IL **See ad on pg 73**
Werner G Smith Inc OH
Zschimmer & Schwarz GA

Organometallic Precursors
RISE Research Institutes of Sweden, RISE Glass Sweden
Zibo Guangtong Chemical Co Ltd China

Plasticizers
Arkema Inc PA
Borregaard LignoTech WI
Croda NJ
Hexion Inc OH
novomer Inc MA
Polymer Innovations Inc CA
SCG Chemicals Co Ltd Thailand
Zschimmer & Schwarz GA

Polycarbosilane
Momentive Performance Materials Inc NY
Starfire Systems Inc NY

Refractory Additives
Almatis Inc PA
BassTech Intl NJ
Borregaard LignoTech WI
Cancarb Limited Canada
FELDCO Intl CA
Fusion Ceramics Inc OH
Hunter Chemical LLC PA
Innovnano - Advanced Materials SA Portugal
Refractory Minerals Co Inc PA
Vanderbilt Minerals, LLC CT
Zschimmer & Schwarz GA

Release Agents
BassTech Intl NJ
Dow Corning Corp MI
Hexion Inc OH
Shamrock Technologies Inc NJ
Zschimmer & Schwarz GA

Rheological Additives
Borregaard LignoTech WI
Croda NJ
Polymer Innovations Inc CA
Shamrock Technologies Inc NJ
Vanderbilt Minerals, LLC CT
Zschimmer & Schwarz GA

Sintering Aids
Baikowski Malakoff Inc NC
Empower Materials Inc DE
Nyacol Nano Technologies Inc MA
Polymer Innovations Inc CA
Starfire Systems Inc NY

Suspending Agents
Borregaard LignoTech WI
Croda NJ
Trinity Ceramic Supply Inc TX
Vanderbilt Minerals, LLC CT
Zschimmer & Schwarz GA
ZYP Coatings Inc TN

Tape-Casting Additives
Croda NJ
Empower Materials Inc DE
Polymer Innovations Inc CA
Zschimmer & Schwarz GA

Thickening Agents
Polymer Innovations Inc CA
Trinity Ceramic Supply Inc TX
Vanderbilt Minerals, LLC CT

Viscosity Stabilizers
Hexion Inc OH
norcross Viscosity Controls MI
Vanderbilt Minerals, LLC CT

Wetting Agents
Croda NJ
Polymer Innovations Inc CA
Zschimmer & Schwarz GA

ADVANCED STRUCTURAL & TECHNICAL CERAMICS

Adhesives

Aremco Products Inc NY
Arkema Inc PA
CerCo LLC OH
CoorsTek CO
Denka Corp NY
Hexion Inc OH
Momentive Performance Materials Inc NY
Starfire Systems Inc NY

Alumina Products

Accuratus Corp NJ
AdTech Ceramics TN
AdValue Technology LLC AZ **See ad on pg 43**
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Almatis Inc PA
Alteo NA LLC OH **See ad on pg 11**
Aremco Products Inc NY

Associated Ceramics & Technology Inc PA
See ad on pg 65
Astral Material Industrial Co Ltd China
Astro Met Advanced Ceramics Inc OH
Beijing Cerametek Materials Co Ltd China
Bharat Heavy Electricals Ltd NY
Blasch Precision Ceramics Inc NY
Bullen OH
Ceramco Inc NH
CeramTec North America Corp SC
CeramTec-ETEC Germany
Ceranova Corp MA
CerCo LLC OH
China Unipretec Ceramic Technology Co Ltd China
CoorsTek CO
Custom Processing Services PA
Denka Corp NY
Du-Co Ceramics Company PA
EBL Products Inc CT
Elcon Precision LLC CA **See ad on pg 107**
Federal-Mogul MI
FELDCO Intl CA
Ferro Ceramic Grinding Inc MA
Ferro-Ceramic Grinding Inc MA
Ferrotec Ceramic Products China
GrainBound LLC PA
H.C. Starck GmbH Germany
Induceramic Canada
International Ceramic Engineering MA
IPS Ceramics LTD UK
Ipsen Ceramics IL
Jyoti Ceramic Industries Pvt Ltd India
Leico Industries Inc NJ
Lithoz GmbH NY
Maryland Ceramic & Steatite Co Inc MD
Master Bond Inc NJ

McDanel Advanced Ceramic Technologies LLC PA
See ad on pg 61
Morgan Advanced Materials CA
Morgan Technical Ceramics Auburn CA
Nanoe France
NEVZ-Ceramics, Close JSC Russia
NGK Spark Plug Co Ltd Japan
Nyacol Nano Technologies Inc MA
O'Keefe Ceramics Inc CO
Ortech Inc CA
PicoParts Ltd Israel
P-Ker Engineering NY
Precision Ceramics FL
Precision Ferrites and Ceramics Inc CA
PremaTech Advanced Ceramics MA
Progressive Technology Inc CA

Rauschert Industries Inc GA **See ad on pg 69**
Refractron Technologies Corp NY
Robocasting Enterprises LLC NM

- RocCera LLC NY
- Saint-Gobain norPro OH
- Suntech Advanced Ceramics (Shenzhen) Co Ltd China

- **Superior Technical Ceramics Corp VT** **See ad on pg 63**
- Toto Ltd Japan
- Valley Design Corp MA
- Viridis3D LLC MA
- Zhengzhou Mission Ceramic Products Co Ltd China
- Zircar Zirconia, Inc NY

Armor, Ceramic

- Advanced Ceramics Manufacturing AZ
- Advanced Materials Associates China
- Cerakote Ceramic Coatings OR
- CeramTec North America Corp SC
- Ceranova Corp MA
- CerCo LLC OH
- CoorsTek CO
- GrainBound LLC PA
- H.C. Starck GmbH Germany
- Israel Ceramic & Silicate Inst Israel
- NEVZ-Ceramics, Close JSC Russia
- New Tech Ceramics Inc IA
- O'Keefe Ceramics Inc CO
- Ortech Inc CA
- Saint-Gobain Ceramics & Plastics MA
- **Superior Graphite Co IL** **See ad on pg 73**
- Surmet Corp MA
- **TevTech LLC MA** **See ad on pg 83**

Bearings

- Astro Met Advanced Ceramics Inc OH
- Boca Bearing Company FL
- CoorsTek CO
- FELDCO Intl CA
- Ferrotec Ceramic Products China
- H.C. Starck GmbH Germany
- Koyo Bearings SC
- **McDanel Advanced Ceramic Technologies LLC PA** **See ad on pg 61**
- New Tech Ceramics Inc IA
- O'Keefe Ceramics Inc CO
- Ortech Inc CA
- Precision Ceramics FL
- **Rauschert Industries Inc GA** **See ad on pg 69**
- Saint-Gobain High Performance Ceramics & Refractories MA
- Suntech Advanced Ceramics (Shenzhen) Co Ltd China
- Toto Ltd Japan

Beryllia Products

- AdTech Ceramics TN
- Materion Ceramics AZ
- P-Ker Engineering NY

Bioceramics, Dental

- Astro Met Advanced Ceramics Inc OH
- Ferro-Ceramic Grinding Inc MA
- Ferrotec Ceramic Products China
- H.C. Starck GmbH Germany
- Mineral Research Processing France
- **Mo-Sci Corp MO** **See ad on pg 97**
- novaBone Products LLC FL
- Progressive Technology Inc CA
- Refractron Technologies Corp NY
- Specialty Glass Inc FL
- Z-Systems USA Inc Canada

Bioceramics, Medical

- AdTech Ceramics TN
- Astro Met Advanced Ceramics Inc OH
- CeramTec North America Corp SC
- CoorsTek CO
- **Elcon Precision LLC CA** **See ad on pg 107**
- Ferro-Ceramic Grinding Inc MA
- Ferrotec Ceramic Products China
- Lithoz GmbH NY
- Momentive Performance Materials Inc NY
- Morgan Technical Ceramics Auburn CA
- **Mo-Sci Corp MO** **See ad on pg 97**
- NEVZ-Ceramics, Close JSC Russia
- nGimat LLC KY
- NGK Spark Plug Co Ltd Japan
- novaBone Products LLC FL
- O'Keefe Ceramics Inc CO
- Precision Ferrites and Ceramics Inc CA
- Refractron Technologies Corp NY
- Robocasting Enterprises LLC NM
- Tethon 3D NE
- Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
- Z-Systems USA Inc Canada

Boride Products

- Advanced Ceramics Manufacturing AZ
- Advanced Materials Associates China
- Beijing Cerametek Materials Co Ltd China
- Dunhua Zhengxing Abrasive Co Ltd China
- Momentive Performance Materials Inc NY
- Refrac Systems AZ
- Saint-Gobain High Performance Ceramics & Refractories MA
- Treibacher Industrie AG Austria

Carbide Products

- Advanced Ceramics Manufacturing AZ
- Advanced Materials Associates China
- Beijing Cerametek Materials Co Ltd China
- Cancarb Limited Canada
- CoorsTek CO
- Custom Processing Services PA
- Denka Corp NY
- Dunhua Zhengxing Abrasive Co Ltd China
- FELDCO Intl CA
- Ferrotec Ceramic Products China
- H.C. Starck GmbH Germany
- Induceramic Canada
- Momentive Performance Materials Inc NY
- Morgan Technical Ceramics Auburn CA
- MSE Supplies AZ
- NGK Spark Plug Co Ltd Japan
- O'Keefe Ceramics Inc CO
- Ortech Inc CA
- Precision Ceramics FL
- Precision Ferrites and Ceramics Inc CA
- PremaTech Advanced Ceramics MA
- Refrac Systems AZ
- Saint-Gobain Ceramics & Plastics MA
- Silicon Carbide Products Inc NY
- **Superior Graphite Co IL** **See ad on pg 73**
- Toto Ltd Japan
- Treibacher Industrie AG Austria
- Zhengzhou Mission Ceramic Products Co Ltd China

Catalysts

- Arkema Inc PA
- Blasch Precision Ceramics Inc NY
- CARBO TX
- CerPoTech AS Norway
- Haldor Topsoe A/S Denmark
- Induceramic Canada
- Johnson Matthey Technology Centre UK
- MemPro Materials Corp CO
- Momentive Performance Materials Inc NY
- Nexceris LLC OH
- P-Ker Engineering NY
- Robocasting Enterprises LLC NM
- Saint-Gobain norPro OH
- Zibo Guangtong Chemical Co Ltd China

Cermets

- AdTech Ceramics TN
- Advanced Materials Associates China
- CeramTec North America Corp SC
- CoorsTek CO
- Innovnano - Advanced Materials SA Portugal

Coatings

- Advanced Materials Associates China
- Aremco Products Inc NY
- Arkema Inc PA
- Bharat Heavy Electricals Ltd NY
- Cerakote Ceramic Coatings OR
- **Cerion Nanomaterials NY** **See ad on pg 71**
- CerPoTech AS Norway
- CoorsTek CO
- Hexion Inc OH
- Jyoti Ceramic Industries Pvt Ltd India
- Master Bond Inc NJ
- Materion Ceramics AZ
- Morgan Advanced Materials CA
- Nanofilm OH
- New Tech Ceramics Inc IA
- Nexceris LLC OH
- P-Ker Engineering NY
- Saint-Gobain Ceramics & Plastics MA
- Sigma Advanced Materials NY
- Technology Assessment and Transfer Inc (TA&T) MD
- Teeter Marketing Services LLC FL
- **TevTech LLC MA** **See ad on pg 83**
- Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
- Zibo Guangtong Chemical Co Ltd China
- ZYP Coatings Inc TN

Composites, Carbon-Carbon

- Advanced Materials Associates China
- Cancarb Limited Canada
- Refrac Systems AZ
- Starfire Systems Inc NY

Composites, Ceramic-Ceramic

- Advanced Ceramics Manufacturing AZ
- Advanced Materials Associates China
- Bharat Heavy Electricals Ltd NY
- Bullen OH
- CerPoTech AS Norway
- Elan Technology GA
- FCT Ingenieurkeramik GmbH Germany
- Morgan Technical Ceramics Auburn CA
- NEVZ-Ceramics, Close JSC Russia
- New Tech Ceramics Inc IA
- O'Keefe Ceramics Inc CO
- PremaTech Advanced Ceramics MA
- Refrac Systems AZ
- Silicon Carbide Products Inc NY
- Starfire Systems Inc NY
- Technology Assessment and Transfer Inc (TA&T) MD
- Viridis3D LLC MA
- Zhengzhou Mission Ceramic Products Co Ltd China
- ZIRCAR Ceramics Inc NY

Composites, Ceramic-Metal

- AdTech Ceramics TN
- Advanced Materials Associates China
- Diamorph AB UK
- Elan Technology GA
- Innovnano - Advanced Materials SA Portugal

NEVZ-Ceramics, Close JSC Russia
New Tech Ceramics Inc IA
Precision Ceramics FL
Precision Ferrites and Ceramics Inc CA
Refrac Systems AZ
Sigma Advanced Materials NY
Starfire Systems Inc NY
Technology Assessment and Transfer Inc (TA&T) MD
Viridis3D LLC MA
Zibo Guangtong Chemical Co Ltd China

Composites, Ceramic-Polymer
Advanced Materials Associates China
Bullen OH
Cerakote Ceramic Coatings OR
novaBone Products LLC FL
O'Keefe Ceramics Inc CO
Starfire Systems Inc NY
Verity Technical Consultants LLC OH
Viridis3D LLC MA

Composites, Intermetallic
FELDCO Intl CA
Zibo Guangtong Chemical Co Ltd China

Cutting Tools
Advanced Ceramics Manufacturing AZ
Advanced Materials Associates China
Astro Met Advanced Ceramics Inc OH
Cerakote Ceramic Coatings OR
CeramTec North America Corp SC
China Unipretec Ceramic Technology Co Ltd China
CoorsTek CO
Ferro-Ceramic Grinding Inc MA
New Tech Ceramics Inc IA
NGK Spark Plug Co Ltd Japan
PremaTech Advanced Ceramics MA
Rauschert Industries Inc GA **See ad on pg 69**
RocCera LLC NY
Thermocarbon FL
Zibo Guangtong Chemical Co Ltd China

Cylinders
Advanced Ceramics Manufacturing AZ
Cerakote Ceramic Coatings OR
CoorsTek CO
Ferrotec Ceramic Products China
Morgan Technical Ceramics Auburn CA
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Dies
Astro Met Advanced Ceramics Inc OH
North Star Equipment Inc WA
Petro Mold Company PA
Ram Products Inc OH
Refractron Technologies Corp NY
China Unipretec Ceramic Technology Co Ltd China
Zircoa Inc OH

Engine Components
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Cerakote Ceramic Coatings OR
CeramTec North America Corp SC
China Unipretec Ceramic Technology Co Ltd China
Elcon Precision LLC CA **See ad on pg 107**
Federal-Mogul MI
Ferrotec Ceramic Products China
GE Global Research NY
H.C. Starck GmbH Germany
Precision Ceramics FL
PremaTech Advanced Ceramics MA
Toyota Central R&D Labs Inc Japan

Filters
Akron Porcelain & Plastics Co OH
Bharat Heavy Electricals Ltd NY
Blasch Precision Ceramics Inc NY
Induceramic Canada
Maryland Ceramic & Steatite Co Inc MD
Rauschert Industries Inc GA **See ad on pg 69**
Refractron Technologies Corp NY
Robocasting Enterprises LLC NM
Starfire Systems Inc NY
Valley Design Corp MA
Zhengzhou Mission Ceramic Products Co Ltd China

Glass-Ceramics
Accuratus Corp NJ
Aremco Products Inc NY
Astro Met Advanced Ceramics Inc OH
Bharat Heavy Electricals Ltd NY
Cerlase France
China Unipretec Ceramic Technology Co Ltd China
CoorsTek CO
Elan Technology GA
Ferro-Ceramic Grinding Inc MA
Israel Ceramic & Silicate Inst Israel
Morgan Advanced Materials CA
Ortech Inc CA
Petro Mold Company PA
P-Ker Engineering NY
Polymer Innovations Inc CA
Precision Ceramics FL
PremaTech Advanced Ceramics MA
RISE Research Institutes of Sweden, RISE Glass Sweden
Schott North America Inc NY **See ad on pg 41**
Starfire Systems Inc NY
Technical Products Inc WI
TevTech LLC MA **See ad on pg 83**
Valley Design Corp MA
Zibo Guangtong Chemical Co Ltd China

Heat Exchangers
Arkema Inc PA
Blasch Precision Ceramics Inc NY
Dowa High Temp Furnaces India
Elcon Precision LLC CA **See ad on pg 107**
FCT Ingenieurkeramik GmbH Germany
Ferrotec Ceramic Products China
Induceramic Canada
Precision Ceramics FL
Refrac Systems AZ
Saint-Gobain High Performance Ceramics & Refractories MA

Honeycombs
Bharat Heavy Electricals Ltd NY
Blasch Precision Ceramics Inc NY
Induceramic Canada
Rauschert Industries Inc GA **See ad on pg 69**
Robocasting Enterprises LLC NM
Zhengzhou Mission Ceramic Products Co Ltd China

Industrial Parts
Accuratus Corp NJ
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Akron Porcelain & Plastics Co OH
Astral Material Industrial Co Ltd China
Astro Met Advanced Ceramics Inc OH
Bharat Heavy Electricals Ltd NY
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
CeramTec North America Corp SC
CeramTec-ETEC Germany
CerCo LLC OH
China Unipretec Ceramic Technology Co Ltd China
Dowa High Temp Furnaces India
Du-Co Ceramics Company PA
Elcon Precision LLC CA **See ad on pg 107**
EZG Manufacturing Inc OH **Inside front cover**
FCT Ingenieurkeramik GmbH Germany
Ferrotec Ceramic Products China
GE Global Research NY
H.C. Starck GmbH Germany
Induceramic Canada
Industrial Ceramic Products Inc OH
Jyoti Ceramic Industries Pvt Ltd India
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Morgan Advanced Materials CA
Morgan Technical Ceramics Auburn CA
NGK Spark Plug Co Ltd Japan
Precision Ceramics FL
PremaTech Advanced Ceramics MA
Rauschert Industries Inc GA **See ad on pg 69**
Silicon Carbide Products Inc NY
Sonya Ceramics (Export Division) India
Zhengzhou Mission Ceramic Products Co Ltd China

Injection-Molded Ceramics
AdTech Ceramics TN
Bharat Heavy Electricals Ltd NY
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
CerCo LLC OH
CerPoTech AS Norway
China Unipretec Ceramic Technology Co Ltd China
Diamorph AB UK
Ferro-Ceramic Grinding Inc MA
Indo US MIM Tec India
Ortech Inc CA
Rauschert Industries Inc GA **See ad on pg 69**
Starfire Systems Inc NY
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Superior Technical Ceramics Corp VT **See ad on pg 63**

Lasers, Ceramic
Accuratus Corp NJ
Ceranova Corp MA
Cerinnov France
Cerlase France
CerPoTech AS Norway

II-VI Aerospace & Defense **See ad on pg 67**
Israel Ceramic & Silicate Inst Israel
Morgan Technical Ceramics Auburn CA
nGimat LLC KY
Precision Ceramics FL
Technology Assessment and Transfer Inc (TA&T) MD

Magnesium & Compounds
Elcon Precision LLC CA **See ad on pg 107**

Membranes, Ceramic

Bharat Heavy Electricals Ltd NY
Cerlase France
CerPoTech AS Norway
Induceramic Canada
norECs AS Norway

Rauschert Industries Inc GA **See ad on pg 69**
Refractron Technologies Corp NY

Nitride Products

Accuratus Corp NJ
AdTech Ceramics TN
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Beijing Cerametek Materials Co Ltd China
Blasch Precision Ceramics Inc NY
FCT Ingenieurkeramik GmbH Germany
H.C. Starck GmbH Germany
Induceramic Canada
Momentive Performance Materials Inc NY
NEVZ-Ceramics, Close JSC Russia
NGK Spark Plug Co Ltd Japan
O'Keefe Ceramics Inc CO
Precision Ceramics FL
Precision Ferrites and Ceramics Inc CA
Saint-Gobain Ceramics & Plastics MA
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY

Superior Technical Ceramics Corp VT **See ad on pg 63**
Treibacher Industrie AG Austria
Zhengzhou Mission Ceramic Products Co Ltd China

Nuclear Waste Containers

Precision Ferrites and Ceramics Inc CA

Optical Ceramics

Ceranova Corp MA
Elcon Precision LLC CA **See ad on pg 107**
FELDCO Intl CA
Innovnano - Advanced Materials SA Portugal
Morgan Technical Ceramics Auburn CA
MSE Supplies AZ
nGimat LLC KY
PremaTech Advanced Ceramics MA
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
Surmet Corp MA
Technology Assessment and Transfer Inc (TA&T) MD
Toto Ltd Japan

Oxide Products

Accuratus Corp NJ
Arlimin Industries CO

Associated Ceramics & Technology Inc PA **See ad on pg 65**
Astro Met Advanced Ceramics Inc OH
Beijing Cerametek Materials Co Ltd China
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
CeramTec North America Corp SC
CeramTec-ETEC Germany
CerPoTech AS Norway
Du-Co Ceramics Company PA
FELDCO Intl CA
H.C. Starck GmbH Germany
Hunter Chemical LLC PA
Imerys Fused Minerals Murg GmbH Germany
Innovnano - Advanced Materials SA Portugal
Jyoti Ceramic Industries Pvt Ltd India
MSE Supplies AZ
Nanocerox UT
nGimat LLC KY
Nyacol Nano Technologies Inc MA
Rauschert Industries Inc GA **See ad on pg 69**
Refractron Technologies Corp NY
Robocasting Enterprises LLC NM
Superior Technical Ceramics Corp VT **See ad on pg 63**
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
ZIRCAR Ceramics Inc NY

Porous Ceramics

Associated Ceramics & Technology Inc PA **See ad on pg 65**
Bharat Heavy Electricals Ltd NY
Ceramco Inc NH
P-Ker Engineering NY
Robocasting Enterprises LLC NM
Technology Assessment and Transfer Inc (TA&T) MD
Tethon 3D NE
Zhengzhou Mission Ceramic Products Co Ltd China
ZIRCAR Ceramics Inc NY
Zircar Zirconia, Inc NY

Reinforcements, Fiber

MemPro Materials Corp CO

Reinforcements, Whiskers

ZIRCAR Ceramics Inc NY

Rings

Astro Met Advanced Ceramics Inc OH
CeramTec-ETEC Germany
CoorsTek CO
China Unipretec Ceramic Technology Co Ltd China
Dunhua Zhengxing Abrasive Co Ltd China
Elcon Precision LLC CA **See ad on pg 107**
FCT Ingenieurkeramik GmbH Germany
Ferrotec Ceramic Products China
Industrial Ceramic Products Inc OH
Ipsen Ceramics IL
Morgan Technical Ceramics Auburn CA
Ortech Inc CA
Precision Ceramics FL
PremaTech Advanced Ceramics MA
Rauschert Industries Inc GA **See ad on pg 69**
Refractron Technologies Corp NY

Saint-Gobain High Performance Ceramics & Refractories MA
Saint-Gobain norPro OH
Silicon Carbide Products Inc NY
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
Superior Technical Ceramics Corp VT **See ad on pg 63**
Zhengzhou Mission Ceramic Products Co Ltd China

Rods

Accuratus Corp NJ
Advanced Ceramics Manufacturing AZ
Astro Met Advanced Ceramics Inc OH
CeramTec-ETEC Germany
China Unipretec Ceramic Technology Co Ltd China
CoorsTek CO
Du-Co Ceramics Company PA
Dunhua Zhengxing Abrasive Co Ltd China
Elcon Precision LLC CA **See ad on pg 107**
FCT Ingenieurkeramik GmbH Germany
Ferrotec Ceramic Products China
Industrial Ceramic Products Inc OH
Morgan Technical Ceramics Auburn CA
Ortech Inc CA
Precision Ceramics FL
PremaTech Advanced Ceramics MA
Progressive Technology Inc CA
Rauschert Industries Inc GA **See ad on pg 69**
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
Superior Technical Ceramics Corp VT **See ad on pg 63**
Zhengzhou Mission Ceramic Products Co Ltd China

Silicide Products

Astral Material Industrial Co Ltd China

Silicon Carbide Products

Accuratus Corp NJ
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Astral Material Industrial Co Ltd China
Blasch Precision Ceramics Inc NY
Cancarb Limited Canada
CoorsTek CO
Custom Processing Services PA
Diamorph AB UK
FCT Ingenieurkeramik GmbH Germany
FELDCO Intl CA
Ferrotec Ceramic Products China
H.C. Starck GmbH Germany

II-VI Aerospace & Defense **See ad on pg 67**
Morgan Advanced Materials CA
O'Keefe Ceramics Inc CO
Ortech Inc CA
Precision Ceramics FL
Precision Ferrites and Ceramics Inc CA
PremaTech Advanced Ceramics MA
Rauschert Industries Inc GA **See ad on pg 69**
Refratechnik Ceramics GmbH Germany
Saint-Gobain Ceramics & Plastics MA
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY
Starfire Systems Inc NY
Technology Assessment and Transfer Inc (TA&T) MD
TevTech LLC MA **See ad on pg 83**
Zhengzhou Mission Ceramic Products Co Ltd China

Silicon Nitride Products

Accuratus Corp NJ
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Beijing Cerametek Materials Co Ltd China
CoorsTek CO
FELDCO Intl CA
Ferrotec Ceramic Products China
H.C. Starck GmbH Germany
Induceramic Canada
International Ceramic Engineering MA
Morgan Advanced Materials CA
O'Keefe Ceramics Inc CO
Precision Ceramics FL
Precision Ferrites and Ceramics Inc CA
Rauschert Industries Inc GA **See ad on pg 69**
Saint-Gobain High Performance Ceramics & Refractories MA
Technology Assessment and Transfer Inc (TA&T) MD
Zhengzhou Mission Ceramic Products Co Ltd China

Thread Guides

Akron Porcelain & Plastics Co OH
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Astro Met Advanced Ceramics Inc OH
Ceramco Inc NH
CeramTec North America Corp SC
Industrial Ceramic Products Inc OH
International Ceramic Engineering MA
Ortech Inc CA
Rauschert Industries Inc GA **See ad on pg 69**
Superior Technical Ceramics Corp VT **See ad on pg 63**
Zhengzhou Mission Ceramic Products Co Ltd China

Transparent Ceramics

Ceranova Corp MA
CoorsTek CO
Ferrotec Ceramic Products China
Israel Ceramic & Silicate Inst Israel
nGimat LLC KY
Precision Ferrites and Ceramics Inc CA
PremaTech Advanced Ceramics MA
Surmet Corp MA

Tubes

Accuratus Corp NJ
AdValue Technology LLC AZ **See ad on pg 43**
Advanced Ceramics Manufacturing AZ
Akron Porcelain & Plastics Co OH
Aremco Products Inc NY
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Astro Met Advanced Ceramics Inc OH
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
CeramTec North America Corp SC
China Unipretec Ceramic Technology Co Ltd China
CoorsTek CO
Du-Co Ceramics Company PA
Dunhua Zhengxing Abrasive Co Ltd China
EBL Products Inc CT
Elcon Precision LLC CA **See ad on pg 107**
Ferrotec Ceramic Products China
Induceramic Canada
Industrial Ceramic Products Inc OH
International Ceramic Engineering MA
Jyoti Ceramic Industries Pvt Ltd India
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Morgan Technical Ceramics Auburn CA
Ortech Inc CA
Precision Ceramics FL
Progressive Technology Inc CA
Rauschert Industries Inc GA **See ad on pg 69**
Refractron Technologies Corp NY
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
Superior Technical Ceramics Corp VT **See ad on pg 63**
Zhengzhou Mission Ceramic Products Co Ltd China
Zircoa Inc OH

Wear-Resistant Parts

Accuratus Corp NJ
AdValue Technology LLC AZ **See ad on pg 43**
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Akron Porcelain & Plastics Co OH
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Astral Material Industrial Co Ltd China
Astro Met Advanced Ceramics Inc OH
Bharat Heavy Electricals Ltd NY
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
CeramTec North America Corp SC
CeramTec-ETEC Germany
CerCo LLC OH
China Unipretec Ceramic Technology Co Ltd China
CoorsTek CO
Diamorph AB UK
EBL Products Inc CT
FCT Ingenieurkeramik GmbH Germany
FELDCO Intl CA
Ferrotec Ceramic Products China
H.C. Starck GmbH Germany
Ipsen Ceramics IL
Jyoti Ceramic Industries Pvt Ltd India
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Morgan Advanced Materials CA
Morgan Technical Ceramics Auburn CA
NEVZ-Ceramics, Close JSC Russia
New Tech Ceramics Inc IA
NGK Spark Plug Co Ltd Japan
O'Keefe Ceramics Inc CO
Ortech Inc CA
P-Ker Engineering NY
Precision Ceramics FL
PremaTech Advanced Ceramics MA
Progressive Technology Inc CA
Rauschert Industries Inc GA **See ad on pg 69**
Refrac Systems AZ
Refractron Technologies Corp NY
RocCera LLC NY
Saint-Gobain Ceramics & Plastics MA
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY
Starfire Systems Inc NY
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
Superior Technical Ceramics Corp VT **See ad on pg 63**
Technology Assessment and Transfer Inc (TA&T) MD
Zhengzhou Mission Ceramic Products Co Ltd China
Zircoa Inc OH

Zirconia Products

Accuratus Corp NJ
AdTech Ceramics TN

AdValue Technology LLC AZ **See ad on pg 43**
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Akron Porcelain & Plastics Co OH
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Astral Material Industrial Co Ltd China
Astro Met Advanced Ceramics Inc OH
Beijing Cerametek Materials Co Ltd China
Bharat Heavy Electricals Ltd NY
Ceramco Inc NH
CeramTec North America Corp SC
CeramTec-ETEC Germany
CoorsTek CO
EBL Products Inc CT
FCT Ingenieurkeramik GmbH Germany
Ferrotec Ceramic Products China
H.C. Starck GmbH Germany
Imerys Fused Minerals Murg GmbH Germany
Induceramic Canada
Innovnano - Advanced Materials SA Portugal
International Ceramic Engineering MA
Israel Ceramic & Silicate Inst Israel
Jyoti Ceramic Industries Pvt Ltd India
Lithoz GmbH NY
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Morgan Advanced Materials CA
MSE Supplies AZ
Nanoe France
NEVZ-Ceramics, Close JSC Russia
Nyacol Nano Technologies Inc MA
O'Keefe Ceramics Inc CO
Ortech Inc CA
PicoParts Ltd Israel
P-Ker Engineering NY
Precision Ferrites and Ceramics Inc CA
PremaTech Advanced Ceramics MA
Progressive Technology Inc CA

Rauschert Industries Inc GA **See ad on pg 69**
Refractron Technologies Corp NY
Robocasting Enterprises LLC NM
RocCera LLC NY
Saint-Gobain Ceramics & Plastics MA
Saint-Gobain norPro OH
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Superior Technical Ceramics Corp VT **See ad on pg 63**
Wistra GmbH Germany
China Unipretec Ceramic Technology Co Ltd China
Zhengzhou Mission Ceramic Products Co Ltd China
Zibo Guangtong Chemical Co Ltd China
Zircoa Inc OH

ARTWARE

Ceramic Artware

Arlimin Industries CO
Art On Ceramic NY
Ceramic Arts Network OH
Milestone Decal Art LLC NY
StudioLX - Home Decor IL
Tethon 3D NE
Viridis3D LLC MA

Glass Artware

Arlimin Industries CO
RISE Research Institutes of Sweden, RISE Glass Sweden
StudioLX - Home Decor IL
Viridis3D LLC MA

Lighting

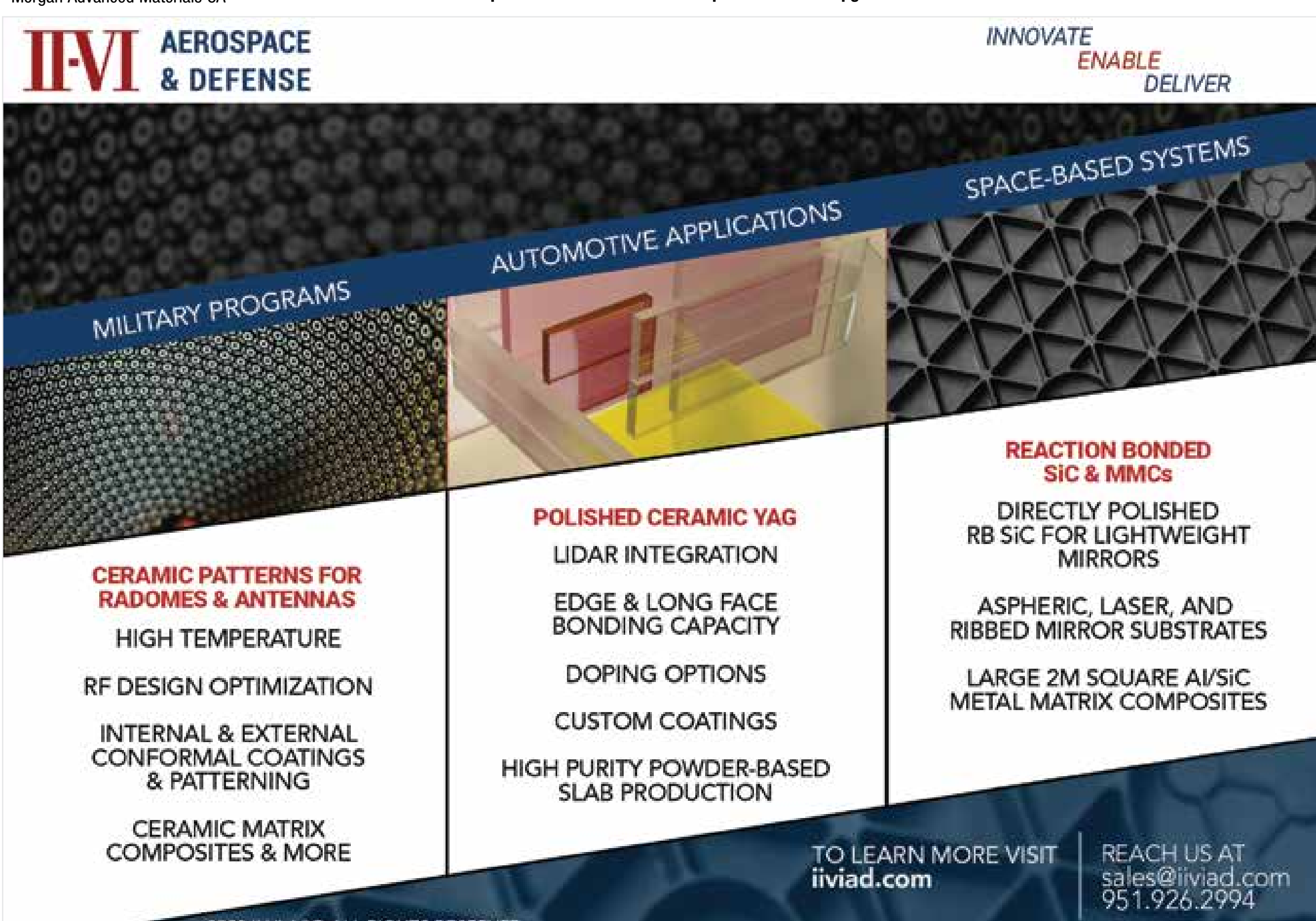
Akron Porcelain & Plastics Co OH
Viridis3D LLC MA

Ornamental Artware

Ceramic Arts Network OH
StudioLX - Home Decor IL
Viridis3D LLC MA

Pottery

ACCCO Inc/Burley Clay Products Co OH
Arlimin Industries CO
Ceramic Arts Network OH



North Star Equipment Inc WA
Peter Pugger Mfg Inc CA
Petro Mold Company PA
Ram Products Inc OH
Sheffield Pottery MA
StudioLX - Home Decor IL
Viridis3D LLC MA

■ CERAMIC & METALLIC POWDERS & MATERIALS

Abrasive Grains

Alteo NA LLC OH See ad on pg 11
Baikowski Malakoff Inc NC
Electro Abrasives Corp NY
FELDCO Intl CA
GMA Industries Inc MI
Imerys Refractory Minerals GA
Kyanite Mining Corp VA
Prince Minerals Inc TX
Saint-Gobain Abrasives MA
Saint-Gobain Ceramics & Plastics MA
Specialty Glass Inc FL
Washington Mills Electro Minerals Co NY

Adsorbants & Catalysts

GFS Chemicals Inc OH
Saint-Gobain Ceramics & Plastics MA
Saint-Gobain norPro OH

Alumina, Activated

AluChem Inc OH
Applied Ceramics Inc CA
Denka Corp NY
Momentive Performance Materials Inc NY
Nanoe France
Prince Minerals Inc TX
Sauereisen Inc PA

Alumina, Calcined

Almatis Inc PA
Alteo NA LLC OH See ad on pg 11
AluChem Inc OH
APF Recycling Inc OH
Baikowski Malakoff Inc NC
Denka Corp NY
Electro Abrasives Corp NY
Fusion Ceramics Inc OH
Hindalco Industries Limited India
Maryland Refractories Co OH
Nabaltec AG Germany
Nanoe France

PIDC MI See ad on pg 69
Prince Minerals Inc TX
Refractory Minerals Co Inc PA
Sauereisen Inc PA

Alumina, Fused

Alteo NA LLC OH See ad on pg 11
APF Recycling Inc OH
Denka Corp NY
Electro Abrasives Corp NY
GMA Industries Inc MI
Imerys Refractory Minerals GA
Lithoz GmbH NY
McDanel Advanced Ceramic Technologies LLC PA See ad on pg 61
Nanoe France
Prince Minerals Inc TX
Washington Mills Electro Minerals Co NY

Alumina, Fused Brown

Alteo NA LLC OH See ad on pg 11
APF Recycling Inc OH
BassTech Intl NJ
Bosai Minerals Group Co Ltd China
Electro Abrasives Corp NY
GMA Industries Inc MI
Imerys Refractory Minerals GA
Washington Mills Electro Minerals Co NY
Alteo NA LLC OH See ad on pg 11
APF Recycling Inc OH
Electro Abrasives Corp NY
Imerys Refractory Minerals GA
Sauereisen Inc PA
Washington Mills Electro Minerals Co NY

Alumina, High-Purity

Alteo NA LLC OH See ad on pg 11
AluChem Inc OH
APF Recycling Inc OH
Applied Ceramics Inc CA
Associated Ceramics & Technology Inc PA See ad on pg 65
Baikowski Malakoff Inc NC
CARBO TX
CoorsTek CO
Denka Corp NY
International Ceramic Engineering MA
Ipsen Ceramics IL
Lithoz GmbH NY
Materion Advanced Materials NY
Nanoe France
PIDC MI See ad on pg 69
Pred Materials International Inc NY
Prince Minerals Inc TX
Rauschert Industries Inc GA See ad on pg 69
Sauereisen Inc PA
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
Valley Design Corp MA
China Unipretec Ceramic Technology Co Ltd China

Alumina, Hydrated

Almatis Inc PA
Alteo NA LLC OH See ad on pg 11
Denka Corp NY
Fusion Ceramics Inc OH
Hindalco Industries Limited India
Nanoe France
PIDC MI See ad on pg 69
Prince Minerals Inc TX
RE Carroll Inc PA

Alumina, Other Grades

Almatis Inc PA
Alteo NA LLC OH See ad on pg 11
Associated Ceramics & Technology Inc PA See ad on pg 65
Baikowski Malakoff Inc NC
CoorsTek CO
Denka Corp NY
Hindalco Industries Limited India
Imerys Refractory Minerals GA
Nanoe France
PIDC MI See ad on pg 69
Prince Minerals Inc TX
Trinity Ceramic Supply Inc TX
Wesbond Corp DE

Alumina, Reactive

Almatis Inc PA
Alteo NA LLC OH See ad on pg 11
AluChem Inc OH
Baikowski Malakoff Inc NC
Denka Corp NY
Hindalco Industries Limited India
Nabaltec AG Germany
Nanoe France
Prince Minerals Inc TX

Alumina, Single Crystal

Denka Corp NY
Nanoe France
Prince Minerals Inc TX

Alumina, Tabular

Almatis Inc PA
Alteo NA LLC OH See ad on pg 11
AluChem Inc OH
APF Recycling Inc OH
Denka Corp NY
GrainBound LLC PA
Imerys Refractory Minerals GA
Nanoe France
Prince Minerals Inc TX
Sauereisen Inc PA

Alumina, Zirconia Toughened

Applied Ceramics Inc CA
Associated Ceramics & Technology Inc PA See ad on pg 65
CerCo LLC OH
Denka Corp NY
Innovnano - Advanced Materials SA Portugal
Nanocerox UT
Nanoe France
PicoParts Ltd Israel
PIDC MI See ad on pg 69
Prince Minerals Inc TX
Rauschert Industries Inc GA See ad on pg 69
Sauereisen Inc PA
Washington Mills Electro Minerals Co NY
Xiamen Innovacera Advanced Materials Co Ltd China See ad on pg 93
Zircoa Inc OH

Aluminum & Compounds

Atlantic Equipment Engineers NJ
BassTech Intl NJ
Denka Corp NY
Hindalco Industries Limited India
Leico Industries Inc NJ
Refractory Minerals Co Inc PA
Valley Design Corp MA
China Unipretec Ceramic Technology Co Ltd China

Aluminum Nitride

Applied Ceramics Inc CA
Atlantic Equipment Engineers NJ
Bullen OH
Centerline Technologies OH
Denka Corp NY
Ferro-Ceramic Grinding Inc MA
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
International Ceramic Engineering MA
Pred Materials International Inc NY
Reade Advanced Materials RI
Surmet Corp MA
Toyal America Inc IL
Valley Design Corp MA

Aluminum Silicate
Goodfellow Corp PA
Sauereisen Inc PA

Antimony & Compounds
Alfa Aesar Johnson Matthey MA
Atlantic Equipment Engineers NJ
Goodfellow Corp PA
Pred Materials International Inc NY

Arsenic Oxide
Alfa Aesar Johnson Matthey MA

Barium & Compounds
Alfa Aesar Johnson Matthey MA
American Elements Inc CA **Outside back cover, 54**
BassTech Intl NJ
Bosai Minerals Group Co Ltd China
CerPoTech AS Norway
FELDCO Intl CA
GFS Chemicals Inc OH
Trinity Ceramic Supply Inc TX

Barium Carbonate
BassTech Intl NJ
Fusion Ceramics Inc OH
Hexion Inc OH

Barium Titanate
AVX Corp SC
BassTech Intl NJ
Beijing Cerametek Materials Co Ltd China
CerPoTech AS Norway
Euro Support Advanced Materials The Netherlands
Haiku Tech Inc FL
Hexion Inc OH
nGimat LLC KY

Bauxite, Sintered
Alteo NA LLC OH **See ad on pg 11**

Beryllium & Compounds
APF Recycling Inc OH
Centerline Technologies OH
Leico Industries Inc NJ
Materion Advanced Materials NY

Bismuth & Compounds
Atlantic Equipment Engineers NJ
Beijing Cerametek Materials Co Ltd China
CerPoTech AS Norway
FELDCO Intl CA
Fusion Ceramics Inc OH
nGimat LLC KY

Boric Acid
Sauereisen Inc PA

Boron & Compounds
Atlantic Equipment Engineers NJ
Beijing Cerametek Materials Co Ltd China
Denka Corp NY
Electro Abrasives Corp NY
FELDCO Intl CA
Fusion Ceramics Inc OH
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
New Tech Ceramics Inc IA
Rio Tinto Minerals Australia

Boron Carbide
Atlantic Equipment Engineers NJ
CoorsTek CO

Custom Processing Services PA
Denka Corp NY
Dunhua Zhengxing Abrasive Co Ltd China
Electro Abrasives Corp NY
FELDCO Intl CA
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Reade Advanced Materials RI
Washington Mills Electro Minerals Co NY

Boron Nitride
Atlantic Equipment Engineers NJ
Denka Corp NY
Diamorph AB UK
FELDCO Intl CA
Ferro-Ceramic Grinding Inc MA
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
International Ceramic Engineering MA
Momentive Performance Materials Inc NY
Precision Ceramics FL
Reade Advanced Materials RI
Saint-Gobain Ceramics & Plastics MA
China Unipretec Ceramic Technology Co Ltd China

Cadmium & Compounds
Alfa Aesar Johnson Matthey MA
American Elements CA **Outside back cover, 54**
FELDCO Intl CA
GFS Chemicals Inc OH
Hunter Chemical LLC PA

Calcium & Compounds
C&L Development Corp CA
CerPoTech AS Norway
Denka Corp NY
GFS Chemicals Inc OH
Prince Minerals Inc TX

Calcium Aluminates
Almatis Inc PA
CerPoTech AS Norway
Gorka Cement Poland
Mineral Research Processing France
nGimat LLC KY
Sauereisen Inc PA

Calcium Carbonate
Arkema Inc PA
Fusion Ceramics Inc OH
Prince Minerals Inc TX
RE Carroll Inc PA
Unimin Corp CT

Calcium Silicate
Fusion Ceramics Inc OH
Mineral Research Processing France
Sauereisen Inc PA

Carbon Fibers
Goodfellow Corp PA

Carbons, Carbon Black
Cancarb Limited Canada

Carbons, Diamond
Goodfellow Corp PA

Carbons, Graphite
APF Recycling Inc OH
FELDCO Intl CA
Goodfellow Corp PA
Pred Materials International Inc NY
Semco Carbon OH
Superior Graphite Co IL **See ad on pg 73**

Cements
Aremco Products Inc NY
ESL ElectroScience PA
Gwent Electronic Materials Ltd UK

Cements, Refractory
Almatis Inc PA
Aremco Products Inc NY
Diamorph AB UK
Gorka Cement Poland
Kerneos Inc VA
Mineral Research Processing France
Sauereisen Inc PA
Unifrax I LLC NY

Cerium & Compounds
American Elements Inc CA **Outside back cover, 54**
Arlimin Industries CO
CerPoTech AS Norway
FELDCO Intl CA
GFS Chemicals Inc OH
nGimat LLC KY
PIDC MI **See ad on pg 69**
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
Treibacher Industrie AG Austria
Zircar Zirconia Inc NY

Chamotte
Imerys Refractory Minerals GA

Chrome & Compounds
Arlimin Industries CO

Chrome & Compounds
Atlantic Equipment Engineers NJ
CerPoTech AS Norway
Hunter Chemical LLC PA
Monofrax LLC NY

Clay Bodies, Formulated
American Art Clay Co Inc IN
Imerys GA
Laguna Clay Co CA
Sheffield Pottery MA
Tethon 3D NE
Unimin Corp CT

Cobalt & Compounds
Arlimin Industries CO
Atlantic Equipment Engineers NJ
Beijing Cerametek Materials Co Ltd China
Ceramic Color & Chemical Mfg Co PA
CerPoTech AS Norway
FELDCO Intl CA
Fusion Ceramics Inc OH
Goodfellow Corp PA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Hunter Chemical LLC PA
nGimat LLC KY

Copper & Compounds
American Chemet Corp IL
APF Recycling Inc OH
Atlantic Equipment Engineers NJ
Beijing Cerametek Materials Co Ltd China
Ceramic Color & Chemical Mfg Co PA
CerPoTech AS Norway
Goodfellow Corp PA
Shoei Chemical Inc Japan

Dielectric Powders
AVX Corp SC
CerPoTech AS Norway
Euro Support Advanced Materials The Netherlands
Gwent Electronic Materials Ltd UK
Haiku Tech Inc FL
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Dysprosium Oxide
Alfa Aesar Johnson Matthey MA
C&L Development Corp CA
CerPoTech AS Norway
Leico Industries Inc NJ
PIDC MI **See ad on pg 69**
Treibacher Industrie AG Austria

Electrically Conducting Powders
BassTech Intl NJ
CerPoTech AS Norway
Innovnano - Advanced Materials SA Portugal

Erbium Oxide
C&L Development Corp CA
CerPoTech AS Norway
FELDCO Intl CA
Leico Industries Inc NJ
MSE Supplies AZ
PIDC MI **See ad on pg 69**
Treibacher Industrie AG Austria

Europium Oxide
Alfa Aesar Johnson Matthey MA
C&L Development Corp CA
CerPoTech AS Norway
Leico Industries Inc NJ
MSE Supplies AZ
PIDC MI **See ad on pg 69**
Treibacher Industrie AG Austria

Ferrites & Ferromagnetics
Centerline Technologies OH
Powder Processing & Technology LLC IN
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Fibers, Ceramic
MemPro Materials Corp CO
Thermal Products Co Inc GA
Unifrax I LLC NY
Wesbond Corp DE
Zircar Zirconia Inc NY

Fibers, Glass
BassTech Intl NJ
Mo-Sci Corp MO **See ad on pg 97**
RISE Research Institutes of Sweden, RISE Glass Sweden
Schott North America Inc NY **See ad on pg 41**
Unifrax I LLC NY

Fluorides
BassTech Intl NJ
Beijing Cerametek Materials Co Ltd China
Sauereisen Inc PA

Frit
Ceradyne Inc, a 3M Co KY
Ceramic Color & Chemical Mfg Co PA
Fusion Ceramics Inc OH
Laguna Clay Co CA
Polymer Innovations Inc CA
RISE Research Institutes of Sweden, RISE Glass Sweden
Trinity Ceramic Supply Inc TX
Zibo Guangtong Chemical Co Ltd China

Gadolinium Oxide
Alfa Aesar Johnson Matthey MA
American Elements Inc CA **Outside back cover, 54**
CerPoTech AS Norway
PIDC MI **See ad on pg 69**

Gallium & Compounds
Alfa Aesar Johnson Matthey MA
American Elements Inc CA **Outside back cover, 54**
Beijing Cerametek Materials Co Ltd China
CerPoTech AS Norway
Goodfellow Corp PA
MSE Supplies AZ

Germanium & Compounds
Alfa Aesar Johnson Matthey MA
American Elements Inc CA **Outside back cover, 54**
Beijing Cerametek Materials Co Ltd China
C&L Development Corp CA
MSE Supplies AZ
Treibacher Industrie AG Austria

Grain, Refractory
Christy Minerals LLC MO
Imerys Refractory Minerals GA

Graphite
APF Recycling Inc OH
Applied Ceramics Inc CA
Aremco Products Inc NY
Beijing Cerametek Materials Co Ltd China
CoorsTek CO
Momentive Performance Materials Inc NY
Semco Carbon OH
Superior Graphite Co IL **See ad on pg 73**
TevTech LLC MA **See ad on pg 83**

Indium & Compounds
American Elements Inc CA **Outside back cover, 54**
CerPoTech AS Norway
FELDCO Intl CA
Goodfellow Corp PA
MSE Supplies AZ
Pred Materials International Inc NY

Iron & Compounds
Beijing Cerametek Materials Co Ltd China
CerPoTech AS Norway
GFS Chemicals Inc OH
Goodfellow Corp PA
Kyanite Mining Corp VA
Leico Industries Inc NJ
Prince Minerals Inc TX

Iron Oxide
Fusion Ceramics Inc OH
Nutec Bickley Mexico
Prince Minerals Inc TX
Reade Advanced Materials RI

Lanthanides (also see Rare-Earths)
Alfa Aesar Johnson Matthey MA
American Elements CA **Outside back cover, 54**
C&L Development Corp CA
FELDCO Intl CA
GFS Chemicals Inc OH
MSE Supplies AZ
Nanocerox UT
PIDC MI **See ad on pg 69**
Treibacher Industrie AG Austria

Lanthanum & Compounds
Alfa Aesar Johnson Matthey MA
BassTech Intl NJ
C&L Development Corp CA
CerPoTech AS Norway
Fusion Ceramics Inc OH
GFS Chemicals Inc OH
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
PIDC MI **See ad on pg 69**

Lead & Compounds
Goodfellow Corp PA

Lithium & Compounds
BassTech Intl NJ
Beijing Cerametek Materials Co Ltd China
Ceramic Color & Chemical Mfg Co PA
CerPoTech AS Norway
GFS Chemicals Inc OH
MSE Supplies AZ
nGimat LLC KY
Pred Materials International Inc NY
Trinity Ceramic Supply Inc TX

Magnesia, Fused
APF Recycling Inc OH
Du-Co Ceramics Company PA
Fluid Energy Processing & Equipment Co PA
Washington Mills Electro Minerals Co NY

Magnesia-Alumina, Sintered
Baikowski Malakoff Inc NC
Fluid Energy Processing & Equipment Co PA

Magnesium & Compounds
Atlantic Equipment Engineers NJ
BassTech Intl NJ
Bosai Minerals Group Co Ltd China
CerPoTech AS Norway
FELDCO Intl CA
Fusion Ceramics Inc OH
GFS Chemicals Inc OH
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Pred Materials International Inc NY
Prince Minerals Inc TX
Atlantic Equipment Engineers NJ
BassTech Intl NJ
CerPoTech AS Norway
Fusion Ceramics Inc OH
Goodfellow Corp PA
nGimat LLC KY
Prince Minerals Inc TX
RE Carroll Inc PA

Metallic Salts
Alfa Aesar Johnson Matthey MA

American Elements CA **Outside back cover, 54**
Arlimin Industries CO
Hunter Chemical LLC PA

Metallizing Compounds
Alfa Aesar Johnson Matthey MA
Elcon Precision LLC CA **See ad on pg 107**
Gwent Electronic Materials Ltd UK
Sigma Advanced Materials NY

Microspheres, Hollow
Washington Mills Electro Minerals Co NY

Molybdenum & Compounds
APF Recycling Inc OH
Atlantic Equipment Engineers NJ
C&L Development Corp CA
CerPoTech AS Norway
Elcon Precision LLC CA **See ad on pg 107**
GFS Chemicals Inc OH
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany

Nanomaterials

American Elements CA **Outside back cover, 54**

Cerion Nanomaterials NY **See ad on pg 71**
CerPoTech AS Norway
Innovnano - Advanced Materials SA Portugal
MSE Supplies AZ
Nanocerox UT
nGimat LLC KY
Nyacol Nano Technologies Inc MA
Polymer Innovations Inc CA
Pred Materials International Inc NY
TevTech LLC MA **See ad on pg 83**

Neodymium Oxide
Alfa Aesar Johnson Matthey MA
American Elements Inc CA **Outside back cover, 54**
C&L Development Corp CA
CerPoTech AS Norway
Leico Industries Inc NJ
MSE Supplies AZ
PIDC MI **See ad on pg 69**

Nickel & Compounds
American Chemet Corp IL
American Elements Inc CA **Outside back cover, 54**
APF Recycling Inc OH
Arlimin Industries CO
Atlantic Equipment Engineers NJ
Ceramic Color & Chemical Mfg Co PA
CerPoTech AS Norway
FELDCO Intl CA
GFS Chemicals Inc OH
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Hunter Chemical LLC PA
Shoei Chemical Inc Japan

Niobium & Compounds
American Elements Inc CA **Outside back cover, 54**
CerPoTech AS Norway
FELDCO Intl CA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Leico Industries Inc NJ

Organic Precursors
Starfire Systems Inc NY

Pastes, Conductor
Aremco Products Inc NY
Haiku Tech Inc FL
Sauereisen Inc PA
Shoei Chemical Inc Japan

Phosphates
Arkema Inc PA
BassTech Intl NJ
nGimat LLC KY
Refractory Minerals Co Inc PA
Sauereisen Inc PA

Piezoelectric Compositions
APC International Ltd PA
AVX Corp SC
CerPoTech AS Norway
Sparkler Ceramics Pvt Ltd India

Pigments
Arlimin Industries CO
Ceramic Color & Chemical Mfg Co PA
Fusion Ceramics Inc OH
Mason Color Works Inc OH
Sauereisen Inc PA
Wistra GmbH Germany

Plaster, Gypsum
Sheffield Pottery MA

Plaster, Industrial
Sheffield Pottery MA

Potassium & Compounds
CerPoTech AS Norway
GFS Chemicals Inc OH

Powdered Metals
Alfa Aesar Johnson Matthey MA
Arlimin Industries CO
Beijing Cerametek Materials Co Ltd China
Cancarb Limited Canada
Polymer Innovations Inc CA
Pred Materials International Inc NY

Praseodymium Oxide
Alfa Aesar Johnson Matthey MA
C&L Development Corp CA
CerPoTech AS Norway
Leico Industries Inc NJ
Nanocerox UT
PIDC MI **See ad on pg 69**

Precious Metals
Alfa Aesar Johnson Matthey MA
APF Recycling Inc OH
Gwent Electronic Materials Ltd UK
Leico Industries Inc NJ
Shoei Chemical Inc Japan

Rare-Earth Titanates
CerPoTech AS Norway
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Rare-Earths
Alfa Aesar Johnson Matthey MA
American Elements CA **Outside back cover, 54**
Beijing Cerametek Materials Co Ltd China
C&L Development Corp CA
FELDCO Intl CA
GFS Chemicals Inc OH
Innovnano - Advanced Materials SA Portugal
MSE Supplies AZ
Nanocerox UT

PIDC MI **See ad on pg 69**
Pred Materials International Inc NY
Spontaneous Materials CO
Treibacher Industrie AG Austria
Wistra GmbH Germany
Zircar Zirconia Inc NY

Refractory Oxides
Arlimin Industries CO
Christy Minerals LLC MO
Innovnano - Advanced Materials SA Portugal
Leico Industries Inc NJ
nGimat LLC KY

Resins, Molding
Hexion Inc OH
Starfire Systems Inc NY

Samarium Oxide
Alfa Aesar Johnson Matthey MA
C&L Development Corp CA
CerPoTech AS Norway
Nanocerox UT
PIDC MI **See ad on pg 69**

Sand, Foundry
Kyanite Mining Corp VA
U.S. Silica Co MD

Sand, Glass
Fusion Ceramics Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden
U.S. Silica Co MD

Sand, High-Purity Silica
BassTech Intl NJ
Maryland Refractories Co OH
U.S. Silica Co MD
Unimin Corp CT

Scandium & Compounds
Alfa Aesar Johnson Matthey MA
American Elements Inc CA **Outside back cover, 54**
C&L Development Corp CA
FELDCO Intl CA
Leico Industries Inc NJ
Nanocerox UT
Trinity Ceramic Supply Inc TX
Alfa Aesar Johnson Matthey MA
American Elements Inc CA **Outside back cover, 54**
FELDCO Intl CA
Pred Materials International Inc NY

Semiconducting Powders

American Elements Inc CA **Outside back cover, 54**

SiAlON Powder

Pred Materials International Inc NY

Silica

Arkema Inc PA
Denka Corp NY
Ipsen Ceramics IL
Maryland Refractories Co OH
Momentive Performance Materials Inc NY
Nanocerox UT
Saint-Gobain Ceramics & Plastics MA
Sauereisen Inc PA
Sibelco Benelux Belgium
U.S. Silica Co MD

Silica, Fused

APF Recycling Inc OH
BassTech Intl NJ
Bosai Minerals Group Co Ltd China
Centerline Technologies OH
Industrial Ceramic Products Inc OH
Ipsen Ceramics IL
Momentive Performance Materials Inc NY
Valley Design Corp MA

Silicates

BassTech Intl NJ
Denka Corp NY
Nanocerox UT
Sauereisen Inc PA

Silicon & Compounds

Atlantic Equipment Engineers NJ
Elkem Metals Inc PA
FELDCO Intl CA
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Reade Advanced Materials RI
Valley Design Corp MA

Silicon Carbide

American Elements Inc CA **Outside back cover, 54**
APF Recycling Inc OH
Applied Ceramics Inc CA
Atlantic Equipment Engineers NJ
BassTech Intl NJ
Beijing Cerametek Materials Co Ltd China
Bullen OH
Cancarb Limited Canada
CerCo LLC OH
CoorsTek CO
Custom Processing Services PA
Electro Abrasives Corp NY
FELDCO Intl CA
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Imerys Refractory Minerals GA
Momentive Performance Materials Inc NY
Ortech Inc CA
Pred Materials International Inc NY
Rauschert Industries Inc GA **See ad on pg 69**
Saint-Gobain Ceramics & Plastics MA
Starfire Systems Inc NY
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Superior Graphite Co IL **See ad on pg 73**
Texers Technical Ceramics Inc Canada
Treibacher Industrie AG Austria
Valley Design Corp MA
Washington Mills Electro Minerals Co NY

Silicon Nitride

Alteo NA LLC OH **See ad on pg 11**
Applied Ceramics Inc CA
Atlantic Equipment Engineers NJ
Bullen OH
CerCo LLC OH
CoorsTek CO
Denka Corp NY
FELDCO Intl CA
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
International Ceramic Engineering MA
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Ortech Inc CA
Pred Materials International Inc NY
Rauschert Industries Inc GA **See ad on pg 69**
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
Texers Technical Ceramics Inc Canada
China Unipretec Ceramic Technology Co Ltd China

Sodium & Compounds

Atlantic Equipment Engineers NJ
GFS Chemicals Inc OH

Spheres, Ceramic

Saint-Gobain norPro OH
Zircar Zirconia Inc NY

Spheres, Glass

Imerys Refractory Minerals GA
Mo-Sci Corp MO **See ad on pg 97**
RISE Research Institutes of Sweden, RISE Glass Sweden

Strontium & Compounds

Alfa Aesar Johnson Matthey MA
BassTech Intl NJ
CerPoTech AS Norway
Fusion Ceramics Inc OH
GFS Chemicals Inc OH
nGimat LLC KY

Superabrasives

Alteo NA LLC OH **See ad on pg 11**
Diamond Industrial Tools Inc IL
Saint-Gobain Ceramics & Plastics MA

Superconducting Powders

Alfa Aesar Johnson Matthey MA
nGimat LLC KY

Tantalum Metal Powder
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Leico Industries Inc NJ

Tantalum Oxide
CerPoTech AS Norway
FELDCO Intl CA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
PIDC MI **See ad on pg 69**

Terbium Oxide
Alfa Aesar Johnson Matthey MA
C&L Development Corp CA
CerPoTech AS Norway
Leico Industries Inc NJ
Nanocerox UT

Thin-Film Materials

American Elements Inc CA **Outside back cover, 54**

Thick-Film Materials
CerPoTech AS Norway
ESL ElectroScience PA
New Tech Ceramics Inc IA
Shoei Chemical Inc Japan
Cerakote Ceramic Coatings OR
CerPoTech AS Norway
FELDCO Intl CA
Innovnano - Advanced Materials SA Portugal
Materion Advanced Materials NY
New Tech Ceramics Inc IA
Valley Design Corp MA

Tin & Compounds
Arlimin Industries CO
CerPoTech AS Norway
FELDCO Intl CA
Goodfellow Corp PA
Trinity Ceramic Supply Inc TX

Titanium & Compounds
APF Recycling Inc OH
Atlantic Equipment Engineers NJ
C&L Development Corp CA
FELDCO Intl CA
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Leico Industries Inc NJ
Nanocerox UT
TAM Ceramics NY

Titanium Carbide
Atlantic Equipment Engineers NJ
Beijing Cerametek Materials Co Ltd China
FELDCO Intl CA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Reade Advanced Materials RI

Titanium Diboride
Dunhua Zhengxing Abrasive Co Ltd China
FELDCO Intl CA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Momentive Performance Materials Inc NY
New Tech Ceramics Inc IA
Pred Materials International Inc NY
Surmet Corp MA

Titanium Dioxide
BassTech Intl NJ
Beijing Cerametek Materials Co Ltd China
FELDCO Intl CA
Fusion Ceramics Inc OH
Nanocerox UT
nGimat LLC KY
Pred Materials International Inc NY

Titanium Nitride
Atlantic Equipment Engineers NJ
FELDCO Intl CA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Pred Materials International Inc NY

Tungsten Carbide
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Atlantic Equipment Engineers NJ
C&L Development Corp CA
Centerline Technologies OH
Custom Processing Services PA
FELDCO Intl CA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
MSE Supplies AZ
PicoParts Ltd Israel
Pred Materials International Inc NY

Tungsten Oxide
CerPoTech AS Norway
FELDCO Intl CA
H.C. Starck North American Trading LLC MA

Uranium & Compounds
Wistra GmbH Germany

Vanadium & Compounds
Atlantic Equipment Engineers NJ
CerPoTech AS Norway
FELDCO Intl CA

Yttria
APF Recycling Inc OH
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Bullen OH
CoorsTek CO
ESL ElectroScience PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Innovnano - Advanced Materials SA Portugal
Nanocerox UT
nGimat LLC KY
PIDC MI **See ad on pg 69**
Pred Materials International Inc NY
Washington Mills Electro Minerals Co NY
Zircar Zirconia Inc NY

Yttrium & Compounds
Alfa Aesar Johnson Matthey MA
American Elements CA **Outside back cover, 54**
C&L Development Corp CA
CerPoTech AS Norway
GFS Chemicals Inc OH
Nanocerox UT
nGimat LLC KY
PIDC MI **See ad on pg 69**

Zinc & Compounds
CerPoTech AS Norway
FELDCO Intl CA
Leico Industries Inc NJ
Prince Minerals Inc TX
RE Carroll Inc PA
Sauereisen Inc PA
TevTech LLC MA **See ad on pg 83**

Zinc Oxide
American Chemet Corp IL
FELDCO Intl CA
Fusion Ceramics Inc OH
nGimat LLC KY
Prince Minerals Inc TX
Sauereisen Inc PA
uttam industries India

Zirconia
Applied Ceramics Inc CA
China Unipretec Ceramic Technology Co Ltd China
C&L Development Corp CA
Custom Processing Services PA
Innovnano - Advanced Materials SA Portugal
International Ceramic Engineering MA
Leico Industries Inc NJ
Nanocerox UT
Nanoe France
nGimat LLC KY
Ortech Inc CA
PIDC MI **See ad on pg 69**
PremaTech Advanced Ceramics MA
Rauschert Industries Inc GA **See ad on pg 69**
Saint-Gobain Ceramics & Plastics MA
Sauereisen Inc PA
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
TAM Ceramics NY
Washington Mills Electro Minerals Co NY
Zibo Guangtong Chemical Co Ltd China
Zircar Zirconia Inc NY
Zircoa Inc OH

Zirconia, Engineering-Grade
Innovnano - Advanced Materials SA Portugal
Leico Industries Inc NJ
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Nanoe France
Zibo Guangtong Chemical Co Ltd China
Zircoa Inc OH

Zirconia, High-Purity
APF Recycling Inc OH
Applied Ceramics Inc CA
CARBO TX
CoorsTek CO
Innovnano - Advanced Materials SA Portugal
International Ceramic Engineering MA
Nanocerox UT
Nanoe France
Sauereisen Inc PA
Zibo Guangtong Chemical Co Ltd China

Zirconia, Refractory-Grade
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Nanoe France
Washington Mills Electro Minerals Co NY
Zircoa Inc OH

Zirconium & Compounds
Atlantic Equipment Engineers NJ
C&L Development Corp CA
CerPoTech AS Norway
FELDCO Intl CA
Goodfellow Corp PA
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Innovnano - Advanced Materials SA Portugal
Luxfer MEL Technologies NJ
Monofrax LLC NY
PIDC MI **See ad on pg 69**
Saint-Gobain Ceramics & Plastics MA
Zibo Guangtong Chemical Co Ltd China

Zirconium Carbide
Cancarb Limited Canada
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany

Zirconium Carbonate
C&L Development Corp CA
Zibo Guangtong Chemical Co Ltd China

Zirconium Diboride
H.C. Starck North American Trading LLC MA
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany

CLAY & NATURAL MINERALS

Bauxite
APF Recycling Inc OH
Bosai Minerals Group Co Ltd China
Fluid Energy Processing & Equipment Co PA
Hindalco Industries Limited India
Imerys Refractory Minerals GA
Prince Minerals Inc TX

Bentonite
Custom Processing Services PA
Reade Advanced Materials RI
Trinity Ceramic Supply Inc TX
Vanderbilt Minerals, LLC CT

Borax
Rio Tinto Minerals Australia

Chromite
Prince Minerals Inc TX

Clays, Ball
Fusion Ceramics Inc OH
Imerys GA
Old Hickory Clay Co KY
Sheffield Pottery MA
Sibelco Benelux Belgium
Trinity Ceramic Supply Inc TX
Unimin Corp CT

Clays, No
Fusion Ceramics Inc OH
Imerys GA
Old Hickory Clay Co KY
Sheffield Pottery MA
Sibelco Benelux Belgium
Vanderbilt Minerals, LLC CT

Clays, Enamel
Old Hickory Clay Co KY
RISE Research Institutes of Sweden, RISE Glass Sweden
Sibelco Benelux Belgium
Vanderbilt Minerals, LLC CT

Clays, Engobe
Imerys GA
Old Hickory Clay Co KY
Sheffield Pottery MA
Sibelco Benelux Belgium
Vanderbilt Minerals, LLC CT

Clays, Fire or Refractory
Alsey Refractories Co MO
Christy Minerals LLC MO
Endiccott Clay Products Company NE
Furnace Products & Services Inc PA
Imerys Refractory Minerals GA
Maryland Refractories Co OH
Old Hickory Clay Co KY
Peter Pugger Mfg Inc CA
Riverside Refractories Inc AL
Sheffield Pottery MA
Sibelco Benelux Belgium

Clays, Glaze
Imerys GA
Old Hickory Clay Co KY
Peter Pugger Mfg Inc CA
Sheffield Pottery MA
Sibelco Benelux Belgium
Vanderbilt Minerals, LLC CT

Clays, Stoneware
Christy Minerals LLC MO
Old Hickory Clay Co KY
Peter Pugger Mfg Inc CA
Sheffield Pottery MA
Sibelco Benelux Belgium

Cordierite
Maryland Ceramic & Steatite Co Inc MD
Mason Color Works Inc OH
Reade Advanced Materials RI
Refratechnik Ceramics GmbH Germany
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Diatomateous Earth
Reade Advanced Materials RI

Dolomite
Fusion Ceramics Inc OH
Sibelco Benelux Belgium
Trinity Ceramic Supply Inc TX

Feldspar
Avalon Advanced Materials Inc Canada
Fusion Ceramics Inc OH
Imerys GA
Prince Minerals Inc TX
Sheffield Pottery MA
Sibelco Benelux Belgium
Trinity Ceramic Supply Inc TX

Flint
Christy Minerals LLC MO
Fusion Ceramics Inc OH
Sheffield Pottery MA

Forsterite
- Du-Co Ceramics Company PA
- Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Kaolin
- Arkema Inc PA
- Bosai Minerals Group Co Ltd China
- CARBO TX
- Christy Minerals LLC MO
- Fusion Ceramics Inc OH
- Imerys GA
- Imerys Refractory Minerals GA
- M&M Clays Inc GA
- Old Hickory Clay Co KY
- RE Carroll Inc PA
- Reade Advanced Materials RI
- Sheffield Pottery MA
- Trinity Ceramic Supply Inc TX
- U.S. Silica Co MD
- Vanderbilt Minerals, LLC CT

Kyanite
- Kyanite Mining Corp VA

Lime & Limestone
- Prince Minerals Inc TX
- RE Carroll Inc PA

Lithium Minerals
- Avalon Advanced Materials Inc Canada
- Fusion Ceramics Inc OH

Magnesite
- APF Recycling Inc OH
- Bosai Minerals Group Co Ltd China
- Fluid Energy Processing & Equipment Co PA
- Imerys Refractory Minerals GA

Mica
- Imerys GA

Montmorillonite
- Reade Advanced Materials RI
- Vanderbilt Minerals, LLC CT

Mullite
- Christy Minerals LLC MO
- Imerys Refractory Minerals GA
- International Ceramic Engineering MA
- Kyanite Mining Corp VA
- Pred Materials International Inc NY
- Reade Advanced Materials RI
- Texers Technical Ceramics Inc Canada
- Washington Mills Electro Minerals Co NY

Nepheline Syenite
- Fusion Ceramics Inc OH
- Sheffield Pottery MA
- Sibelco Benelux Belgium
- Trinity Ceramic Supply Inc TX

Olivine
- Prince Minerals Inc TX
- Sibelco Benelux Belgium

Pyrite
- Kyanite Mining Corp VA
- Washington Mills Electro Minerals Co NY

Pyrophyllite
- Maryland Ceramic & Steatite Co Inc MD
- Vanderbilt Minerals, LLC CT

Quartz
- Applied Ceramics Inc CA
- Fusion Ceramics Inc OH
- Goodfellow Corp PA
- Imerys GA
- International Ceramic Engineering MA
- Momentive Performance Materials Inc NY
- Multi Lab UK
- Prince Minerals Inc TX
- Sibelco Benelux Belgium

Rutile
- Fusion Ceramics Inc OH
- Prince Minerals Inc TX

Sapphire
- Applied Ceramics Inc CA
- Centerline Technologies OH
- Goodfellow Corp PA
- International Ceramic Engineering MA
- MSE Supplies AZ

Silica
- APF Recycling Inc OH
- Centerline Technologies OH
- Imerys GA
- Imerys Refractory Minerals GA
- Maryland Refractories Co OH
- Prince Minerals Inc TX
- Sibelco Benelux Belgium
- Trinity Ceramic Supply Inc TX
- U.S. Silica Co MD

Soda Ash
- Fusion Ceramics Inc OH
- RE Carroll Inc PA

Spinels
- Almatis Inc PA
- Baikowski Malakoff Inc NC
- Fluid Energy Processing & Equipment Co PA
- GrainBound LLC PA
- Pred Materials International Inc NY
- Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
- Washington Mills Electro Minerals Co NY

Spodumene
- Avalon Advanced Materials Inc Canada
- Fusion Ceramics Inc OH
- Prince Minerals Inc TX
- Trinity Ceramic Supply Inc TX

Steatite
- Du-Co Ceramics Company PA
- International Ceramic Engineering MA
- Maryland Ceramic & Steatite Co Inc MD

Talc
- Custom Processing Services PA
- Fusion Ceramics Inc OH
- Rio Tinto Minerals Australia
- Trinity Ceramic Supply Inc TX

Wollastonite
- Bosai Minerals Group Co Ltd China
- Fusion Ceramics Inc OH
- Reade Advanced Materials RI
- Trinity Ceramic Supply Inc TX
- Vanderbilt Minerals, LLC CT

Zircon
- AluChem Inc OH
- APF Recycling Inc OH
- Fusion Ceramics Inc OH
- Lithoz GmbH NY
- Prince Minerals Inc TX
- Reade Advanced Materials RI
- TAM Ceramics NY

CONSTRUCTION CERAMICS

Brick
- Belden Brick Co OH
- Brick Industry Assn VA
- Cancarb Limited Canada
- Endicott Clay Products Company NE
- Niokem Inc NC
- Zibo Guangtong Chemical Co Ltd China

Brick & Paving
- Belden Brick Co OH
- Brick Industry Assn VA
- Cancarb Limited Canada
- Endicott Clay Products Company NE
- Niokem Inc NC

Pipe, Ceramic-Lined
- CerCo LLC OH

Sanitaryware
- Roca Sanitario SA Spain
- Zibo Guangtong Chemical Co Ltd China

Tile, Floor & Pavers
- Endicott Clay Products Company NE
- Foundation Floors FL
- Heartland Wood Flooring FL
- Somany Ceramics Ltd India

Tile, Wall
- Comtrust Architectural Mesh Co Ltd China
- Endicott Clay Products Company NE
- Peter Pugger Mfg Inc CA
- Somany Ceramics Ltd India

CONSULTANTS & SERVICES
- Jenike & Johanson MA

Advanced Coatings
- Activation Laboratories Ltd Canada
- Advanced Materials Associates China
- Bharat Heavy Electricals Ltd NY
- Cerakote Ceramic Coatings OR
- CoorsTek CO
- Delkic & Associates FL
- Gwent Electronic Materials Ltd UK
- New Tech Ceramics Inc IA
- Technology Assessment and Transfer Inc (TA&T) MD
- Teeter Marketing Services LLC FL
- Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
- Viridis3D LLC MA
- Activation Laboratories Ltd Canada
- Alfred University NY
- AVEKA MN
- CelSian Glass & Solar BV The Netherlands
- CHEMIR - A Division of Evans Analytical Group MO
- CMC Laboratories Inc AZ
- CoorsTek CO
- Edward Orton Jr Ceramic Foundation OH
- Geller Microanalytical Laboratory Inc MA
- GrainBound LLC PA
- H&M Analytical Services Inc NJ
- Hindalco Industries Limited India
- Hitech Materials Pty Ltd NY
- Israel Ceramic & Silicate Inst Israel
- JTF Microscopy Services, LLC NY
- Micromeritics Instrument Corp GA
- Micron Inc DE

NSL Analytical Services Inc OH **See ad on pg 75**
OPF Enterprises TX
Particle Technology Labs IL **See ad on pg 99**
Quantachrome Instruments FL
Refractory Consulting Services OH
RISE Research Institutes of Sweden, RISE Glass Sweden
SEMTech Solutions Inc UK
Spectrochemical Laboratories PA
TA Instruments DE

Analytical Services

NSL Analytical Services Inc OH **See ad on pg 75**

Spectrochemical Laboratories PA

Brick & Structural Clay Processing

Ceramitec Germany
Lucideon UK
Niokem Inc NC
OPF Enterprises TX
Peter Pugger Mfg Inc CA
Verity Technical Consultants LLC OH

Ceramic Materials

Activation Laboratories Ltd Canada
Advanced Materials Associates China
Alfred University NY
AVEKA MN
Bharat Heavy Electricals Ltd NY

Bomas Machine Specialties Inc MA **See ad on pg 81**
Cancarb Limited Canada
CelSian Glass & Solar BV The Netherlands
Cerakote Ceramic Coatings OR
Ceralink Inc NY
Cerion Nanomaterials NY **See ad on pg 71**
Elan Technology GA
Elcon Precision LLC CA **See ad on pg 107**
Ferro-Ceramic Grinding Inc MA
GrainBound LLC PA
H&M Analytical Services Inc NJ
Hitech Materials Pty Ltd NY
Imerys GA
Inst for Applied Materials-Ceramics in Mechanical Engineering, Karlsruhe Inst of Technology Germany
International Ceramic Engineering MA
Lithoz GmbH NY
Lucideon UK
MemPro Materials Corp CO
NSL Analytical Services Inc OH **See ad on pg 75**
O'Keefe Ceramics Inc CO
OPF Enterprises TX
P-Ker Engineering NY
Rauschert Industries Inc GA **See ad on pg 69**
Refrac Systems AZ
Rensselaer Polytechnic Inst NY
Schott North America Inc NY **See ad on pg 41**
Silicon Carbide Products Inc NY
Technology Assessment and Transfer Inc (TA&T) MD
Teeter Marketing Services LLC FL
Texers Technical Ceramics Inc Canada
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
Verity Technical Consultants LLC OH
Viridis3D LLC MA

Chemistry

Activation Laboratories Ltd Canada
CelSian Glass & Solar BV The Netherlands

Cerion Nanomaterials NY **See ad on pg 71**
Chemical Abstracts Service OH
CHEMIR - A Division of Evans Analytical Group MO
H&M Analytical Services Inc NJ
Hitech Materials Pty Ltd NY
NSL Analytical Services Inc OH **See ad on pg 75**

Combustion Systems
Air Products PA
CelSian Glass & Solar BV The Netherlands
Ceramic Services Inc PA

Harrop Industries Inc OH **See ad on pg 58**

Compositions
Activation Laboratories Ltd Canada
Advanced Materials Associates China
CelSian Glass & Solar BV The Netherlands
CHEMIR - A Division of Evans Analytical Group MO
Gwent Electronic Materials Ltd UK
Hitech Materials Pty Ltd NY
NSL Analytical Services Inc OH **See ad on pg 75**

Decorating Processes & Materials
Cerlase France
Lucideon UK
OPF Enterprises TX

Design
Air Force Civil Engineer Center China
CoorsTek CO
Deltech Kiln and Furnace Design, LLC CO
General Glass Equipment Co NJ
I Squared R Element Co NY **See ad on pg 89**
Ingredient Masters Inc OH **See ad on pg 103**
Jenike & Johanson Inc MA
OPF Enterprises TX
RocCera LLC NY
Tethon 3D NE
Viridis3D LLC MA

Electronics & Electrical Materials
Advanced Energy CO
APC International Ltd PA
AVEKA MN
Centerline Technologies OH
Elan Technology GA
Electrosciences Ltd UK
Gwent Electronic Materials Ltd UK
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL

Harrop Industries Inc OH **See ad on pg 58**

I Squared R Element Co NY **See ad on pg 89**
Powder Processing & Technology LLC IN
Semiconductor Energy Laboratory Co Ltd Japan **See ad on pg 91**

Energy
A123 Systems Inc MI
Advanced Energy CO
Air Force Civil Engineer Center China
CelSian Glass & Solar BV The Netherlands
Ceralink Inc NY
FCT Systeme GmbH Germany
Lucideon UK
Polymer Innovations Inc CA
Semiconductor Energy Laboratory Co Ltd Japan **See ad on pg 91**
Texers Technical Ceramics Inc Canada

Engineering
Advanced Materials Associates China
Air Force Civil Engineer Center China
CelSian Glass & Solar BV The Netherlands
Cerinnov France
Ceritherm France
Cyclonaire Corp NE
Deltech Kiln and Furnace Design, LLC CO
FCT Systeme GmbH Germany
General Glass Equipment Co NJ
Hitech Materials Pty Ltd NY
Ingredient Masters Inc OH **See ad on pg 103**
International Ceramic Engineering MA
Jenike & Johanson Inc MA
Lithoz GmbH NY
Nol-Tec Systems Inc MN
Teeter Marketing Services LLC FL
Verity Technical Consultants LLC OH
Wistra GmbH Germany

Environmental
Activation Laboratories Ltd Canada
Air Force Civil Engineer Center China
CelSian Glass & Solar BV The Netherlands
Lucideon UK
SEMTech Solutions Inc UK
Texers Technical Ceramics Inc Canada
Tri-Mer Corp MI

Expert Witness
Advanced Materials Associates China
CHEMIR - A Division of Evans Analytical Group MO
H&M Analytical Services Inc NJ
Hitech Materials Pty Ltd NY
JTF Microscopy Services, LLC NY
Lucideon UK
Particle Technology Labs IL **See ad on pg 99**
Refrac Systems AZ
Refractory Consulting Services OH
Spontaneous Materials CO
Verity Technical Consultants LLC OH

Fabrication
Accuratus Corp NJ
Advanced Materials Associates China
Bullen OH
Ingredient Masters Inc OH **See ad on pg 103**
Lithoz GmbH NY
O'Keefe Ceramics Inc CO
PremaTech Advanced Ceramics MA
Refrac Systems AZ
RocCera LLC NY
Technology Assessment and Transfer Inc (TA&T) MD
Thermal Products Co Inc GA
Verity Technical Consultants LLC OH

Furnaces
Advanced Materials Associates China
American Isostatic Presses OH
CelSian Glass & Solar BV The Netherlands
Centorr Vacuum Industries NH **See ad on pg 87**

Deltech Kiln and Furnace Design, LLC CO
Fosbel Inc OH
General Glass Equipment Co NJ

Harper International Corp NY **See ad on pg 77**
I Squared R Element Co NY **See ad on pg 89**
JTF Microscopy Services, LLC NY
Nutec Bickley Mexico
Refrac Systems AZ
Technology Assessment and Transfer Inc (TA&T) MD
The Furnace Source LLC CT
Trent Inc PA
Winner Technology The Republic of Korea

Glass Processes & Materials
Alfred University NY
CelSian Glass & Solar BV The Netherlands
Ceradyne Inc, a 3M Co KY
Elan Technology GA
JTF Microscopy Services, LLC NY
NSL Analytical Services Inc OH **See ad on pg 75**
Rensselaer Polytechnic Inst NY
RISE Research Institutes of Sweden, RISE Glass Sweden
Saxon Glass Technologies Inc NY
Schott North America Inc NY **See ad on pg 41**
Specialty Glass Inc FL
Tri-Mer Corp MI
Verity Technical Consultants LLC OH
Vesuvius SC

Glazes/Colorants
Cancarb Limited Canada
Ceradyne Inc, a 3M Co KY
Laguna Clay Co CA
Lucideon UK
NSL Analytical Services Inc OH **See ad on pg 75**
OPF Enterprises TX
RISE Research Institutes of Sweden, RISE Glass Sweden

High-Technology Ceramics
Advanced Materials Associates China
APC International Ltd PA
ARBURG GmbH + Co KG Germany
Astro Met Advanced Ceramics Inc OH
Bharat Heavy Electricals Ltd NY
Ceramitec Germany
CHEMIR - A Division of Evans Analytical Group MO
Elcon Precision LLC CA **See ad on pg 107**
Gwent Electronic Materials Ltd UK
Hitech Materials Pty Ltd NY
Lucideon UK
NSL Analytical Services Inc OH **See ad on pg 75**
OPF Enterprises TX
P-Ker Engineering NY
Silicon Carbide Products Inc NY
Technology Assessment and Transfer Inc (TA&T) MD
Viridis3D LLC MA
Wistra GmbH Germany
Zircoa Inc OH

Kilns
Centherm France

Deltech Kiln and Furnace Design, LLC CO
FCT Systeme GmbH Germany
Lucideon UK
Nabertherm Inc DE
OPF Enterprises TX

Litigation
H&M Analytical Services Inc NJ
Lucideon UK
Particle Technology Labs IL **See ad on pg 99**
Refractory Consulting Services OH
Spontaneous Materials CO
Verity Technical Consultants LLC OH

Maintenance & Repairs, After Sales
Cerinnov France

Management
OPF Enterprises TX
Teeter Marketing Services LLC FL

Manufacturing
Advanced Materials Associates China
AVEKA MN
Ceramco Inc NH
CeramTec North America Corp SC
Cerinnov France
CoorsTek CO
Custom Processing Services PA
Cyclonaire Corp NE
Endiccott Clay Products Company NE
Ferro-Ceramic Grinding Inc MA
Ingredient Masters Inc OH **See ad on pg 103**
Jenike & Johanson Inc MA
Laserage Technology Corp IL
Lucideon UK
Maryland Ceramic & Steatite Co Inc MD
Matmatch Germany
O'Keefe Ceramics Inc CO
OPF Enterprises TX
P-Ker Engineering NY
Refrac Systems AZ
Semiconductor Energy Laboratory Co Ltd Japan **See ad on pg 91**
Technology Assessment and Transfer Inc (TA&T) MD
Verity Technical Consultants LLC OH
Wistra GmbH Germany

Markets
Advanced Materials Associates China
Matmatch Germany
OPF Enterprises TX
Teeter Marketing Services LLC FL
Texers Technical Ceramics Inc Canada

Materials Testing & Characterization
Advanced Materials Associates China
Alfred University NY
ARBURG GmbH + Co KG Germany
AVEKA MN
Bharat Heavy Electricals Ltd NY
BuzzMac Intl LLC ME
Ceramitec Germany
CHEMIR - A Division of Evans Analytical Group MO
CSC Force Measurement Inc MA
Cyclonaire Corp NE
Edward Orton Jr Ceramic Foundation OH
Elan Technology GA
Fluid Energy Processing & Equipment Co PA
Geller Microanalytical Laboratory Inc MA
GrainBound LLC PA
H&M Analytical Services Inc NJ
Hindalco Industries Limited India
Hitech Materials Pty Ltd NY
Hysitron Inc MN
Inst for Applied Materials-Ceramics in Mechanical Engineering, Karlsruhe Inst of Technology Germany
Jenike & Johanson Inc MA
JTF Microscopy Services, LLC NY
Lucideon UK
Micromeritics Instrument Corp GA
Nol-Tec Systems Inc MN
norECs AS Norway

NSL Analytical Services Inc OH **See ad on pg 75**
OPF Enterprises TX

Particle Technology Labs IL **See ad on pg 99**
P-Ker Engineering NY
Refractory Consulting Services OH
Semiconductor Energy Laboratory Co Ltd Japan
See ad on pg 91

Spectrochemical Laboratories PA
Taber Industries NY
Washington Mills Electro Minerals Co NY

Modeling
CelSian Glass & Solar BV The Netherlands
CoorsTek CO
Lucideon UK
Ram Products Inc OH
Spontaneous Materials CO
Tethon 3D NE

Nuclear Materials
Advanced Materials Associates China
Dunhua Zhengxing Abrasive Co Ltd China
NSL Analytical Services Inc OH **See ad on pg 75**

Patents
Modern Times Legal MA
Refrac Systems AZ
Spontaneous Materials CO
Teeter Marketing Services LLC FL

Professional Engineer
NSL Analytical Services Inc OH **See ad on pg 75**
Spontaneous Materials CO
Texers Technical Ceramics Inc Canada
Verity Technical Consultants LLC OH

Quality Management/ISO 9000
Elcon Precision LLC CA **See ad on pg 107**
Lucideon UK

Refractories
CelSian Glass & Solar BV The Netherlands
Ceramitec Germany
Dunhua Zhengxing Abrasive Co Ltd China
Edward Orton Jr Ceramic Foundation OH
Fluid Energy Processing & Equipment Co PA
Fosbel Inc OH
Hitech Materials Pty Ltd NY
Industrial Ceramic Products Inc OH
Ipsen Ceramics IL
JTF Microscopy Services, LLC NY
Laguna Clay Co CA
Lucideon UK
Maryland Refractories Co OH
NSL Analytical Services Inc OH **See ad on pg 75**
Refractory Consulting Services OH
Silicon Carbide Products Inc NY
Teeter Marketing Services LLC FL
Texers Technical Ceramics Inc Canada
Viridis3D LLC MA
Wistra GmbH Germany

Research
Advanced Materials Associates China
Alfred University NY
ARBURG GmbH + Co KG Germany
AVEKA MN
CelSian Glass & Solar BV The Netherlands
Ceralink Inc NY
Cerion Nanomaterials NY **See ad on pg 71**
Cerlase France
CHEMIR - A Division of Evans Analytical Group MO
Inst for Applied Materials-Ceramics in Mechanical Engineering, Karlsruhe Inst of Technology Germany
Laeis GmbH Luxembourg
Lithoz GmbH NY
Lucideon UK
OPF Enterprises TX
Refrac Systems AZ
RISE Research Institutes of Sweden, RISE Glass Sweden
Technology Assessment and Transfer Inc (TA&T) MD
Viridis3D LLC MA
Wistra GmbH Germany

Semiconductors (Consultants)
Semiconductor Energy Laboratory Co Ltd Japan
See ad on pg 91
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Software
Chemical Abstracts Service OH
General Glass Equipment Co NJ

Object Research Systems Inc Canada
See ad on pg 81
Outotec Research Oy Pori
Rockwell Automation, Inc WI
Throughput Bluestreak WI

Structural Ceramics
Advanced Materials Associates China
Astro Met Advanced Ceramics Inc OH
Bharat Heavy Electricals Ltd NY
Ceramitec Germany
CeramTec North America Corp SC
FCT Ingenieurkeramik GmbH Germany
Hitech Materials Pty Ltd NY
OPF Enterprises TX
Rauschert Industries Inc GA **See ad on pg 69**
Silicon Carbide Products Inc NY
Technology Assessment and Transfer Inc (TA&T) MD

Superconductors
NSL Analytical Services Inc OH **See ad on pg 75**

Technical Writing
Advanced Materials Associates China
Bharat Heavy Electricals Ltd NY
CelSian Glass & Solar BV The Netherlands
Hitech Materials Pty Ltd NY
JTF Microscopy Services, LLC NY
Spontaneous Materials CO
Teeter Marketing Services LLC FL

Technology Transfer
CelSian Glass & Solar BV The Netherlands
Ceralink Inc NY
Cerlase France
Gwent Electronic Materials Ltd UK
Lucideon UK
Particle Technology Labs IL **See ad on pg 99**
Spontaneous Materials CO
Technology Assessment and Transfer Inc (TA&T) MD
Teeter Marketing Services LLC FL
Viridis3D LLC MA

■ CUSTOM CERAMICS FABRICATION & ENGINEERING SERVICES

Advanced Ceramics, Structural
Accuratus Corp NJ
AdTech Ceramics TN
AdValue Technology LLC AZ **See ad on pg 43**
Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Astro Met Advanced Ceramics Inc OH

Bomas Machine Specialties Inc MA **See ad on pg 81**
Bullen OH
CeramTec North America Corp SC
Ceranova Corp MA
CerCo LLC OH
CiDRA Precision Services LLC CT
CoorsTek CO
Custom Processing Services PA
Dunhua Zhengxing Abrasive Co Ltd China

Elcon Precision LLC CA **See ad on pg 107**
Exothermics Inc NH
FCT Ingenieurkeramik GmbH Germany
FELDCO Intl CA
GE Global Research NY
Induceramic Canada
Innovnano - Advanced Materials SA Portugal
Israel Ceramic & Silicate Inst Israel
Lithoz GmbH NY
Machined Ceramics Inc KY
Maryland Ceramic & Steatite Co Inc MD

McDanel Advanced Ceramic Technologies LLC PA
See ad on pg 61
MemPro Materials Corp CO
Morgan Technical Ceramics Auburn CA
Petro Mold Company PA
P-Ker Engineering NY
Precision Ceramics FL
Precision Ferrites and Ceramics Inc CA

PremaTech Advanced Ceramics MA
Progressive Technology Inc CA

Rauschert Industries Inc GA **See ad on pg 69**
Refrac Systems AZ
Refractron Technologies Corp NY
RocCera LLC NY
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY
Starfire Systems Inc NY
Superior Technical Ceramics Corp VT **See ad on pg 63**
Technical Products Inc WI
Tethon 3D NE
Toto Ltd Japan
Zircoa Inc OH

Calcining, Custom

CerPoTech AS Norway
Christy Minerals LLC MO
OPF Enterprises TX

Powder Processing & Technology LLC IN

Classification, Custom

AVEKA MN

Bomas Machine Specialties Inc MA **See ad on pg 81**
Christy Minerals LLC MO
Du-Co Ceramics Company PA
Fluid Energy Processing & Equipment Co PA

Coatings, Corrosion-Resistant

Aremco Products Inc NY
Cerakote Ceramic Coatings OR
CoorsTek CO
ESL ElectroScience PA
Hexion Inc OH
Induceramic Canada
Master Bond Inc NJ
Starfire Systems Inc NY
Technology Assessment and Transfer Inc (TA&T) MD
TevTech LLC MA **See ad on pg 83**
Verity Technical Consultants LLC OH

Coatings, Thermal-Resistant
Aremco Products Inc NY
Cancarb Limited Canada
Cerakote Ceramic Coatings OR
Delkic & Associates FL
ESL ElectroScience PA
Induceramic Canada
New Tech Ceramics Inc IA
Sigma Advanced Materials NY
Starfire Systems Inc NY
Technology Assessment and Transfer Inc (TA&T) MD
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
Unifrax I LLC NY
Verity Technical Consultants LLC OH
ZYP Coatings Inc TN

Coatings, Wear-Resistant
Cerakote Ceramic Coatings OR
CeramTec-ETEC Germany
CoorsTek CO
ESL ElectroScience PA
Master Bond Inc NJ
New Tech Ceramics Inc IA
Starfire Systems Inc NY
Technology Assessment and Transfer Inc (TA&T) MD
Teeter Marketing Services LLC FL
TevTech LLC MA **See ad on pg 83**

Crushing, Custom
AVEKA MN
Christy Minerals LLC MO
Fluid Energy Processing & Equipment Co PA
Reade Advanced Materials RI
Stedman Machine Co IN

Dielectrics
Accuratus Corp NJ
AdTech Ceramics TN
Associated ceramics CA
CerPoTech AS Norway
Ferro-Ceramic Grinding Inc MA
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Sigma Advanced Materials NY
Starfire Systems Inc NY
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Drying, Custom
AVEKA MN
Fluid Energy Processing & Equipment Co PA
General Spray LLC NJ
Ipsen Ceramics IL
Reade Advanced Materials RI

Engineering
Ferro-Ceramic Grinding Inc MA

Films, Thick
CoorsTek CO
ESL ElectroScience PA
Gwent Electronic Materials Ltd UK
New Tech Ceramics Inc IA
P-Ker Engineering NY
Polymer Innovations Inc CA
Sigma Advanced Materials NY
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Films, Thin
Advanced Energy CO
Cerakote Ceramic Coatings OR
CoorsTek CO
Industrial Hard Carbon LLC NC
Morgan Technical Ceramics Auburn CA
New Tech Ceramics Inc IA
Technology Assessment and Transfer Inc (TA&T) MD
Teeter Marketing Services LLC FL
Verity Technical Consultants LLC OH

Furnace Rebuilds
Cancarb Limited Canada
Fosbel Inc OH
Materials Research Furnaces Inc NH
Oxy-Gon Industries Inc NH **See ad on pg 89**
TevTech LLC MA **See ad on pg 83**
ZIRCAR Ceramics Inc NY
Zircar Zirconia Inc NY

Grinding, Custom

Advanced Ceramic Technology CA
Astro Met Advanced Ceramics Inc OH

Bomas Machine Specialties Inc MA **See ad on pg 81**
Bullen OH
Christy Minerals LLC MO
CiDRA Precision Services LLC CT
CoorsTek CO
Du-Co Ceramics Company PA
FCT Ingenieurkeramik GmbH Germany
Ferro-Ceramic Grinding Inc MA
Fluid Energy Processing & Equipment Co PA
International Ceramic Engineering MA
Machined Ceramics Inc KY
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Morgan Technical Ceramics Auburn CA
Ortech Inc CA
PremaTech Advanced Ceramics MA
Reade Advanced Materials RI
Refractory Machining Services PA
Refractory Minerals Co Inc PA
Refractron Technologies Corp NY
RocCera LLC NY
Stedman Machine Co IN
Union Process OH
Valley Design Corp MA
Washington Mills Electro Minerals Co NY
Zibo Guangtong Chemical Co Ltd China

Hot Repair
Fosbel Inc OH

Joining
Advanced Ceramic Technology CA
CeramTec North America Corp SC
Fosbel Inc OH
Fuse Tech/Hot Tech Group OH
Induceramic Canada
Morgan Technical Ceramics Auburn CA
P-Ker Engineering NY
Precision Ferrites and Ceramics Inc CA
Refrac Systems AZ
RocCera LLC NY
Sigma Advanced Materials NY
Starfire Systems Inc NY

Lapping & Polishing
Advanced Ceramic Technology CA
Astro Met Advanced Ceramics Inc OH
Bullen OH
CoorsTek CO
Du-Co Ceramics Company PA
Dunhua Zhengxing Abrasive Co Ltd China
International Ceramic Engineering MA
Morgan Technical Ceramics Auburn CA
Ortech Inc CA
PremaTech Advanced Ceramics MA
Superior Technical Ceramics Corp VT **See ad on pg 63**
Technical Products Inc WI
Texers Technical Ceramics Inc Canada
Valley Design Corp MA

Laser Cutting & Scribing Services
Cerlase France
CoorsTek CO
Laserage Technology Corp IL
Ortech Inc CA

Machining

Advanced Ceramic Technology CA
Advanced Ceramics Manufacturing AZ
Aremco Products Inc NY
Astro Met Advanced Ceramics Inc OH

Bomas Machine Specialties Inc MA **See ad on pg 81**
Bullen OH
CerCo LLC OH
CiDRA Precision Services LLC CT
Du-Co Ceramics Company PA
Elan Technology GA
FCT Ingenieurkeramik GmbH Germany
FELDCO Intl CA
Ferro-Ceramic Grinding Inc MA
Fosbel Inc OH
International Ceramic Engineering MA
Laserage Technology Corp IL
Machined Ceramics Inc KY
Maryland Ceramic & Steatite Co Inc MD
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Morgan Technical Ceramics Auburn CA
Ortech Inc CA
Precision Ceramics FL

PremaTech Advanced Ceramics MA
Progressive Technology Inc CA

Ram Products Inc OH
Refractory Machining Services PA
RocCera LLC NY
Stahli USA Inc WI
Superior Technical Ceramics Corp VT **See ad on pg 63**
Technical Products Inc WI
Valley Design Corp MA
Zircar Zirconia Inc NY

Milling, Custom

Advanced Ceramic Technology CA
AVEKA MN
Bullen OH
CiDRA Precision Services LLC CT
Custom Processing Services PA
Fluid Energy Processing & Equipment Co PA
International Ceramic Engineering MA
MSE Supplies AZ
Powder Processing & Technology LLC IN
Precision Ceramics FL
PremaTech Advanced Ceramics MA
Reade Advanced Materials RI
Refractory Machining Services PA
RocCera LLC NY
Stedman Machine Co IN
Union Process OH
Valley Design Corp MA
Washington Mills Electro Minerals Co NY

Nuclear Materials

Dunhua Zhengxing Abrasive Co Ltd China
Morgan Technical Ceramics Auburn CA
Peter Pugger Mfg Inc CA
Refrac Systems AZ
Verity Technical Consultants LLC OH

Piezoelectrics

APC International Ltd PA
CerPoTech AS Norway
Electrosciences Ltd UK
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Meggitt Piezo Technologies IN
Sparkler Ceramics Pvt Ltd India

Powder Synthesis

CerPoTech AS Norway

Prototypes

Accuratus Corp NJ
Advanced Ceramic Technology CA
Astro Met Advanced Ceramics Inc OH
Bullen OH
CeramTec North America Corp SC
CerCo LLC OH
CoorsTek CO
Du-Co Ceramics Company PA
ESL ElectroScience PA
FCT Ingenieurkeramik GmbH Germany
Goceram AB Sweden
Industrial Ceramic Products Inc OH
International Ceramic Engineering MA
Lithoz GmbH NY
Morgan Technical Ceramics Auburn CA
Ortech Inc CA
P-Ker Engineering NY
Precision Ceramics FL

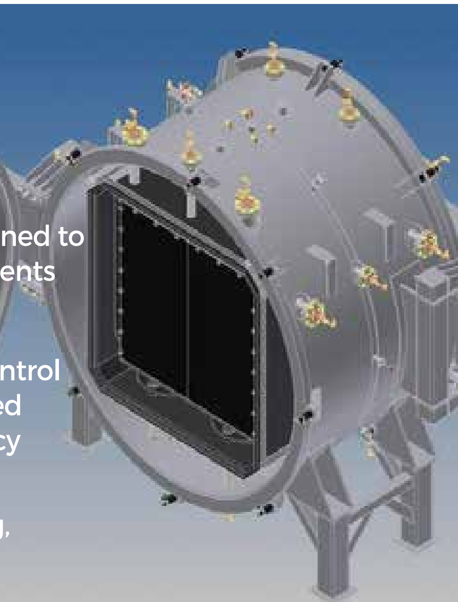
PremaTech Advanced Ceramics MA
Progressive Technology Inc CA
Ram Products Inc OH
Refrac Systems AZ
Robocasting Enterprises LLC NM
RocCera LLC NY
Silicon Carbide Products Inc NY
Technical Products Inc WI
Technology Assessment and Transfer Inc (TA&T) MD
Tethon 3D NE

Refractory Installation

Diamorph AB UK
Fosbel Inc OH
Refractory Consulting Services OH
Riverside Refractories Inc AL
Wistra GmbH Germany

Screen Printing

Aremco Products Inc NY
Gwent Electronic Materials Ltd UK
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL



Screening, Custom
AVEKA MN
CerPoTech AS Norway
Fluid Energy Processing & Equipment Co PA
General Spray LLC NJ
Reade Advanced Materials RI

Seals
Astro Met Advanced Ceramics Inc OH
Bharat Heavy Electricals Ltd NY
CerCo LLC OH
Dunhua Zhengxing Abrasive Co Ltd China
Elan Technology GA
Morgan Technical Ceramics Auburn CA
Ortech Inc CA
P-Ker Engineering NY
Precision Ceramics FL
Refrac Systems AZ
Saint-Gobain High Performance Ceramics & Refractories MA
Texers Technical Ceramics Inc Canada

Spray Drying
Arch Maintenance Services GA
AVEKA MN
CeramTec North America Corp SC
CerPoTech AS Norway
Dorst America Inc PA
Elan Technology GA
General Spray LLC NJ

Powder Processing & Technology LLC IN
Verity Technical Consultants LLC OH

Superconductors
Precision Ceramics FL

Toll Blending, Processing
AVEKA MN
CerPoTech AS Norway
Custom Processing Services PA
Euro Support Advanced Materials The Netherlands
Fluid Energy Processing & Equipment Co PA
Fusion Ceramics Inc OH
General Spray LLC NJ
Gwent Electronic Materials Ltd UK
Peter Pugger Mfg Inc CA
Powder Processing & Technology LLC IN
Reade Advanced Materials RI
Refrac Systems AZ
TAM Ceramics NY

Toll Firing, Contract
ACCCO Inc/Burley Clay Products Co OH
Advanced Ceramics Manufacturing AZ
Astro Met Advanced Ceramics Inc OH
CeramTec North America Corp SC
Christy Minerals LLC MO
FCT Ingenieurkeramik GmbH Germany
FCT Systeme GmbH Germany

Harrop Industries Inc OH **See ad on pg 58**
Ipsen Ceramics IL
Oxy-Gon Industries Inc NH **See ad on pg 89**
Refrac Systems AZ
Sunrock Ceramics Co IL
TAM Ceramics NY
TevTech LLC MA **See ad on pg 83**

Ultrasonic Machining
Ferro-Ceramic Grinding Inc MA
PremaTech Advanced Ceramics MA

DECORATING

Coating Equipment
Cerakote Ceramic Coatings OR
Cerinnov France
Haiku Tech Europe BV The Netherlands
Industrial Hard Carbon LLC NC
Laguna Clay Co CA

Colors
Arlimin Industries CO
Ceramic Color & Chemical Mfg Co PA
Cerlase France
Fusion Ceramics Inc OH
Mason Color Works Inc OH

Decal Equipment
Art On Ceramic NY
Cerinnov France

Decals
Cerlase France
IPS Ceramics LTD UK
Milestone Decal Art LLC NY

Decorating Equipment
Cerinnov France

Decorating Supplies
Ceramic Color & Chemical Mfg Co PA

Enamels
Ceramic Color & Chemical Mfg Co PA
Cerinnov France
Cerlase France
Fusion Ceramics Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden

Engobes
American Art Clay Co Inc IN
Ceramic Color & Chemical Mfg Co PA
Fusion Ceramics Inc OH
Mason Color Works Inc OH

Frits
Ceradyne Inc, a 3M Co KY
Ceramic Color & Chemical Mfg Co PA
Fusion Ceramics Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden
Trinity Ceramic Supply Inc TX

Glazes
American Art Clay Co Inc IN
Ceramic Color & Chemical Mfg Co PA
Cerlase France
Fusion Ceramics Inc OH
Laguna Clay Co CA
Mason Color Works Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden
Sheffield Pottery MA

Glazing Equipment
Arlimin Industries CO
Cerinnov France
Du-Co Ceramics Company PA
HED Intl Inc NJ

Inks
American Art Clay Co Inc IN
Ceramic Color & Chemical Mfg Co PA
Fusion Ceramics Inc OH
Gwent Electronic Materials Ltd UK
Zibo Guangtong Chemical Co Ltd China

Lehrs
Nabertherm Inc DE
Recco Furnaces CA

Pigments
Arlimin Industries CO
Ceramic Color & Chemical Mfg Co PA
Fusion Ceramics Inc OH
Mason Color Works Inc OH

Porcelain Enamels
Cerlase France
Fusion Ceramics Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden

Precious Metals
FELDCO Intl CA
Fusion Ceramics Inc OH
Gwent Electronic Materials Ltd UK

Screen Printing Equipment
Aremco Products Inc NY
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL

Silver Pastes, Conducting
Master Bond Inc NJ

Spray Booths
American Art Clay Co Inc IN
Laguna Clay Co CA

Stains
Ceramic Color & Chemical Mfg Co PA
Fusion Ceramics Inc OH
Mason Color Works Inc OH
Sheffield Pottery MA
Trinity Ceramic Supply Inc TX

Used Equipment

Mohr Corp MI **See ad on pg 79**

DINNERWARE

China, Fine
Cerinnov France
StudioLX - Home Decor IL

Earthenware
Petro Mold Company PA
Sheffield Pottery MA
Tethon 3D NE

Porcelain
Akron Porcelain & Plastics Co OH
Art On Ceramic NY
Cerinnov France
Sheffield Pottery MA
StudioLX - Home Decor IL
Tethon 3D NE
Wistra GmbH Germany

Stoneware
ACCCO Inc/Burley Clay Products Co OH
Petro Mold Company PA
Sheffield Pottery MA
Tethon 3D NE

Tableware, Glass
RISE Research Institutes of Sweden, RISE Glass Sweden
StudioLX - Home Decor IL

DRYING, FIRING & MELTING

Blowers
Zenith China

Burners
Air Products PA
Ceritherm France
Furnace Products & Services Inc PA
HED Intl Inc NJ
Swindell Dressler Intl Co PA
Zenith China

Calciners
Applied Test Systems Inc PA
Euro Support Advanced Materials The Netherlands
Fluid Energy Processing & Equipment Co PA
Harper International Corp NY **See ad on pg 77**
HED Intl Inc NJ
Keith Co CA
Nabertherm Inc DE
Raymond Bartlett Snow
Recco Furnaces CA
Thermcraft Inc NC **See ad on pg 88**
Wistra GmbH Germany
Wyssmont Co NJ
Zenith China

Cars, Dryer
Zenith China

Cars, Kiln
Basic Machinery Co Inc NC
Ceritherm France
Deltech Inc CO **See ad on pg 85**
Harrop Industries Inc OH **See ad on pg 58**
Keith Co CA
Magneco Metrel Inc IL
Recco Furnaces CA
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan
Wistra GmbH Germany
Zenith China

Cars, Transfer
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan

Controllers
Applied Test Systems Inc PA
Carbolite Gero UK **See ad on pg 101**
General Glass Equipment Co NJ
HED Intl Inc NJ
Paragon Industries LP TX
PSH Kilns & Furnaces Canada
Zenith China

Controllers, Combustion
Air Products PA
Fives north American Combustion Inc OH

Controllers, Furnace
Carbolite Gero UK **See ad on pg 101**
Nabertherm Inc DE

Thermcraft Inc NC **See ad on pg 88**
Verder Scientific Inc PA **See ad on pg 101**

Controllers, Temperature
Applied Test Systems Inc PA
Datapaq Inc NH
Edward Orton Jr Ceramic Foundation OH
Nabertherm Inc DE
Optocon AG Germany
Paragon Industries LP TX
PSH Kilns & Furnaces Canada
Verder Scientific Inc PA **See ad on pg 101**

Data Acquisition Systems
Applied Test Systems Inc PA
Datapaq Inc NH
HED Intl Inc NJ
Nabertherm Inc DE

Dryers
Aadvanced Machinery Inc MI
Applied Test Systems Inc PA
Basic Machinery Co Inc NC
Ceramic Services Inc PA
Cerlase France
Cober Muegge LLC CT
Fives north American Combustion Inc OH
Fluid Energy Processing & Equipment Co PA
Furnace Products & Services Inc PA
Goceram AB Sweden
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Harrop Industries Inc OH **See ad on pg 58**
HED Intl Inc NJ
Keith Co CA
Laeis GmbH Luxembourg
Littleford Day Inc MI
Nabertherm Inc DE
Raymond Bartlett Snow
Spray Drying Systems Inc MD
Swindell Dressler Intl Co PA
Wyssmont Co NJ
Zibo Guangtong Chemical Co Ltd China

Electrodes
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
I Squared R Element Co NY **See ad on pg 89**

Environmental Control Systems
Air Products PA
Applied Test Systems Inc PA
Control Instruments Corp NJ

Furnaces
American Isostatic Presses OH
Applied Test Systems Inc PA
Carbolite Gero UK **See ad on pg 101**

Centorr Vacuum Industries NH **See ad on pg 87**
CM Furnaces Inc NJ
Cober Muegge LLC CT
Deltech Inc CO **See ad on pg 85**
FCT Systeme GmbH Germany
Furnace Products & Services Inc PA
Gasbarre Products Inc PA **See ad on pg 95**
Goceram AB Sweden
Harper International Corp NY **See ad on pg 77**

Harrop Industries Inc OH **See ad on pg 58**
HED Intl Inc NJ
L&L Kiln Mfg Inc NJ

L&L Special Furnace Co Inc PA **See ad on pg 87**
Materials Research Furnaces Inc NH
Mohr Corp MI **See ad on pg 79**
Nabertherm Inc DE
Oxy-Gon Industries Inc NH **See ad on pg 89**
Paragon Industries LP TX
PSH Kilns & Furnaces Canada
Quintus Technologies LLC OH
RD Webb Company Inc MA
Seco/Warwick Corp PA
Swindell Dressler Intl Co PA

TevTech LLC MA **See ad on pg 83**
The Furnace Source LLC CT
Thermcraft Inc NC **See ad on pg 88**
Trent Inc PA

Verder Scientific Inc PA	**See ad on pg 101**
Wyssmont Co NJ	

Furnaces, Alternative Fuels

Ceritherm France	
Harper International Corp NY	**See ad on pg 77**
Harrop Industries Inc OH	**See ad on pg 58**
Keith Co CA	
Recco Furnaces CA	
Swindell Dressler Intl Co PA	
Thermcraft Inc NC	**See ad on pg 88**
Verder Scientific Inc PA	**See ad on pg 101**

Furnaces, Electric

Aadvanced Machinery Inc MI	
American Isostatic Presses OH	
Applied Test Systems Inc PA	
Aremco Products Inc NY	
Carbolite Gero UK	**See ad on pg 101**

Centorr Vacuum Industries NH	**See ad on pg 87**
Ceramic Services Inc PA	
Ceritherm France	
CM Furnaces Inc NJ	

Deltech Inc CO	**See ad on pg 85**
Deltech Kiln and Furnace Design, LLC CO	
FCT Systeme GmbH Germany	
Gasbarre Products Inc PA	**See ad on pg 95**
Harper International Corp NY	**See ad on pg 77**
Harrop Industries Inc OH	**See ad on pg 58**
HED Intl Inc NJ	
Keith Co CA	
L&L Kiln Mfg Inc NJ	
L&L Special Furnace Co Inc PA	**See ad on pg 87**
Lucifer Furnaces Inc PA	
Materials Research Furnaces Inc NH	
Nabertherm Inc DE	
Oxy-Gon Industries Inc NH	**See ad on pg 89**
Paragon Industries LP TX	
PSH Kilns & Furnaces Canada	
RD Webb Company Inc MA	
Recco Furnaces CA	
Seco/Warwick Corp PA	
The Furnace Source LLC CT	
Thermcraft Inc NC	**See ad on pg 88**
Trent Inc PA	
Verder Scientific Inc PA	**See ad on pg 101**
Winner Technology The Republic of Korea	
Wyssmont Co NJ	
Zircar Zirconia Inc NY	

Furnaces, Gas

Aadvanced Machinery Inc MI	
Ceramic Services Inc PA	
Ceritherm France	
Harper International Corp NY	**See ad on pg 77**
Harrop Industries Inc OH	**See ad on pg 58**
HED Intl Inc NJ	

Keith Co CA
L&L Kiln Mfg Inc NJ
L&L Special Furnace Co Inc PA See ad on pg 87
Materials Research Furnaces Inc NH
Nabertherm Inc DE
Recco Furnaces CA
Seco/Warwick Corp PA
Swindell Dressler Intl Co PA
The Furnace Source LLC CT
Thermcraft Inc NC See ad on pg 88
Wyssmont Co NJ

Furnaces, Glass-Melting

Applied Test Systems Inc PA
Carbolite Gero UK See ad on pg 101
Ceradyne Inc, a 3M Co KY
CM Furnaces Inc NJ

Deltech Inc CO See ad on pg 85
Deltech Kiln and Furnace Design, LLC CO
Furnace Products & Services Inc PA
General Glass Equipment Co NJ
Magneco Metrel Inc IL
Nabertherm Inc DE
Paragon Industries LP TX
PSH Kilns & Furnaces Canada
RISE Research Institutes of Sweden, RISE Glass Sweden

Verder Scientific Inc PA See ad on pg 101
Zircar Zirconia Inc NY

Furnaces, High-Temperature

Applied Test Systems Inc PA
Cancarb Limited Canada
Carbolite Gero UK See ad on pg 101
Centorr Vacuum Industries NH See ad on pg 87
Ceritherm France
CM Furnaces Inc NJ
Cober Muegge LLC CT
Dalmia Inst of Scientific & Industrial Research India
Deltech Inc CO See ad on pg 85
Detroit Process Machinery MI
FCT Systeme GmbH Germany
Furnace Products & Services Inc PA
Gasbarre Products Inc PA See ad on pg 95
Harper International Corp NY See ad on pg 77
Harrop Industries Inc OH See ad on pg 58
HED Intl Inc NJ
Lucifer Furnaces Inc PA
Materials Research Furnaces Inc NH
Nabertherm Inc DE
Nutec Bickley Mexico

Oxy-Gon Industries Inc NH See ad on pg 89
Plansee SE MA
PSH Kilns & Furnaces Canada
Quintus Technologies LLC OH
RD Webb Company Inc MA
Seco/Warwick Corp PA
Swindell Dressler Intl Co PA
The Furnace Source LLC CT

Thermcraft Inc NC See ad on pg 88
Verder Scientific Inc PA See ad on pg 101
Winner Technology The Republic of Korea
Zircar Zirconia Inc NY

Furnaces, Laboratory

Carbolite Gero UK See ad on pg 101
Centorr Vacuum Industries NH See ad on pg 87
CM Furnaces Inc NJ
Cober Muegge LLC CT
Deltech Inc CO See ad on pg 85
Deltech Kiln and Furnace Design, LLC CO
FCT Systeme GmbH Germany
Harper International Corp NY See ad on pg 77
L&L Special Furnace Co Inc PA See ad on pg 87
Lucifer Furnaces Inc PA
Materials Research Furnaces Inc NH
Nabertherm Inc DE
Nutec Bickley Mexico
Oxy-Gon Industries Inc NH See ad on pg 89
RD Webb Company Inc MA
RocCera LLC NY
The Furnace Source LLC CT
Verder Scientific Inc PA See ad on pg 101
Winner Technology The Republic of Korea
Zircar Zirconia Inc NY

Furnaces, Vacuum

Applied Test Systems Inc PA
AVS Inc MA
Centorr Vacuum Industries NH See ad on pg 87
Cober Muegge LLC CT
FCT Systeme GmbH Germany
Gasbarre Products Inc PA See ad on pg 95
Goceram AB Sweden
Materials Research Furnaces Inc NH
Nabertherm Inc DE
Nutec Bickley Mexico

Oxy-Gon Industries Inc NH See ad on pg 89
RocCera LLC NY
Seco/Warwick Corp PA

The Furnace Source LLC CT
Verder Scientific Inc PA — See ad on pg 101

Heating Elements

Applied Test Systems Inc PA
CM Furnaces Inc NJ
Hotek Alliance Ltd Zibo

I Squared R Element Co NY — See ad on pg 89
Keith Co CA
L&L Kiln Mfg Inc NJ
Lucifer Furnaces Inc PA
Materials Research Furnaces Inc NH
Oxy-Gon Industries Inc NH — See ad on pg 89
Plansee SE MA
PSH Kilns & Furnaces Canada
Recco Furnaces CA
Seco/Warwick Corp PA
Thermal Products Co Inc GA
Thermcraft Inc NC — See ad on pg 88
Trent Inc PA
Verder Scientific Inc PA — See ad on pg 101
Winner Technology The Republic of Korea

Humidification Systems

CM Furnaces Inc NJ

Kilns

Applied Test Systems Inc PA
Carbolite Gero UK — See ad on pg 101
Ceramic Services Inc PA
Ceritherm France
Detroit Process Machinery MI
FCT Systeme GmbH Germany
Fives north American Combustion Inc OH
Furnace Products & Services Inc PA
Harper International Corp NY — See ad on pg 77
Harrop Industries Inc OH — See ad on pg 58
HED Intl Inc NJ
Keith Co CA
L&L Kiln Mfg Inc NJ

L&L Special Furnace Co Inc PA — See ad on pg xx
Laeis GmbH Luxembourg
Laguna Clay Co CA
Lucifer Furnaces Inc PA
Mohr Corp MI — See ad on pg 79
Nutec Bickley Mexico
PSH Kilns & Furnaces Canada
RD Webb Company Inc MA
Recco Furnaces CA
RocCera LLC NY
Takasago Industry Co Ltd Japan
Thermcraft Inc NC — See ad on pg 88
Wistra GmbH Germany

Kilns, Bell

Carbolite Gero UK — See ad on pg 101
Ceramic Services Inc PA

Ceritherm France
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED Intl Inc NJ
Keith Co CA
L&L Kiln Mfg Inc NJ
L&L Special Furnace Co Inc PA **See ad on pg 87**
Lucifer Furnaces Inc PA
Nabertherm Inc DE
Nutec Bickley Mexico
PSH Kilns & Furnaces Canada
Recco Furnaces CA
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan
Thermcraft Inc NC **See ad on pg 88**
Aadvanced Machinery Inc MI
American Art Clay Co Inc IN
Applied Test Systems Inc PA
Carbolite Gero UK **See ad on pg 101**
Ceramic Services Inc PA
Ceritherm France
CM Furnaces Inc NJ
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED Intl Inc NJ
Keith Co CA
L&L Kiln Mfg Inc NJ
L&L Special Furnace Co Inc PA **See ad on pg 87**
Lucifer Furnaces Inc PA
Nabertherm Inc DE
Nutec Bickley Mexico
Paragon Industries LP TX
PSH Kilns & Furnaces Canada
Recco Furnaces CA
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan
Thermcraft Inc NC **See ad on pg 88**
Verder Scientific Inc PA **See ad on pg 101**

Kilns, Box
Nutec Bickley Mexico

Kilns, Chamber
Carbolite Gero UK **See ad on pg 101**
Ceritherm France
Harrop Industries Inc OH **See ad on pg 58**
L&L Kiln Mfg Inc NJ
Lucifer Furnaces Inc PA
Nabertherm Inc DE
Nutec Bickley Mexico
Takasago Industry Co Ltd Japan
Thermcraft Inc NC **See ad on pg 88**
Verder Scientific Inc PA **See ad on pg 101**

Kilns, Conveyor
Ceramic Services Inc PA
Ceritherm France
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED Intl Inc NJ
Keith Co CA
Lucifer Furnaces Inc PA
Nabertherm Inc DE
Nutec Bickley Mexico
Recco Furnaces CA

Kilns, Elevator
Aadvanced Machinery Inc MI
Applied Test Systems Inc PA
Ceramic Services Inc PA
Ceritherm France
CM Furnaces Inc NJ
Euro Support Advanced Materials The Netherlands
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED Intl Inc NJ
Keith Co CA
L&L Kiln Mfg Inc NJ
L&L Special Furnace Co Inc PA **See ad on pg 87**
Lucifer Furnaces Inc PA
Nabertherm Inc DE
Nutec Bickley Mexico
Recco Furnaces CA
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan

Kilns, Envelope
Ceritherm France
Harrop Industries Inc OH **See ad on pg 58**
HED INtl Inc NJ
Keith Co CA
L&L Kiln Mfg Inc NJ
L&L Special Furnace Co Inc PA **See ad on pg 87**
Nabertherm Inc DE
Nutec Bickley Mexico
PSH Kilns & Furnaces Canada
Recco Furnaces CA
Swindell Dressler Intl Co PA

Kilns, Periodic (Batch)
Aadvanced Machinery Inc MI
Carbolite Gero UK **See ad on pg 101**
Ceramic Services Inc PA
Ceritherm France
CM Furnaces Inc NJ
Cober Muegge LLC CT
FCT Systeme GmbH Germany
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED INtl Inc NJ
Keith Co CA
L&L Kiln Mfg Inc NJ
L&L Special Furnace Co Inc PA **See ad on pg 87**
Lucifer Furnaces Inc PA
Nabertherm Inc DE
Nutec Bickley Mexico
RD Webb Company Inc MA
Recco Furnaces CA
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan
Thermcraft Inc NC **See ad on pg 88**

Kilns, Pusher Plate
Ceritherm France
CM Furnaces Inc NJ
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED INtl Inc NJ
Ipsen Ceramics IL
Keith Co CA
Lucifer Furnaces Inc PA
Nutec Bickley Mexico
Recco Furnaces CA

Kilns, Roller Hearth
Ceramic Services Inc PA
Ceritherm France
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED INtl Inc NJ
Keith Co CA
Lucifer Furnaces Inc PA
Nutec Bickley Mexico
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan
Wistra GmbH Germany

Kilns, Rotary
Ceritherm France
CM Furnaces Inc NJ
Deltech Inc CO **See ad on pg 85**
Fives north American Combustion Inc OH
Furnace Products & Services Inc PA
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED INtl Inc NJ
Lucifer Furnaces Inc PA
Nutec Bickley Mexico
Raymond Bartlett Snow
Thermcraft Inc NC **See ad on pg 88**
Verder Scientific Inc PA **See ad on pg 101**

Kilns, Shuttle
Basic Machinery Co Inc NC
Ceramic Services Inc PA
Ceritherm France
CM Furnaces Inc NJ
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
HED INtl Inc NJ
Keith Co CA
L&L Kiln Mfg Inc NJ
L&L Special Furnace Co Inc PA **See ad on pg 87**
Lucifer Furnaces Inc PA
Nabertherm Inc DE
Nutec Bickley Mexico
Recco Furnaces CA
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan
Thermcraft Inc NC **See ad on pg 88**
Wistra GmbH Germany

Kilns, Test/Lab
American Art Clay Co Inc IN
Applied Test Systems Inc PA
Carbolite Gero UK **See ad on pg 101**
Ceramic Services Inc PA
CM Furnaces Inc NJ
Cober Muegge LLC CT
FCT Systeme GmbH Germany
Harper International Corp NY **See ad on pg 77**
Harrop Industries Inc OH **See ad on pg 58**
Keith Co CA
L&L Kiln Mfg Inc NJ
L&L Special Furnace Co Inc PA **See ad on pg 87**
Lucifer Furnaces Inc PA
Nabertherm Inc DE
Nutec Bickley Mexico
Paragon Industries LP TX
PSH Kilns & Furnaces Canada
RD Webb Company Inc MA
Recco Furnaces CA
Takasago Industry Co Ltd Japan
Thermcraft Inc NC **See ad on pg 88**
Verder Scientific Inc PA **See ad on pg 101**

Kilns, Tunnel (Continuous)
Applied Test Systems Inc PA
Basic Machinery Co Inc NC
Ceramic Services Inc PA
Ceritherm France
CM Furnaces Inc NJ
Cober Muegge LLC CT
Deltech Inc CO **See ad on pg 85**
Euro Support Advanced Materials The Netherlands

Harper International Corp NY — See ad on pg 77

Harrop Industries Inc OH — **See ad on pg 58**
Keith Co CA
Nutec Bickley Mexico
Recco Furnaces CA
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan
Wistra GmbH Germany

Lehrs

Ceramic Services Inc PA
Harrop Industries Inc OH — **See ad on pg 58**
Keith Co CA
Recco Furnaces CA

Microwave Systems

Bharat Heavy Electricals Ltd NY
Ceralink Inc NY
Ceritherm France
CM Furnaces Inc NJ
Cober Muegge LLC CT
Gerling Applied Engineering Inc CA
Harper International Corp NY — **See ad on pg 77**

Harrop Industries Inc OH — **See ad on pg 58**
RocCera LLC NY
Takasago Industry Co Ltd Japan

Oxygen Supply

Air Products PA

Process/Quality Control Systems

Applied Test Systems Inc PA
Datapaq Inc NH
General Glass Equipment Co NJ
Materials Research Furnaces Inc NH

Pyrometric Cones/Plaques

American Art Clay Co Inc IN
Edward Orton Jr Ceramic Foundation OH
Industrial Ceramic Products Inc OH
PSH Kilns & Furnaces Canada
Trinity Ceramic Supply Inc TX

Sensors, Temperature

Datapaq Inc NH
Penn Tool Co NJ
Zibo Guangtong Chemical Co Ltd China

Thermocouples & Accessories

AdValue Technology LLC AZ — **See ad on pg 43**
American Art Clay Co Inc IN
American Isostatic Presses OH
CM Furnaces Inc NJ
Datapaq Inc NH
Gasbarre Products Inc PA — **See ad on pg 95**
Harrop Industries Inc OH — **See ad on pg 58**
Keith Co CA
Leico Industries Inc NJ
Materials Research Furnaces Inc NH
McDanel Advanced Ceramic Technologies LLC PA — **See ad on pg 61**
PSH Kilns & Furnaces Canada
Quintus Technologies LLC OH
Recco Furnaces CA
Verder Scientific Inc PA — **See ad on pg 101**

EDUCATION & RESOURCES

Associations & Societies

Assoc of American Ceramic Component Manufacturers (AACCM) OH
Brick Industry Assn VA
Glass Mfg Industry Council OH
Indian Ceramic Society India
International Centre for Diffraction Data PA
Journal of the American Ceramic Society OH
SAMPE CA
The American Ceramic Society OH

Books

APC International Ltd PA
Bharat Heavy Electricals Ltd NY
Journal of the American Ceramic Society OH
SAMPE CA
Sheffield Pottery MA

Computer Software

Matmatch Germany

Continuing Education

Alfred University NY
Arizona State University AZ
CelSian Glass & Solar BV The Netherlands
Fraunhofer Institute for Ceramic Technologies and Systems IKTS Germany
International Centre for Diffraction Data PA
Jenike & Johanson Inc MA
JTF Microscopy Services, LLC NY
Spontaneous Materials CO
Tethon 3D NE

Degree Programs, ABET Accredited

Alfred University NY
Case Western Reserve University OH
Massachusetts Inst of Technology MA
Missouri University of Science and Technology MO
Rensselaer Polytechnic Inst NY

Degree Programs, Ceramic

The American Ceramic Society OH
Alfred University NY
Fraunhofer Institute for Ceramic Technologies and Systems IKTS Germany
Massachusetts Inst of Technology MA
Missouri University of Science and Technology MO

Degree Programs, Glass Engrg Science

Alfred University NY
Fraunhofer Institute for Ceramic Technologies and Systems IKTS Germany

Degree Programs, Materials Science
Alfred University NY
Arizona State University AZ
Case Western Reserve University OH
Fraunhofer Institute for Ceramic Technologies and Systems IKTS Germany
Massachusetts Inst of Technology MA
Missouri University of Science and Technology MO
Rensselaer Polytechnic Inst NY

Employment Services
SAMPE CA

Publications
American Ceramic Society Bulletin OH
American Scientific Publishers CA
Chemical Abstracts Service OH
GrainBound LLC PA
Indian Ceramic Society India
Journal of the American Ceramic Society OH

■ ELECTRICAL/ELECTRONIC CERAMICS

Antennas, Dielectric
Euro Support Advanced Materials The Netherlands
O'Keefe Ceramics Inc CO
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Capacitors
Associated Ceramics & Technology Inc PA **See ad on pg 65**
AVX Corp SC
Euro Support Advanced Materials The Netherlands
Ferro-Ceramic Grinding Inc MA
Induceramic Canada
Murata Manufacturing Co Ltd Japan
Polymer Innovations Inc CA

Ceramic-Brazed Assemblies
AdTech Ceramics TN
CeramTec North America Corp SC

Elcon Precision LLC CA **See ad on pg 107**
Induceramic Canada
Morgan Technical Ceramics Auburn CA
Precision Ferrites and Ceramics Inc CA

Conductors
AdTech Ceramics TN
CerPoTech AS Norway
ESL ElectroScience PA
Master Bond Inc NJ
norECs AS Norway

Crystals
Induceramic Canada
Kyocera International Inc CA
Momentive Performance Materials Inc NY
MSE Supplies AZ
TevTech LLC MA **See ad on pg 83**

Dielectrics
AVX Corp SC
Centerline Technologies OH
CerPoTech AS Norway
ESL ElectroScience PA
Euro Support Advanced Materials The Netherlands
Gwent Electronic Materials Ltd UK
Morgan Advanced Materials CA
NGK Spark Plug Co Ltd Japan
Pacific Ceramics Inc CA

Ferrites & Ferromagnetics
Advanced Ceramic Technology CA
Pacific Ceramics Inc CA
Polymer Innovations Inc CA
Precision Ferrites and Ceramics Inc CA
Spontaneous Materials CO

Filters, Dielectric
CerPoTech AS Norway
Euro Support Advanced Materials The Netherlands
Murata Manufacturing Co Ltd Japan
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Fuel Cells, Solid Oxide
AdTech Ceramics TN
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Bharat Heavy Electricals Ltd NY
Cancarb Limited Canada
CerPoTech AS Norway
ESL ElectroScience PA
Euro Support Advanced Materials The Netherlands
Gwent Electronic Materials Ltd UK
H.C. Starck GmbH Germany
H.C. Starck Surface Technology and Ceramic Powders GmbH Germany
Morgan Technical Ceramics Auburn CA
Nexceris LLC OH
norECs AS Norway
Polymer Innovations Inc CA
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

High-Voltage Insulators
Akron Porcelain & Plastics Co OH
Bharat Heavy Electricals Ltd NY
Ceramco Inc NH
CeramTec North America Corp SC
Du-Co Ceramics Company PA
Elcon Precision LLC CA **See ad on pg 107**
Morgan Technical Ceramics Auburn CA
Precision Ferrites and Ceramics Inc CA
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**

Hybrid Circuits & Packages
AdTech Ceramics TN
AVX Corp SC
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**
Precision Ferrites and Ceramics Inc CA

IC Packages
AdTech Ceramics TN
Kyocera International Inc CA
NGK Spark Plug Co Ltd Japan

Insulators, Electrical/Electronic
Accuratus Corp NJ
AdTech Ceramics TN
AdValue Technology LLC AZ **See ad on pg 43**
Akron Porcelain & Plastics Co OH
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
CeramTec North America Corp SC
CerCo LLC OH
Du-Co Ceramics Company PA
ER Advanced Ceramics Inc OH
ESL ElectroScience PA
Federal-Mogul MI
Maryland Ceramic & Steatite Co Inc MD
Materion Ceramics AZ
Morgan Technical Ceramics Auburn CA
NEVZ-Ceramics, Close JSC Russia
P-Ker Engineering NY
Precision Ferrites and Ceramics Inc CA
Sonya Ceramics (Export Division) India
Superior Technical Ceramics Corp VT **See ad on pg 63**
Toto Ltd Japan
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**
Zircoa Inc OH

Magnets
Spontaneous Materials CO

Microwave Packages
AdTech Ceramics TN
Kyocera International Inc CA
Precision Ferrites and Ceramics Inc CA

Multilayer Ceramic Capacitors
Euro Support Advanced Materials The Netherlands
Murata Manufacturing Co Ltd Japan
Polymer Innovations Inc CA

Multilayer Ceramics, AlN
AdTech Ceramics TN
NEVZ-Ceramics, Close JSC Russia
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**

Multilayer Ceramics, Custom
AdTech Ceramics TN
EBL Products Inc CT
Euro Support Advanced Materials The Netherlands
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**

Piezoelectrics
APC International Ltd PA
AVX Corp SC
EBL Products Inc CT
Meggitt Piezo Technologies IN
Morgan Advanced Materials CA
Polymer Innovations Inc CA
Sparkler Ceramics Pvt Ltd India

Resistors, Thick-Film
ESL ElectroScience PA
Murata Manufacturing Co Ltd Japan
Polymer Innovations Inc CA

Resonators
AVX Corp SC
Murata Manufacturing Co Ltd Japan
NGK Spark Plug Co Ltd Japan
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

RF Components
AdTech Ceramics TN
Advanced Ceramic Technology CA
Advanced Energy CO
Murata Manufacturing Co Ltd Japan
Precision Ferrites and Ceramics Inc CA
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Semiconductors
Cancarb Limited Canada
Elcon Precision LLC CA **See ad on pg 107**
Momentive Performance Materials Inc NY
NEVZ-Ceramics, Close JSC Russia

Semiconductor Energy Laboratory Co Ltd Japan
See ad on pg 91

Toto Ltd Japan

Sensors

AdTech Ceramics TN
AVX Corp SC
Bullen OH
CeramTec North America Corp SC
EBL Products Inc CT
Gwent Electronic Materials Ltd UK
Murata Manufacturing Co Ltd Japan
Neoptix Canada
Optocon AG Germany
Polymer Innovations Inc CA
Quality Thermistor Inc ID
Sparkler Ceramics Pvt Ltd India
Technisonic Research Inc CT

Spark Plugs

Associated Ceramics & Technology Inc PA
See ad on pg 65

CerCo LLC OH
Federal-Mogul MI
Gwent Electronic Materials Ltd UK
NGK Spark Plug Co Ltd Japan

Substrates, Alumina

Accuratus Corp NJ
AdTech Ceramics TN
Bullen OH
Centerline Technologies OH
CeramTec North America Corp SC
CoorsTek CO
Du-Co Ceramics Company PA
Laserage Technology Corp IL
NEVZ-Ceramics, Close JSC Russia
NGK Spark Plug Co Ltd Japan
Ortech Inc CA
Saint-Gobain norPro OH
Toto Ltd Japan
Valley Design Corp MA
Xiamen Innovacera Advanced Materials Co Ltd China
See ad on pg 93

Substrates, Aluminum Nitride

Accuratus Corp NJ
AdTech Ceramics TN
Bullen OH
Centerline Technologies OH
CoorsTek CO
Laserage Technology Corp IL
MSE Supplies AZ
NEVZ-Ceramics, Close JSC Russia
Ortech Inc CA
Starfire Systems Inc NY
Valley Design Corp MA
Xiamen Innovacera Advanced Materials Co Ltd China
See ad on pg 93

Substrates, Glass

Accuratus Corp NJ
Bullen OH
Centerline Technologies OH
Laserage Technology Corp IL
RISE Research Institutes of Sweden, RISE Glass Sweden
Saint-Gobain Recherche France
Valley Design Corp MA
Accuratus Corp NJ
Akron Porcelain & Plastics Co OH
Bullen OH
Centerline Technologies OH
CoorsTek CO
Du-Co Ceramics Company PA
MSE Supplies AZ
NGK Spark Plug Co Ltd Japan
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
Valley Design Corp MA
Zircar Zirconia Inc NY

Substrates, Silicon Carbide

Bullen OH
Centerline Technologies OH
Ortech Inc CA
Toto Ltd Japan
Valley Design Corp MA

Superconductors, High-Temperature

Xiamen Innovacera Advanced Materials Co Ltd China
See ad on pg 93

Tapes

Du-Co Ceramics Company PA
ESL ElectroScience PA
Euro Support Advanced Materials The Netherlands
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Maryland Ceramic & Steatite Co Inc MD
Polymer Innovations Inc CA

Thermistors

AVX Corp SC
Gwent Electronic Materials Ltd UK
Murata Manufacturing Co Ltd Japan
Polymer Innovations Inc CA
Quality Thermistor Inc ID

Transducers

APC International Ltd PA
CSC Force Measurement Inc MA
EBL Products Inc CT
Meggitt Piezo Technologies IN
Neoptix Canada
Sparkler Ceramics Pvt Ltd India
Technisonic Research Inc CT

Transformers

RoMan Manufacturing MI
Warner Power LLC MI

Ultrasonic Ceramics

APC International Ltd PA
EBL Products Inc CT
Meggitt Piezo Technologies IN

Varistors

AVX Corp SC
Kyocera International Inc CA
Polymer Innovations Inc CA

FABRICATING & FINISHING

Abrasives
Allied High Tech Products Inc CA
Diacut Inc CO
Diamond Industrial Tools Inc IL
Dunhua Zhengxing Abrasive Co Ltd China
Dynacut Inc PA
Electro Abrasives Corp NY
Engis Corp IL
FELDCO Intl CA
Jet Edge Waterjet Systems MN
Reade Advanced Materials RI
Saint-Gobain Abrasives MA
Sigmadiamant Spain
Stahli USA Inc WI

Superior Graphite Co IL **See ad on pg 73**
Suntech Advanced Ceramics (Shenzhen) Co Ltd China
Washington Mills Electro Minerals Co NY

Brickmaking Equipment
Basic Machinery Co Inc NC
EZG Manufacturing Inc OH **Inside front cover**
Laeis GmbH Luxembourg
Stedman Machine Co IN

Casting Equipment, Pressure
American Isostatic Presses OH
Cerinnov France
Cerlase France
Dorst America Inc PA
HED INtl Inc NJ
Laguna Clay Co CA
Maryland Ceramic & Steatite Co Inc MD

Casting Equipment, Tape
Ferro-Ceramic Grinding Inc MA
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
HED INtl Inc NJ
Polymer Innovations Inc CA

CNC Mills
Elcon Precision LLC CA **See ad on pg 107**
Liberty Machinery Co IL
OptiPro Systems LLC NY
Penn Tool Co NJ
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Coating Equipment
Allied High Tech Products Inc CA
Cerakote Ceramic Coatings OR
Dynacut Inc PA
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Liberty Machinery Co IL

Cold-End Coatings, Glass
RISE Research Institutes of Sweden, RISE Glass Sweden

Controllers
Dorst America Inc PA
General Glass Equipment Co NJ
Laguna Clay Co CA
Rockwell Automation, Inc WI

Cutting Equipment
Basic Machinery Co Inc NC
Diamond Industrial Tools Inc IL
General Glass Equipment Co NJ
Haiku Tech Inc FL
Jet Edge Waterjet Systems MN
Liberty Machinery Co IL
OptiPro Systems LLC NY
Penn Tool Co NJ
Sigmadiamant Spain
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Cutting Tools
Diacut Inc CO
Dynacut Inc PA
Engis Corp IL
Jet Edge Waterjet Systems MN
New Tech Ceramics Inc IA
Penn Tool Co NJ
Sigmadiamant Spain

CVD Equipment
Advanced Energy CO
Centorr Vacuum Industries NH **See ad on pg 87**
Liberty Machinery Co IL

Deburring Equipment
Engis Corp IL
Liberty Machinery Co IL
Mohr Corp MI **See ad on pg 79**
Penn Tool Co NJ

Diamond Drills
Diamond Industrial Tools Inc IL
Greenlee Diamond Tool Co IL

Diamond Hones
Diamond Industrial Tools Inc IL
Engis Corp IL
Greenlee Diamond Tool Co IL
Saint-Gobain Abrasives MA
Stahli USA Inc WI

Diamond Saw Blades
Allied High Tech Products Inc CA
Aremco Products Inc NY
Comtrust Architectural Mesh Co Ltd China
Diacut Inc CO
Diamond Industrial Tools Inc IL
Dynacut Inc PA
Engis Corp IL
Greenlee Diamond Tool Co IL
LECO Corp MI
Liberty Machinery Co IL
Saint-Gobain Abrasives MA
Texers Technical Ceramics Inc Canada

Diamond Saws
Allied High Tech Products Inc CA
Aremco Products Inc NY
Diacut Inc CO
Dynacut Inc PA
Greenlee Diamond Tool Co IL
Liberty Machinery Co IL

Diamond Tools
Diamond Industrial Tools Inc IL
Engis Corp IL
Greenlee Diamond Tool Co IL
LECO Corp MI
Penn Tool Co NJ
Saint-Gobain Abrasives MA
Sigmadiamant Spain

Dicing Equipment
Aremco Products Inc NY
Diacut Inc CO
Diamond Industrial Tools Inc IL
Dynacut Inc PA
Liberty Machinery Co IL
Nutec Bickley Mexico

Dies
Gasbarre Products Inc PA **See ad on pg 95**
Ram Products Inc OH

Dressing Wheels, Diamond
Diacut Inc CO
Diamond Industrial Tools Inc IL
Dynacut Inc PA
Engis Corp IL
Greenlee Diamond Tool Co IL

Electroplating Equipment
Haiku Tech Inc FL
Liberty Machinery Co IL
Penn Tool Co NJ

Extruders
Aadvanced Machinery Inc MI
American Art Clay Co Inc IN
Basic Machinery Co Inc NC
Detroit Process Machinery MI
Dorst America Inc PA
Ipsen Ceramics IL
Laguna Clay Co CA
Mohr Corp MI **See ad on pg 79**
North Star Equipment Inc WA
Peter Pugger Mfg Inc CA

Feeders
Ingredient Masters Inc OH **See ad on pg 103**
Isoform Ltd UK
Mohr Corp MI **See ad on pg 79**
Wyssmont Co NJ

Forming Equipment
American Isostatic Presses OH
ARBURG GmbH + Co KG Germany
Dorst America Inc PA
HED INtl Inc NJ
Ipsen Ceramics IL
Isoform Ltd UK
Lithoz GmbH NY
Mohr Corp MI **See ad on pg 79**
Quintus Technologies LLC OH
Ram Products Inc OH

Glass Finishing Equipment
General Glass Equipment Co NJ
Liberty Machinery Co IL
Lithoz GmbH NY
OptiPro Systems LLC NY

Glass Forming Equipment
General Glass Equipment Co NJ

Glass Shear Spray
RISE Research Institutes of Sweden, RISE Glass Sweden

Glass Supplies
Ipsen Ceramics IL

Grinders, Centerless
Diamond Industrial Tools Inc IL
Liberty Machinery Co IL
Precision Ferrites and Ceramics Inc CA
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Grinders, Cylindrical
Diamond Industrial Tools Inc IL
Liberty Machinery Co IL
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Grinders, Finished Product
DCM Tech MN
Ipsen Ceramics IL
Liberty Machinery Co IL
OptiPro Systems LLC NY
Stahli USA Inc WI

Grinding Wheels
Allied High Tech Products Inc CA
Diacut Inc CO
Diamond Industrial Tools Inc IL
Dynacut Inc PA
Engis Corp IL
Greenlee Diamond Tool Co IL
Penn Tool Co NJ
Sigmadiamant Spain
Stahli USA Inc WI

Hydraulic Systems
Isoform Ltd UK
Ram Products Inc OH

Injection-Molding Equipment
ARBURG GmbH + Co KG Germany
Goceram AB Sweden
Mohr Corp MI **See ad on pg 79**
Rockwell Automation, Inc WI
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Jiggering Equipment
Cerinnov France
Ram Products Inc OH

Lapping Equipment
Allied High Tech Products Inc CA
Diamond Industrial Tools Inc IL
Dynacut Inc PA
Engis Corp IL
Liberty Machinery Co IL
OptiPro Systems LLC NY
Sigmadiamant Spain
Stahli USA Inc WI

Lapping Supplies
Allied High Tech Products Inc CA
Diamond Industrial Tools Inc IL
Dunhua Zhengxing Abrasive Co Ltd China
Engis Corp IL
FELDCO Intl CA
Stahli USA Inc WI

Laser Scribers
Centerline Technologies OH
Cerlase France
Laserage Technology Corp IL

Machining Equipment
Advanced Ceramic Technology CA
Dynacut Inc PA
International Ceramic Engineering MA
Liberty Machinery Co IL
OptiPro Systems LLC NY
Penn Tool Co NJ
Stahli USA Inc WI

Mandrels, Diamond
Diacut Inc CO
Diamond Industrial Tools Inc IL

Engis Corp IL
Greenlee Diamond Tool Co IL

Molds, Case

Petro Mold Company PA
Ram Products Inc OH

Molds, Ceramic-Forming

Akron Porcelain & Plastics Co OH
Cerinnov France
Cerlase France
Goceram AB Sweden
Ipsen Ceramics IL
Isoform Ltd UK
Laeis GmbH Luxembourg
Laguna Clay Co CA
Petro Mold Company PA
Ram Products Inc OH
Viridis3D LLC MA

Molds, Models

Petro Mold Company PA
Ram Products Inc OH
Viridis3D LLC MA

Plasma Etching Systems

Advanced Energy CO
Liberty Machinery Co IL

Pneumatic Systems

Cyclonaire Corp NE
Ingredient Masters Inc OH **See ad on pg 103**
Ram Products Inc OH
Young Industries Inc PA

Polishing Equipment

Allied High Tech Products Inc CA
Diamond Industrial Tools Inc IL
Dynacut Inc PA
Engis Corp IL
LECO Corp MI
Liberty Machinery Co IL
OptiPro Systems LLC NY
Penn Tool Co NJ
Sigmadiamant Spain
Stahli USA Inc WI

Polishing Powder & Supplies

Baikowski Malakoff Inc NC
C&L Development Corp CA
Engis Corp IL
Sigmadiamant Spain
Stahli USA Inc WI

Presses, Compacting

Detroit Process Machinery MI
Digital Press Inc PA
Dorst America Inc PA

Gasbarre Products (PTX Pentronix) PA **See ad on pg 95**
Gasbarre Products Inc PA **See ad on pg 95**
Mohr Corp MI **See ad on pg 79**
Quintus Technologies LLC OH

Presses, Dry

Aadvanced Machinery Inc MI
Dorst America Inc PA
Gasbarre Products Inc PA **See ad on pg 95**
Maryland Ceramic & Steatite Co Inc MD
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Presses, Extrusion

Dorst America Inc PA
Maryland Ceramic & Steatite Co Inc MD
Mohr Corp MI **See ad on pg 79**
Peter Pugger Mfg Inc CA

Presses, Hot

American Isostatic Presses OH
Centorr Vacuum Industries NH **See ad on pg 87**
FCT Ingenieurkeramik GmbH Germany
FCT Systeme GmbH Germany
Materials Research Furnaces Inc NH
Oxy-Gon Industries Inc NH **See ad on pg 89**
Refrac Systems AZ

Presses, Hot Isostatic

American Isostatic Presses OH
AVS Inc MA
FCT Ingenieurkeramik GmbH Germany
Quintus Technologies LLC OH

Presses, Hydraulic

Aadvanced Machinery Inc MI
ARBURG GmbH + Co KG Germany
AVS Inc MA
Digital Press Inc PA
Dorst America Inc PA
Gasbarre Products Inc PA **See ad on pg 95**
Laeis GmbH Luxembourg
Materials Research Furnaces Inc NH
Mohr Corp MI **See ad on pg 79**
Ram Products Inc OH

Presses, Isostatic

Aadvanced Machinery Inc MI
American Isostatic Presses OH
Cerinnov France
Cerlase France
Detroit Process Machinery MI
Dorst America Inc PA

Gasbarre Products (PTX Pentronix) PA **See ad on pg 95**
Gasbarre Products Inc PA **See ad on pg 95**
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Isoform Ltd UK
Mohr Corp MI **See ad on pg 79**
Quintus Technologies LLC OH
RocCera LLC NY
Suntech Advanced Ceramics (Shenzhen) Co Ltd China

Presses, Other

ARBURG GmbH + Co KG Germany
Isoform Ltd UK

Presses, Pressure Casting

Cerlase France
Dorst America Inc PA
Peter Pugger Mfg Inc CA
Ram Products Inc OH

Presses, Refractory Shapes

Laeis GmbH Luxembourg

Presses, Rotary

Aadvanced Machinery Inc MI
Materials Research Furnaces Inc NH

Presses, Tile (Ceramic)

Laeis GmbH Luxembourg
Peter Pugger Mfg Inc CA

Pug Mills

Aadvanced Machinery Inc MI
Basic Machinery Co Inc NC
Dorst America Inc PA
Mohr Corp MI **See ad on pg 79**
Peter Pugger Mfg Inc CA
Sheffield Pottery MA
Young Industries Inc PA

PVD Equipment

Liberty Machinery Co IL
Teeter Marketing Services LLC FL

Roofing Tile Machinery

Laeis GmbH Luxembourg

Setting Equipment

Basic Machinery Co Inc NC

Slab Rollers

North Star Equipment Inc WA

Spray Booths

Treibacher Industrie AG Austria

Sputtering Equipment

Advanced Energy CO
FCT Ingenieurkeramik GmbH Germany

Superabrasives

Diamond Industrial Tools Inc IL
Dynacut Inc PA
Engis Corp IL
Greenlee Diamond Tool Co IL
Liberty Machinery Co IL
Teeter Marketing Services LLC FL

Surface Modification Systems

Teeter Marketing Services LLC FL

Tilemaking Equipment

Basic Machinery Co Inc NC
Peter Pugger Mfg Inc CA
Ram Products Inc OH

Tools, Modeling

Sheffield Pottery MA
Viridis3D LLC MA

Turning Machines, Insulator
Liberty Machinery Co IL

Ultrasonic Machining Equipment
Bullen OH
International Ceramic Engineering MA
Liberty Machinery Co IL
OptiPro Systems LLC NY

Used Equipment
Aadvanced Machinery Inc MI
Basic Machinery Co Inc NC
Cerinnov France
Diamond Industrial Tools Inc IL
Dorst America Inc PA
Dynacut Inc PA
Liberty Machinery Co IL
Mohr Corp MI **See ad on pg 79**
Ram Products Inc OH
Viridis3D LLC MA

Vibratory Finishing Equipment
Liberty Machinery Co IL
Penn Tool Co NJ
Rockwell Automation, Inc WI

Wheels, Cutoff & Grinding
Diacut Inc CO
Diamond Industrial Tools Inc IL
Dynacut Inc PA
Engis Corp IL
Greenlee Diamond Tool Co IL
LECO Corp MI
Liberty Machinery Co IL
Penn Tool Co NJ

Wheels, Diamond
Aremco Products Inc NY
Diacut Inc CO
Diamond Industrial Tools Inc IL
Dynacut Inc PA
Engis Corp IL
Greenlee Diamond Tool Co IL
LECO Corp MI
Sigmadiamant Spain
Stahli USA Inc WI

■ GLASS PRODUCTS

Automotive Glass
Arkema Inc PA
RISE Research Institutes of Sweden, RISE Glass Sweden
Saint-Gobain Recherche France
Schott North America Inc NY **See ad on pg 41**

Beads/Spheres
Ceradyne Inc, a 3M Co KY
Maryland Ceramic & Steatite Co Inc MD

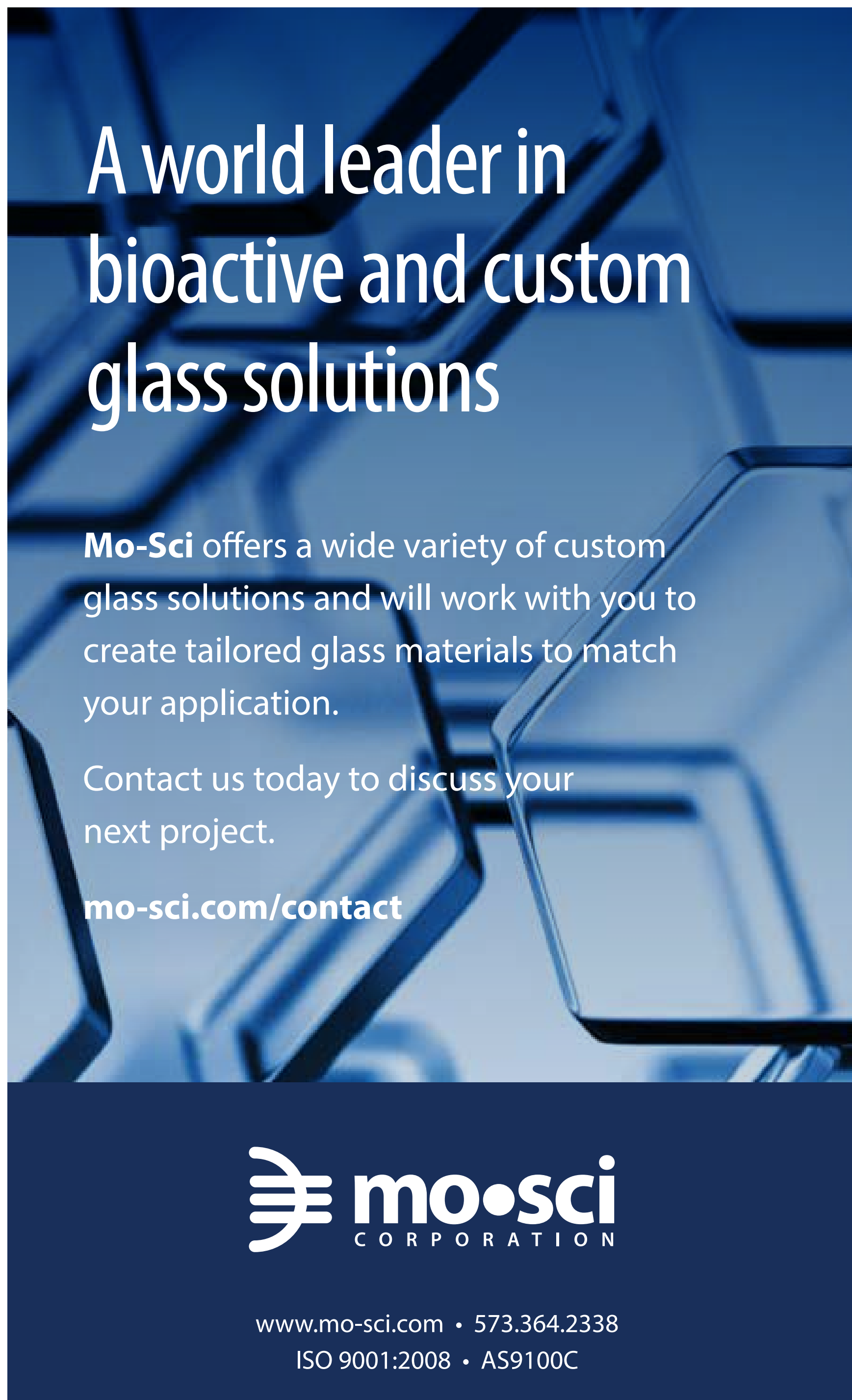
Mo-Sci Corp MO **See ad on pg 97**
Reade Advanced Materials RI
Zircoa Inc OH

Bioglass
Ceradyne Inc, a 3M Co KY

Mo-Sci Corp MO **See ad on pg 97**
RISE Research Institutes of Sweden, RISE Glass Sweden
Specialty Glass Inc FL

Borosilicate Glass
Bullen OH
Elan Technology GA
Garg Process Glass India Pvt Ltd India
RISE Research Institutes of Sweden, RISE Glass Sweden
Schott North America Inc NY **See ad on pg 41**

Specialty Glass Inc FL
Valley Design Corp MA



Chemically Strengthened Glass
Arkema Inc PA
Garg Process Glass India Pvt Ltd India
RISE Research Institutes of Sweden, RISE Glass Sweden
Saint-Gobain Recherche France
Saxon Glass Technologies Inc NY
Schott North America Inc NY **See ad on pg 41**
Vesuvius SC

Container Glass
Arkema Inc PA
Cerinnov France
Owens-Illinois Inc OH
RISE Research Institutes of Sweden, RISE Glass Sweden
Saint-Gobain Recherche France
Vesuvius SC

Fibers, Continuous
Saint-Gobain Recherche France
Verity Technical Consultants LLC OH

Fibers, Optical
Adamant Co Ltd Japan
Corning Incorporated NY
Optocon AG Germany
Schott North America Inc NY **See ad on pg 41**

Flat & Safety Glass
Arkema Inc PA
RISE Research Institutes of Sweden, RISE Glass Sweden
Saint-Gobain Recherche France
Vesuvius SC

Fused Silica Glass
Accuratus Corp NJ
Arkema Inc PA
Bullen OH
Imerys Refractory Minerals GA
RISE Research Institutes of Sweden, RISE Glass Sweden
Valley Design Corp MA

Glass-Ceramics
Accuratus Corp NJ
Advanced Ceramic Technology CA
Arkema Inc PA
Bullen OH
Cerlase France
Elan Technology GA

Ivoclar Vivadent, Inc **See ad on pg 95**
Petro Mold Company PA
PremaTech Advanced Ceramics MA

Schott North America Inc NY **See ad on pg 41**
Specialty Glass Inc FL
StudioLX - Home Decor IL
TevTech LLC MA **See ad on pg 83**
Texers Technical Ceramics Inc Canada
Valley Design Corp MA
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**

Glass-to-Metal Seals
Elan Technology GA
ESL ElectroScience PA
RISE Research Institutes of Sweden, RISE Glass Sweden
Schott North America Inc NY **See ad on pg 41**
Specialty Glass Inc FL

Laboratory & Technical Glass
Arkema Inc PA
Garg Process Glass India Pvt Ltd India
LECO Corp MI
RISE Research Institutes of Sweden, RISE Glass Sweden
Saxon Glass Technologies Inc NY
Schott North America Inc NY **See ad on pg 41**
Specialty Glass Inc FL
TevTech LLC MA **See ad on pg 83**

Laminated Glass
Arkema Inc PA
RISE Research Institutes of Sweden, RISE Glass Sweden
Vesuvius SC

Laser Glasses
Cerinnov France
Israel Ceramic & Silicate Inst Israel
RISE Research Institutes of Sweden, RISE Glass Sweden

Lenses
TevTech LLC MA **See ad on pg 83**

Lighting
Osram Sylvania Inc MA

Mirrors
Valley Design Corp MA

Optical & Optoelectronic Ceramics
NEVZ-Ceramics, Close JSC Russia
Specialty Glass Inc FL
TevTech LLC MA **See ad on pg 83**
Vesuvius SC

Optical Substrates
Bullen OH
FELDCO Intl CA
Schott North America Inc NY **See ad on pg 41**
Specialty Glass Inc FL
Valley Design Corp MA
Vesuvius SC

Optical Thin Films
FELDCO Intl CA
Schott North America Inc NY **See ad on pg 41**
TevTech LLC MA **See ad on pg 83**

Solar
Ceradyne Inc, a 3M Co KY
FELDCO Intl CA
Materion Ceramics AZ
TevTech LLC MA **See ad on pg 83**
Texers Technical Ceramics Inc Canada
Vesuvius SC

Specialty Glass
Ceradyne Inc, a 3M Co KY
Corning Incorporated NY
Fusion Ceramics Inc OH
Garg Process Glass India Pvt Ltd India
Israel Ceramic & Silicate Inst Israel
Refrac Systems AZ
RISE Research Institutes of Sweden, RISE Glass Sweden
Saint-Gobain Recherche France
Saxon Glass Technologies Inc NY
Schott North America Inc NY **See ad on pg 41**

Specialty Glass Inc FL
Vesuvius SC

Technical Glass
Ceradyne Inc, a 3M Co KY
Elan Technology GA
RISE Research Institutes of Sweden, RISE Glass Sweden
Saxon Glass Technologies Inc NY

Schott North America Inc NY **See ad on pg 41**

Specialty GLASS
solving the science of glass™
since 1977
305 Marlborough Street • Oldsmar, Florida 34677
Phone (813) 855-5779 • e-mail: info@sgiglass.com
www.sgiglass.com

Specialty Glass Inc FL
Vesuvius SC

Tubing & Rod
AdValue Technology LLC AZ **See ad on pg 43**
Garg Process Glass India Pvt Ltd India
Morgan Advanced Materials CA
Specialty Glass Inc FL

LABORATORY EQUIPMENT & SUPPLIES

Chemicals
Arkema Inc PA
Bayville Chemical Supply Co Inc NY
Nanofilm OH
RocCera LLC NY

Colorimeters
HunterLab VA

Density Measurement Instruments
Micromeritics Instrument Corp GA
Particle Technology Labs IL **See ad on pg 99**
Penn Tool Co NJ
Quantachrome Instruments FL
RocCera LLC NY

Detectors
Control Instruments Corp NJ
Penn Tool Co NJ
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

Dimension Measurement Instruments
CSC Force Measurement Inc MA
Penn Tool Co NJ

Dryers
Applied Test Systems Inc PA
Ceramic Services Inc PA
Cober Muegge LLC CT
Detroit Process Machinery MI
EIRICH Machines, Inc IL
Goceram AB Sweden
Littleford Day Inc MI
Recco Furnaces CA
Wyssmont Co NJ

Fiberoptic Illuminators
Carl Zeiss MircoImaging Inc NY

Glass Testing Instruments
Mo-Sci Corp MO **See ad on pg 97**
RISE Research Institutes of Sweden, RISE Glass Sweden
Taber Industries NY

Glassware
AdValue Technology LLC AZ **See ad on pg 43**
Garg Process Glass India Pvt Ltd India
RISE Research Institutes of Sweden, RISE Glass Sweden

Glossimeters
Horiba Instruments Inc CA

Hardness Measurement Instruments
Allied High Tech Products Inc CA

Buehler Ltd IL **See ad on pg 99**
Carl Zeiss MircoImaging Inc NY
LECO Corp MI
Nanoscience Instruments AZ
Penn Tool Co NJ
Taber Industries NY

Hot Plates
RocCera LLC NY
Zhengzhou Mission Ceramic Products Co Ltd China

Lab Crucibles
AdValue Technology LLC AZ **See ad on pg 43**
Ceramco Inc NH
CoorsTek CO
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Robocasting Enterprises LLC NM
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**
Zhengzhou Mission Ceramic Products Co Ltd China

Lab Furnace Tubes
AdValue Technology LLC AZ **See ad on pg 43**
Carbolite Gero UK **See ad on pg 101**
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Nabertherm Inc DE
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**
Zhengzhou Mission Ceramic Products Co Ltd China

Lab Furnaces
Aadvanced Machinery Inc MI
American Isostatic Presses OH
Applied Test Systems Inc PA
AVS Inc MA
Carbolite Gero UK See ad on pg 101

Centorr Vacuum Industries NH See ad on pg 87
Ceramic Services Inc PA
CM Furnaces Inc NJ
CSC Force Measurement Inc MA
Deltech Inc CO See ad on pg 85
Detroit Process Machinery MI
L&L Special Furnace Co Inc PA See ad on pg 87
Lucifer Furnaces Inc PA
Materials Research Furnaces Inc NH
Nabertherm Inc DE
Oxy-Gon Industries Inc NH See ad on pg 89
Paragon Industries LP TX
RD Webb Company Inc MA

TevTech LLC MA See ad on pg 83
The Furnace Source LLC CT
Thermcraft Inc NC See ad on pg 88
Trent Inc PA
Verder Scientific Inc PA See ad on pg 101
Zhengzhou Mission Ceramic Products Co Ltd China
ZIRCAR Ceramics Inc NY
Zircar Zirconia Inc NY

Light Sources
Allied High Tech Products Inc CA
Carl Zeiss Mircolmaging Inc NY
Spectronics Corp NY

Mechanical Property Measurement Instruments
Applied Test Systems Inc PA
Buehler Ltd IL See ad on pg 99
BuzzMac Intl LLC ME
CSC Force Measurement Inc MA
Nanoscience Instruments AZ
TA Instruments DE
Taber Industries NY

Microscopes, Hot Stages
Carl Zeiss Mircolmaging Inc NY
Dalmia Inst of Scientific & Industrial Research India
TA Instruments DE

Microscopes, Interference
Buehler Ltd IL See ad on pg 99
Carl Zeiss Mircolmaging Inc NY

Microscopes, Other
AdValue Technology LLC AZ See ad on pg 43
Allied High Tech Products Inc CA
Carl Zeiss Mircolmaging Inc NY
Nanoscience Instruments AZ
TA Instruments DE

Microscopes, Polarizing
Buehler Ltd IL See ad on pg 99
Carl Zeiss Mircolmaging Inc NY
JTF Microscopy Services, LLC NY

Microscopes, Reflected Light
Allied High Tech Products Inc CA
Buehler Ltd IL See ad on pg 99
Carl Zeiss Mircolmaging Inc NY
LECO Corp MI

Microscopes, Scanning Electron
Nanoscience Instruments AZ
SEMTech Solutions Inc UK

Microscopes, Transmission Electron
Horiba Instruments Inc CA

Mills, Laboratory
Advanced Ceramics Manufacturing AZ
Custom Processing Services PA
Detroit Process Machinery MI
Fluid Energy Processing & Equipment Co PA
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC

Ivoclar Vivadent, Inc See ad on pg 95
MSE Supplies AZ
Stedman Machine Co IN
Union Process OH

Mixers, Laboratory
Custom Processing Services PA
Detroit Process Machinery MI
EIRICH Machines, Inc IL
Fritsch GmbH - Milling and Sizing Germany
Lancaster Products PA
Littleford Day Inc MI
Peter Pugger Mfg Inc CA
Ram Products Inc OH
Verder Scientific Inc PA See ad on pg 101

Moisture Testing
LECO Corp MI
Micromeritics Instrument Corp GA

Optical Comparitors
Penn Tool Co NJ

Optical Property Measurement Instruments
Fritsch GmbH - Milling and Sizing Germany

pH Meters
Horiba Instruments Inc CA
Mettler-Toledo Inc OH
Ocean Optics Inc FL

Porosimeters
Micromeritics Instrument Corp GA
Particle Technology Labs IL See ad on pg 99
Quantachrome Instruments FL

Powders Samplers
Fritsch Milling & Sizing Inc NC
Quantachrome Instruments FL

Recorders
CSC Force Measurement Inc MA
Datapaq Inc NH
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

Rheometers
Particle Technology Labs IL See ad on pg 99
TA Instruments DE

Sample Preparation Equipment
Allied High Tech Products Inc CA

Buehler Ltd IL See ad on pg 99
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC
Micromeritics Instrument Corp GA
Ram Products Inc OH

Verder Scientific Inc PA See ad on pg 101

Thermometers
Optocon AG Germany
Penn Tool Co NJ
Xiamen Innovacera Advanced Materials Co Ltd China See ad on pg 93

Viscosity Measurement Instruments
Carl Zeiss Mircolmaging Inc NY
norcross Viscosity Controls MI
RISE Research Institutes of Sweden, RISE Glass Sweden
Rockwell Automation, Inc WI
TA Instruments DE

Visual Inspection Instruments
Buehler Ltd IL See ad on pg 99
Haiku Tech Inc FL
Penn Tool Co NJ
Taber Industries NY

Weighing/Scales
CSC Force Measurement Inc MA
Mettler-Toledo Inc OH
Penn Tool Co NJ
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

■ LABORATORY SERVICES

Atomic Adsorption
Spectrochemical Laboratories PA

Auger Analysis
Evans Analytical Group LLC CA
High Temperature Materials Lab TN
Micron Inc DE

Chemical Analysis
Activation Laboratories Ltd Canada
CelSian Glass & Solar BV The Netherlands
CHEMIR - A Division of Evans Analytical Group MO
Dalmia Inst of Scientific & Industrial Research India
Edward Orton Jr Ceramic Foundation OH
Evans Analytical Group LLC CA
Geller Microanalytical Laboratory Inc MA
H&M Analytical Services Inc NJ
Hindalco Industries Limited India
Israel Ceramic & Silicate Inst Israel
Japan Fine Ceramics Center Japan
Lucideon UK
NSL Analytical Services Inc OH **See ad on pg 75**
RISE Research Institutes of Sweden, RISE Glass Sweden
Setaram Instrumentation France
Technology of Materials CA
Washington Mills Electro Minerals Co NY

Clay Testing
Activation Laboratories Ltd Canada
Edward Orton Jr Ceramic Foundation OH
Imerys GA
Laguna Clay Co CA
Technology of Materials CA

Composition
Activation Laboratories Ltd Canada
Alfred University NY
CelSian Glass & Solar BV The Netherlands
CHEMIR - A Division of Evans Analytical Group MO
Dalmia Inst of Scientific & Industrial Research India
Edward Orton Jr Ceramic Foundation OH
Japan Fine Ceramics Center Japan
P-Ker Engineering NY
Rauschert Industries Inc GA **See ad on pg 69**
Viridis3D LLC MA

Corrosion Testing
Activation Laboratories Ltd Canada
All Waste Matters UK
CelSian Glass & Solar BV The Netherlands
CHEMIR - A Division of Evans Analytical Group MO
Dalmia Inst of Scientific & Industrial Research India
Edward Orton Jr Ceramic Foundation OH
P-Ker Engineering NY
SEMTech Solutions Inc UK

Density Determination
Activation Laboratories Ltd Canada
AVEKA MN
CHEMIR - A Division of Evans Analytical Group MO
Cyclonaire Corp NE
Edward Orton Jr Ceramic Foundation OH
GrainBound LLC PA
Hindalco Industries Limited India
Hysitron Inc MN
Israel Ceramic & Silicate Inst Israel
Japan Fine Ceramics Center Japan
Micromeritics Instrument Corp GA
NSL Analytical Services Inc OH **See ad on pg 75**
Particle Technology Labs IL **See ad on pg 99**
Quantachrome Instruments FL

Differential Thermal Analysis
Activation Laboratories Ltd Canada
AVEKA MN
CHEMIR - A Division of Evans Analytical Group MO
Edward Orton Jr Ceramic Foundation OH
Evans Analytical Group LLC CA
High Temperature Materials Lab TN
Hindalco Industries Limited India
Japan Fine Ceramics Center Japan
Micron Inc DE
Netzsch Instruments NA LLC MA
RISE Research Institutes of Sweden, RISE Glass Sweden
Setaram Instrumentation France
TA Instruments DE
Technology of Materials CA

Electron Microprobe Analysis
Activation Laboratories Ltd Canada
GrainBound LLC PA
High Temperature Materials Lab TN
Japan Fine Ceramics Center Japan
Micron Inc DE
Rensselaer Polytechnic Inst NY
Technology of Materials CA

Failure Analysis
CHEMIR - A Division of Evans Analytical Group MO
CMC Laboratories Inc AZ
CoorsTek CO
Edward Orton Jr Ceramic Foundation OH
Geller Microanalytical Laboratory Inc MA
H&M Analytical Services Inc NJ
High Temperature Materials Lab TN
Japan Fine Ceramics Center Japan
JTF Microscopy Services, LLC NY
Micron Inc DE
NSL Analytical Services Inc OH **See ad on pg 75**
Rensselaer Polytechnic Inst NY
RISE Research Institutes of Sweden, RISE Glass Sweden
SEMTech Solutions Inc UK
Technology of Materials CA

Fracture Analysis
CHEMIR - A Division of Evans Analytical Group MO
CoorsTek CO
High Temperature Materials Lab TN
Japan Fine Ceramics Center Japan
JTF Microscopy Services, LLC NY
Micron Inc DE
NSL Analytical Services Inc OH **See ad on pg 75**
Rensselaer Polytechnic Inst NY
RISE Research Institutes of Sweden, RISE Glass Sweden
SEMTech Solutions Inc UK
Spectrochemical Laboratories PA

Materials Analysis
Activation Laboratories Ltd Canada
Alfred University NY
CHEMIR - A Division of Evans Analytical Group MO
CSC Force Measurement Inc MA

Edward Orton Jr Ceramic Foundation OH
Elan Technology GA
Evans Analytical Group LLC CA
Geller Microanalytical Laboratory Inc MA
GrainBound LLC PA
H&M Analytical Services Inc NJ
Harper International Corp NY **See ad on pg 77**

Harrop Industries Inc OH **See ad on pg 58**
High Temperature Materials Lab TN
Hysitron Inc MN
Japan Fine Ceramics Center Japan
Jenike & Johanson Inc MA
JTF Microscopy Services, LLC NY
Micromeritics Instrument Corp GA
Micron Inc DE
Monofrax LLC NY
NSL Analytical Services Inc OH **See ad on pg 75**
Particle Technology Labs IL **See ad on pg 99**
RISE Research Institutes of Sweden, RISE Glass Sweden
SEMTech Solutions Inc UK
Setaram Instrumentation France
Spectrochemical Laboratories PA
Technology of Materials CA
Washington Mills Electro Minerals Co NY

Mechanical Properties
Activation Laboratories Ltd Canada
Advanced Ceramics Manufacturing AZ
Alfred University NY
BuzzMac Intl LLC ME
CHEMIR - A Division of Evans Analytical Group MO
CSC Force Measurement Inc MA
Edward Orton Jr Ceramic Foundation OH
High Temperature Materials Lab TN
Hysitron Inc MN
Japan Fine Ceramics Center Japan
TA Instruments DE
Taber Industries NY

Nondestructive Testing
SEMTech Solutions Inc UK

Optical Properties
Activation Laboratories Ltd Canada
CHEMIR - A Division of Evans Analytical Group MO
Rensselaer Polytechnic Inst NY

Particle-Size Analysis
Activation Laboratories Ltd Canada
AVEKA MN
CHEMIR - A Division of Evans Analytical Group MO
Custom Processing Services PA
Cyclonaire Corp NE
Geller Microanalytical Laboratory Inc MA
H&M Analytical Services Inc NJ
Harper International Corp NY **See ad on pg 77**
Israel Ceramic & Silicate Inst Israel
Japan Fine Ceramics Center Japan
Micromeritics Instrument Corp GA
Micron Inc DE
NSL Analytical Services Inc OH **See ad on pg 75**

Particle Technology Labs IL **See ad on pg 99**
P-Ker Engineering NY
SEMTech Solutions Inc UK
Technology Assessment and Transfer Inc (TA&T) MD
Technology of Materials CA
Washington Mills Electro Minerals Co NY

Pore Structure Analysis
GrainBound LLC PA
Japan Fine Ceramics Center Japan
Micromeritics Instrument Corp GA
Particle Technology Labs IL **See ad on pg 99**
P-Ker Engineering NY
Quantachrome Instruments FL
SEMTech Solutions Inc UK

Residual Stress Analysis
American Stress Technologies Inc PA
High Temperature Materials Lab TN
Japan Fine Ceramics Center Japan
RISE Research Institutes of Sweden, RISE Glass Sweden
TA Instruments DE

Scanning Electron Microscopy
Activation Laboratories Ltd Canada
Alfred University NY
AVEKA MN
CHEMIR - A Division of Evans Analytical Group MO
CoorsTek CO
Edward Orton Jr Ceramic Foundation OH
Evans Analytical Group LLC CA
GrainBound LLC PA
H&M Analytical Services Inc NJ
High Temperature Materials Lab TN

Hitachi High Technologies America, Inc **See ad on pg 101**
Hindalco Industries Limited India
Israel Ceramic & Silicate Inst Israel
Japan Fine Ceramics Center Japan
JTF Microscopy Services, LLC NY
Micron Inc DE
NSL Analytical Services Inc OH **See ad on pg 75**
Particle Technology Labs IL **See ad on pg 99**
SEMTech Solutions Inc UK
Technology of Materials CA
Washington Mills Electro Minerals Co NY

Spectroscopy
Activation Laboratories Ltd Canada
CHEMIR - A Division of Evans Analytical Group MO
CoorsTek CO
Evans Analytical Group LLC CA
GrainBound LLC PA
Japan Fine Ceramics Center Japan
Micron Inc DE
NSL Analytical Services Inc OH **See ad on pg 75**
Spectrochemical Laboratories PA

Surface-Area Analysis
AVEKA MN
Harper International Corp NY **See ad on pg 77**
Hindalco Industries Limited India
Japan Fine Ceramics Center Japan
Micromeritics Instrument Corp GA
NSL Analytical Services Inc OH **See ad on pg 75**
Particle Technology Labs IL **See ad on pg 99**
Quantachrome Instruments FL

RISE Research Institutes of Sweden, RISE Glass Sweden
SEMTech Solutions Inc UK
Technology Assessment and Transfer Inc (TA&T) MD

Thermal Analysis

Activation Laboratories Ltd Canada
Alfred University NY
AVEKA MN
CHEMIR - A Division of Evans Analytical Group MO
Datapaq Inc NH

Edward Orton Jr Ceramic Foundation OH
Evans Analytical Group LLC CA
Harper International Corp NY — **See ad on pg 77**

Harrop Industries Inc OH — **See ad on pg 58**
High Temperature Materials Lab TN
Israel Ceramic & Silicate Inst Israel
Japan Fine Ceramics Center Japan
Mettler-Toledo Inc OH
Micron Inc DE
Netzsch Instruments NA LLC MA
Particle Technology Labs IL — **See ad on pg 99**
P-Ker Engineering NY
Setaram Instrumentation France
TA Instruments DE
Technology Assessment and Transfer Inc (TA&T) MD

Transmission Electron Microscopy

Evans Analytical Group LLC CA
GrainBound LLC PA

Hitachi High Technologies America, Inc — **See ad on pg 101**
High Temperature Materials Lab TN
Japan Fine Ceramics Center Japan
Micron Inc DE
NSL Analytical Services Inc OH — **See ad on pg 75**

Tribological Studies

High Temperature Materials Lab TN
Japan Fine Ceramics Center Japan
Micron Inc DE
Taber Industries NY

X-Ray Diffraction

Activation Laboratories Ltd Canada
Alfred University NY
American Stress Technologies Inc PA
CHEMIR - A Division of Evans Analytical Group MO
Edward Orton Jr Ceramic Foundation OH
Evans Analytical Group LLC CA
GrainBound LLC PA
H&M Analytical Services Inc NJ
High Temperature Materials Lab TN
Hindalco Industries Limited India
Israel Ceramic & Silicate Inst Israel
Japan Fine Ceramics Center Japan
Micron Inc DE
NSL Analytical Services Inc OH — **See ad on pg 75**
Technology of Materials CA
Washington Mills Electro Minerals Co NY

X-Ray Fluorescence

CHEMIR - A Division of Evans Analytical Group MO
Euro Support Advanced Materials The Netherlands
H&M Analytical Services Inc NJ
Spectrochemical Laboratories PA

MATERIALS PREPARATION, HANDLING & PACKAGING

Agglomerators

Applicon Co IN
Lancaster Products PA
Littleford Day Inc MI

Bagging Equipment

Applicon Co IN
Cyclonaire Corp NE
Ingredient Masters Inc OH — **See ad on pg 103**
Lancaster Products PA
Nol-Tec Systems Inc MN

Barcode Labels

Rockwell Automation, Inc WI
Applicon Co IN
Carolina Material Technologies NC
Cyclonaire Corp NE
General Glass Equipment Co NJ
Ingredient Masters Inc OH — **See ad on pg 103**
Laguna Clay Co CA
Lancaster Products PA
Mohr Corp MI — **See ad on pg 79**
Nol-Tec Systems Inc MN
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA
Young Industries Inc PA

Batching Equipment

Ingredient Masters Inc OH — **See ad on pg 103**

Batching Plants & Systems

Applicon Co IN
Cyclonaire Corp NE
EIRICH Machines, Inc IL
Ingredient Masters Inc OH — **See ad on pg 103**

- Lancaster Products PA
- Mixer Systems Inc WI
- Nol-Tec Systems Inc MN
- Rockwell Automation, Inc WI
- Siemens Process Industries and Drives GA

Belts, Elevator
- Carolina Material Technologies NC

Bin Activators
- Carolina Material Technologies NC

Bin Dischargers
- Applicon Co IN
- Carolina Material Technologies NC
- Cyclonaire Corp NE
- Nol-Tec Systems Inc MN

Bins, Storage
- **Ingredient Masters Inc OH** **See ad on pg 103**
- Jenike & Johanson Inc MA
- Mixer Systems Inc WI
- Nol-Tec Systems Inc MN
- Penn Tool Co NJ
- Tempo Plastic CA

Blenders
- Aadvanced Machinery Inc MI
- Applicon Co IN
- Cyclonaire Corp NE
- Detroit Process Machinery MI
- EIRICH Machines, Inc IL
- **Gasbarre Products Inc PA** **See ad on pg 95**
- **Glen Mills Inc NJ** **See ad on pg 43**
- Laguna Clay Co CA
- Lancaster Products PA
- Littleford Day Inc MI
- **Mohr Corp MI** **See ad on pg 79**
- Netzsch Premier Technologies LLC PA
- Nol-Tec Systems Inc MN
- Young Industries Inc PA

Briquetting & Tableting Equipment
- Aadvanced Machinery Inc MI
- Applicon Co IN
- **Mohr Corp MI** **See ad on pg 79**

Classifiers
- Applicon Co IN
- AVEKA MN
- Fluid Energy Processing & Equipment Co PA
- Netzsch Premier Technologies LLC PA
- Raymond Bartlett Snow
- Young Industries Inc PA

Conveyors
- Basic Machinery Co Inc NC
- Carolina Material Technologies NC
- General Glass Equipment Co NJ
- Nol-Tec Systems Inc MN
- Rockwell Automation, Inc WI
- Siemens Process Industries and Drives GA
- Velco GmbH The Netherlands
- Young Industries Inc PA

Conveyors, Belt
- Applicon Co IN
- Carolina Material Technologies NC
- **Ingredient Masters Inc OH** **See ad on pg 103**
- Mixer Systems Inc WI

Conveyors, Bucket
- Applicon Co IN
- **Ingredient Masters Inc OH** **See ad on pg 103**

Conveyors, Pneumatic
- Applicon Co IN
- Carolina Material Technologies NC
- Cyclonaire Corp NE
- **Ingredient Masters Inc OH** **See ad on pg 103**
- Nol-Tec Systems Inc MN
- Velco GmbH The Netherlands

Conveyors, Screw
- Applicon Co IN
- Carolina Material Technologies NC
- Cyclonaire Corp NE
- **Ingredient Masters Inc OH** **See ad on pg 103**
- Mixer Systems Inc WI

Conveyors, Vibrating
- Applicon Co IN
- Carolina Material Technologies NC
- OH Vibrator Co OH

Crushers
- Aadvanced Machinery Inc MI
- AVEKA MN
- Basic Machinery Co Inc NC
- Detroit Process Machinery MI
- Fritsch GmbH - Milling and Sizing Germany
- Fritsch Milling & Sizing Inc NC
- **Glen Mills Inc NJ** **See ad on pg 43**
- Lancaster Products PA
- **Mohr Corp MI** **See ad on pg 79**
- Stedman Machine Co IN
- Williams Patent Crusher & Pulverizer Co Inc MO
- Wyssmont Co NJ

Crushers, Hammermill
- AVEKA MN
- **Glen Mills Inc NJ** **See ad on pg 43**
- Mixer Systems Inc WI
- Stedman Machine Co IN
- **Verder Scientific Inc PA** **See ad on pg 101**
- Williams Patent Crusher & Pulverizer Co Inc MO
- Wyssmont Co NJ

Crushers, Impact
- Applicon Co IN
- **Glen Mills Inc NJ** **See ad on pg 43**
- Stedman Machine Co IN
- Williams Patent Crusher & Pulverizer Co Inc MO
- Wyssmont Co NJ

Crushers, Jaw
- Applicon Co IN
- Fritsch GmbH - Milling and Sizing Germany
- Fritsch Milling & Sizing Inc NC
- **Glen Mills Inc NJ** **See ad on pg 43**
- **Verder Scientific Inc PA** **See ad on pg 101**

Crushers, Primary
- Stedman Machine Co IN
- Williams Patent Crusher & Pulverizer Co Inc MO

Crushers, Roll
- Applicon Co IN
- Lancaster Products PA
- Williams Patent Crusher & Pulverizer Co Inc MO

Cullet-Handling Equipment
- Applicon Co IN
- General Glass Equipment Co NJ

Drum Tumblers
- **Glen Mills Inc NJ** **See ad on pg 43**

Dryers, Fluid Bed
- Applicon Co IN
- AVEKA MN
- Williams Patent Crusher & Pulverizer Co Inc MO

Dryers, Rotating Tray
- Raymond Bartlett Snow
- Wyssmont Co NJ

Dust Collectors
- Cyclonaire Corp NE
- Nol-Tec Systems Inc MN
- RoboVent MI

Dust Control Equipment
- Carolina Material Technologies NC
- Mixer Systems Inc WI
- Penn Tool Co NJ
- RoboVent MI
- Young Industries Inc PA

Edge Protectors
- Tempo Plastic CA

Electric Screen Heating
- Midwestern Industries Inc OH

Environmental/Waste Treatment Equipment
- Carolina Material Technologies NC
- Cober Muegge LLC CT
- Control Instruments Corp NJ
- Fritsch GmbH - Milling and Sizing Germany
- Mixer Systems Inc WI
- OPF Enterprises TX
- **Oxy-Gon Industries Inc NH** **See ad on pg 89**
- Rockwell Automation, Inc WI
- Siemens Process Industries and Drives GA
- Young Industries Inc PA

Feeders
- Basic Machinery Co Inc NC
- Carolina Material Technologies NC

- **EZG Manufacturing Inc OH** **Inside front cover**
- OH Vibrator Co OH
- Fritsch GmbH - Milling and Sizing Germany
- Fritsch Milling & Sizing Inc NC
- General Glass Equipment Co NJ
- Jenike & Johanson Inc MA
- Nol-Tec Systems Inc MN
- Young Industries Inc PA

Feeders, Batch
- Applicon Co IN
- Carolina Material Technologies NC
- **Ingredient Masters Inc OH** **See ad on pg 103**
- Merkle International Inc IL
- Mixer Systems Inc WI
- Nol-Tec Systems Inc MN
- Siemens Process Industries and Drives GA

Feeders, Gravimetric
- Applicon Co IN
- Carolina Material Technologies NC

Feeders, Pneumatic
Carolina Material Technologies NC
Cyclonaire Corp NE
Nol-Tec Systems Inc MN

Filters
Texers Technical Ceramics Inc Canada

Granulators
Aadvanced Machinery Inc MI
Applicon Co IN
Fritsch GmbH - Milling and Sizing Germany
Littleford Day Inc MI
Mohr Corp MI **See ad on pg 79**
Netzsch Premier Technologies LLC PA
Wyssmont Co NJ

Grinders
Buehler Ltd IL **See ad on pg 99**
Diamond Industrial Tools Inc IL
Fluid Energy Processing & Equipment Co PA
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC
Glen Mills Inc NJ **See ad on pg 43**
Mohr Corp MI **See ad on pg 79**
Netzsch Premier Technologies LLC PA
Stedman Machine Co IN
Verder Scientific Inc PA **See ad on pg 101**
Wyssmont Co NJ

Grinding Media
CerCo LLC OH
CoorsTek CO
Dunhua Zhengxing Abrasive Co Ltd China
ER Advanced Ceramics Inc OH
Federal-Mogul MI
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC
Glen Mills Inc NJ **See ad on pg 43**
Jyoti Ceramic Industries Pvt Ltd India
MSE Supplies AZ
Netzsch Premier Technologies LLC PA
Texers Technical Ceramics Inc Canada
Union Process OH
Verder Scientific Inc PA **See ad on pg 101**
Zibo Guangtong Chemical Co Ltd China
Zircoa Inc OH

Grinding Mills, Vibratory
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC

Gunning Equipment, Refractory
Reed Gunite & Shotcrete Equipment CA
Velco GmbH The Netherlands

Hoppers
Basic Machinery Co Inc NC
Carolina Material Technologies NC
Ingredient Masters Inc OH **See ad on pg 103**
Jenike & Johanson Inc MA
Mixer Systems Inc WI
Reed Gunite & Shotcrete Equipment CA

Hydraulic Systems
Basic Machinery Co Inc NC
Ram Products Inc OH

Impeller, Mixing
Lancaster Products PA
Mixer Systems Inc WI

Materials Handling Equipment
Basic Machinery Co Inc NC
Carolina Material Technologies NC
Cyclonaire Corp NE

EZG Manufacturing Inc OH **Inside front cover**
Gasbarre Products Inc PA **See ad on pg 95**
Lancaster Products PA
Mixer Systems Inc WI
Nol-Tec Systems Inc MN
North Star Equipment Inc WA
Penn Tool Co NJ
Reed Gunite & Shotcrete Equipment CA
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA
Tempo Plastic CA
Young Industries Inc PA

Mill Linings
CerCo LLC OH
ER Advanced Ceramics Inc OH
Jyoti Ceramic Industries Pvt Ltd India

Mills
Custom Processing Services PA
ER Advanced Ceramics Inc OH
Euro Support Advanced Materials The Netherlands
Fritsch Milling & Sizing Inc NC
Glen Mills Inc NJ **See ad on pg 43**
Hockmeyer Equipment Corp NC
Netzsch Premier Technologies LLC PA
Raymond Bartlett Snow
Stedman Machine Co IN
Union Process OH

Mills, Attritor
Aadvanced Machinery Inc MI
Custom Processing Services PA
Detroit Process Machinery MI
Glen Mills Inc NJ **See ad on pg 43**
Netzsch Premier Technologies LLC PA
Union Process OH
Wyssmont Co NJ

Mills, Ball & Pebble
Aadvanced Machinery Inc MI
Advanced Ceramics Manufacturing AZ
Detroit Process Machinery MI
ER Advanced Ceramics Inc OH
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC
Glen Mills Inc NJ **See ad on pg 43**
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Mohr Corp MI **See ad on pg 79**
MSE Supplies AZ
Netzsch Premier Technologies LLC PA
Raymond Bartlett Snow
Union Process OH

Mills, Centrifugal
Fritsch GmbH - Milling and Sizing Germany
Glen Mills Inc NJ **See ad on pg 43**
Verder Scientific Inc PA **See ad on pg 101**

Mills, Hammer
AVEKA MN
Glen Mills Inc NJ **See ad on pg 43**
Stedman Machine Co IN
Verder Scientific Inc PA **See ad on pg 101**
Williams Patent Crusher & Pulverizer Co Inc MO

Mills, Jar
Detroit Process Machinery MI
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC

Mills, Jet
AVEKA MN
Fluid Energy Processing & Equipment Co PA
Netzsch Premier Technologies LLC PA

Mills, Planetary
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC
Hockmeyer Equipment Corp NC
MSE Supplies AZ
Verder Scientific Inc PA **See ad on pg 101**

Mills, Rod
Wyssmont Co NJ

Mills, Roll
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
MSE Supplies AZ
Raymond Bartlett Snow
Williams Patent Crusher & Pulverizer Co Inc MO

Mills, Vibratory
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC

Mining & Beneficiation Equipment
Netzsch Premier Technologies LLC PA
Reed Gunite & Shotcrete Equipment CA
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

Mixers, Batch
Carolina Material Technologies NC
Custom Processing Services PA
EIRICH Machines, Inc IL

EZG Manufacturing Inc OH **Inside front cover**

Glen Mills Inc NJ **See ad on pg 43**
Goceram AB Sweden
Lancaster Products PA
Mixer Systems Inc WI
Mohr Corp MI **See ad on pg 79**
Netzsch Premier Technologies LLC PA
Nol-Tec Systems Inc MN
OPF Enterprises TX
Peter Pugger Mfg Inc CA

Mixers, Drum
Glen Mills Inc NJ **See ad on pg 43**
Hockmeyer Equipment Corp NC

Mixers, Pneumatic
Carolina Material Technologies NC
EIRICH Machines, Inc IL
Nol-Tec Systems Inc MN

Mixers, Portable
Jiffy Mixer Co Inc CA
Mixer Systems Inc WI
Peter Pugger Mfg Inc CA

Mixers, Refractory
Applicon Co IN
EIRICH Machines, Inc IL

EZG Manufacturing Inc OH **Inside front cover**
Laeis GmbH Luxembourg
Lancaster Products PA
Littleford Day Inc MI
Mixer Systems Inc WI
Netzsch Premier Technologies LLC PA
Peter Pugger Mfg Inc CA
Reed Gunite & Shotcrete Equipment CA

Mixers, Vacuum
Applicon Co IN
EIRICH Machines, Inc IL
Netzsch Premier Technologies LLC PA
Peter Pugger Mfg Inc CA

Mixing Equipment
Aadvanced Machinery Inc MI
Carolina Material Technologies NC
Custom Processing Services PA

Detroit Process Machinery MI
EIRICH Machines, Inc IL
ER Advanced Ceramics Inc OH
General Glass Equipment Co NJ

Glen Mills Inc NJ **See ad on pg 43**
Goceram AB Sweden
Hockmeyer Equipment Corp NC
Laguna Clay Co CA
Lancaster Products PA
Littleford Day Inc MI
Mixer Systems Inc WI
Mohr Corp MI **See ad on pg 79**
Netzsch Premier Technologies LLC PA
OPF Enterprises TX
Peter Pugger Mfg Inc CA
Resodyn Acoustic Mixers Inc MT
Young Industries Inc PA

Nozzles
CerCo LLC OH
Dunhua Zhengxing Abrasive Co Ltd China
H.C. Starck GmbH Germany
Maryland Ceramic & Steatite Co Inc MD

Packaging
Tempo Plastic CA

Packaging Equipment
Basic Machinery Co Inc NC

Pneumatic Systems
Applicon Co IN
Carolina Material Technologies NC
Cyclonaire Corp NE
Nol-Tec Systems Inc MN
Reed Gunite & Shotcrete Equipment CA
Velco GmbH The Netherlands
Young Industries Inc PA

Process Control Equipment
Control Instruments Corp NJ
Datapaq Inc NH
General Glass Equipment Co NJ
Ingredient Masters Inc OH **See ad on pg 103**
Nol-Tec Systems Inc MN
norcross Viscosity Controls MI
Ram Products Inc OH
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

Pulverizers
Aadvanced Machinery Inc MI
Applicon Co IN
Basic Machinery Co Inc NC
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC
Glen Mills Inc NJ **See ad on pg 43**
Mixer Systems Inc WI
Stedman Machine Co IN
Williams Patent Crusher & Pulverizer Co Inc MO
Wyssmont Co NJ

Pumps
ER Advanced Ceramics Inc OH
Ram Products Inc OH
Reed Gunite & Shotcrete Equipment CA

Pumps, Concrete
Reed Gunite & Shotcrete Equipment CA

Scale Systems
CSC Force Measurement Inc MA
Mettler-Toledo Inc OH
Nol-Tec Systems Inc MN

Screens & Screening Equipment
Aadvanced Machinery Inc MI
Basic Machinery Co Inc NC
OH Vibrator Co OH
Control Instruments Corp NJ
Detroit Process Machinery MI
Fritsch GmbH - Milling and Sizing Germany

Fritsch Milling & Sizing Inc NC
Glen Mills Inc NJ **See ad on pg 43**
Midwestern Industries Inc OH
Mohr Corp MI **See ad on pg 79**
Sicco Engineering Works India

Separators
Fritsch GmbH - Milling and Sizing Germany
Midwestern Industries Inc OH
Williams Patent Crusher & Pulverizer Co Inc MO
Basic Machinery Co Inc NC
Fritsch GmbH - Milling and Sizing Germany
Glen Mills Inc NJ **See ad on pg 43**
Stedman Machine Co IN
Williams Patent Crusher & Pulverizer Co Inc MO

Single-Wafer Packs
Tempo Plastic CA

Size Reduction Equipment
AVEKA MN
Basic Machinery Co Inc NC
Custom Processing Services PA
EIRICH Machines, Inc IL
ER Advanced Ceramics Inc OH
Fluid Energy Processing & Equipment Co PA
Fritsch GmbH - Milling and Sizing Germany
Glen Mills Inc NJ **See ad on pg 43**
Lancaster Products PA
Netzsch Premier Technologies LLC PA
Raymond Bartlett Snow
Stedman Machine Co IN
Union Process OH
Williams Patent Crusher & Pulverizer Co Inc MO
Wyssmont Co NJ

Spray Dryers
Aadvanced Machinery Inc MI
Arch Maintenance Services GA
AVEKA MN
Detroit Process Machinery MI
Dorst America Inc PA
Elan Technology GA
Euro Support Advanced Materials The Netherlands
Mohr Corp MI **See ad on pg 79**
Spray Drying Systems Inc MD

Storage Equipment
Basic Machinery Co Inc NC
Cyclonaire Corp NE

Substrate Wafer Trays
Tempo Plastic CA

Used Equipment
Aadvanced Machinery Inc MI
American Isostatic Presses OH

Detroit Process Machinery MI
Dorst America Inc PA

Mohr Corp MI **See ad on pg 79**
Reed Gunite & Shotcrete Equipment CA

Vacuum Cleaning Systems
Carolina Material Technologies NC

Ventilating Equipment
American Art Clay Co Inc IN

Vibrators
Carolina Material Technologies NC
OH Vibrator Co OH
Rockwell Automation, Inc WI

Vibrators, Bin
Carolina Material Technologies NC
OH Vibrator Co OH
Cyclonaire Corp NE

Weighing Equipment
Carolina Material Technologies NC
CSC Force Measurement Inc MA
Cyclonaire Corp NE
Mettler-Toledo Inc OH
Nol-Tec Systems Inc MN
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

Wire Cloth
Midwestern Industries Inc OH

■ PLANT CONSTRUCTION, DESIGN & ENGINEERING

Brick Production
Basic Machinery Co Inc NC
Laeis GmbH Luxembourg
Swindell Dressler Intl Co PA

Casting Plants
Dorst America Inc PA
ER Advanced Ceramics Inc OH

Ceramic Production
Cerinnov France
Cerlase France
GrainBound LLC PA
Lucideon UK
Maryland Ceramic & Steatite Co Inc MD
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
Viridis3D LLC MA

Combustion Systems
Air Products PA
Swindell Dressler Intl Co PA

Decals & Decorating
Cerinnov France
Cerlase France
Gwent Electronic Materials Ltd UK

Drying & Firing
Basic Machinery Co Inc NC
Ceramic Services Inc PA

Harrop Industries Inc OH **See ad on pg 58**
Swindell Dressler Intl Co PA
Wistra GmbH Germany

Electronic Materials Production
Haiku Tech Europe BV The Netherlands
Haiku Tech Inc FL
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD

Environmental Control
Cyclonaire Corp NE
Ferro-Ceramic Grinding Inc MA
Mixer Systems Inc WI
Nol-Tec Systems Inc MN
RoboVent MI
Rockwell Automation, Inc WI
Saint-Gobain norPro OH
Tri-Mer Corp MI

Fabrication Shops
Ferro-Ceramic Grinding Inc MA
Maryland Ceramic & Steatite Co Inc MD

Glass Production
CelSian Glass & Solar BV The Netherlands
General Glass Equipment Co NJ
RISE Research Institutes of Sweden, RISE Glass Sweden
Schott North America Inc NY **See ad on pg 41**
Tri-Mer Corp MI

Inspection Systems
CSC Force Measurement Inc MA
Fosbel Inc OH
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

Laboratories
Activation Laboratories Ltd Canada

Optical-Fiber Production
Ocean Optics Inc FL

Refractory Production
ER Advanced Ceramics Inc OH
Fosbel Inc OH
Laeis GmbH Luxembourg
Laguna Clay Co CA
Swindell Dressler Intl Co PA

Structural Ceramics Production
CerCo LLC OH
Maryland Ceramic & Steatite Co Inc MD
Swindell Dressler Intl Co PA
Takasago Industry Co Ltd Japan
TevTech LLC MA **See ad on pg 83**

Tile Production
Laeis GmbH Luxembourg
LIXIL Corporation Japan
Peter Pugger Mfg Inc CA

Whiteware Production
LIXIL Corporation Japan
Ram Products Inc OH
Swindell Dressler Intl Co PA

■ PORCELAIN ENAMEL

Appliances
Roca Sanitario SA Spain
Zenith China

Architectural Units
Roca Sanitario SA Spain
Zenith China

Ceramic Coatings, Thermal Protection
Cerinnov France
Cerlase France
Trans-Tech Inc, a subsidiary of Skyworks Solutions Inc MD
Zenith China

■ REFRACTORIES

Acid
Allied Mineral Products Inc OH
Magneco Metrel Inc IL
Pacific Refractories Ltd India
Vitcas Ltd UK

Aggregate
Christy Minerals LLC MO
Furnace Products & Services Inc PA
Magneco Metrel Inc IL
Maryland Refractories Co OH

Alumina
Advanced Ceramic Technology CA
Allied Mineral Products Inc OH
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Astral Material Industrial Co Ltd China
Baikowski Malakoff Inc NC
Bucher Emhart Glass SA Switzerland
Ceramco Inc NH
CeramTec-ETEC Germany
Dalmia Inst of Scientific & Industrial Research India
Du-Co Ceramics Company PA
Elcon Precision LLC CA **See ad on pg 107**
ER Advanced Ceramics Inc OH
Fosbel Inc OH
General Material Industrial Co China
GrainBound LLC PA
IPS Ceramics LTD UK
Ipsen Ceramics IL
Magneco Metrel Inc IL
Maryland Refractories Co OH
Pacific Refractories Ltd India
Plibrico Company IL **See ad on pg 105**
Precision Ferrites and Ceramics Inc CA
Rath Inc DE
Refractory Minerals Co Inc PA
RHI US Ltd NY
Refratechnik Ceramics GmbH Germany
Riverside Refractories Inc AL
Selee Corp NC
Sunrock Ceramics Co IL
Texers Technical Ceramics Inc Canada
Wistra GmbH Germany
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**
ZIRCAR Ceramics Inc NY
Zircar Refractory Composites Inc NY

Zircar Zirconia Inc NY

Anchors
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Magneco Metrel Inc IL

Arches, Suspended
Fosbel Inc OH
Ipsen Ceramics IL
Merkle International Inc IL

AZS
Bucher Emhart Glass SA Switzerland
Fosbel Inc OH
Magneco Metrel Inc IL
Monofrax LLC NY
RHI US Ltd NY

Backwalls
Fosbel Inc OH
Merkle International Inc IL

Basic
Allied Mineral Products Inc OH
Furnace Products & Services Inc PA
Magneco Metrel Inc IL
RHI US Ltd NY

Bauxite
Refratechnik Ceramics GmbH Germany

Blankets
Associated Ceramics & Technology Inc PA **See ad on pg 65**
Morgan Thermal Ceramics GA
RHI US Ltd NY
Thermal Products Co Inc GA
Unifrax I LLC NY
ZIRCAR Ceramics Inc NY
Zircar Refractory Composites Inc NY
Zircar Zirconia Inc NY

Boards
Agni Fiber Boards Pvt Ltd India
Morgan Thermal Ceramics GA
RHI US Ltd NY
Saint-Gobain Ceramics & Plastics MA
Thermal Products Co Inc GA
Unifrax I LLC NY

ZIRCAR Ceramics Inc NY
Zircar Refractory Composites Inc NY
Zircar Zirconia Inc NY

Brick
APF Recycling Inc OH
Cancarb Limited Canada

General Material Industrial Co China
HarbisonWalker Intl PA
Insulating Firebrick Inc PA
Morgan Thermal Ceramics GA
Pacific Refractories Ltd India
Refratechnik Ceramics GmbH Germany
RHI US Ltd NY
Sunrock Ceramics Co IL
Wistra GmbH Germany

Brick, Acid-Resisting
Pacific Refractories Ltd India
Vitcas Ltd UK

Brick, Fireclay
Allied Mineral Products Inc OH
Alsey Refractories Co MO
Pacific Refractories Ltd India
RHI US Ltd NY
Vitcas Ltd UK

Carbon
Astral Material Industrial Co Ltd China
Cancarb Limited Canada
Pacific Refractories Ltd India

Castable
Allied Mineral Products Inc OH
Alsey Refractories Co MO
Aremco Products Inc NY
Cancarb Limited Canada
Capital Refractories Ltd UK
Furnace Products & Services Inc PA
HarbisonWalker Intl PA
Industrial Ceramic Products Inc OH
Magneco Metrel Inc IL
Pacific Refractories Ltd India

Plibrico Company IL **See ad on pg 105**
Plibrico Japan Co Ltd Japan
Reno Refractories Inc AL
RHI US Ltd NY
Riverside Refractories Inc AL
Selee Corp NC
Vitcas Ltd UK
Zircar Refractory Composites Inc NY

Cements
Allied Mineral Products Inc OH
Aremco Products Inc NY
Capital Refractories Ltd UK
Dalmia Inst of Scientific & Industrial Research India
Furnace Products & Services Inc PA
Gorka Cement Poland
Kerneos Inc VA
Plibrico Company IL **See ad on pg 105**
Reno Refractories Inc AL
Unifrax I LLC NY
Vitcas Ltd UK
ZIRCAR Ceramics Inc NY
Zircar Zirconia Inc NY

Clay Flux
Furnace Products & Services Inc PA
Peter Pugger Mfg Inc CA
RHI US Ltd NY

Coatings
Allied Mineral Products Inc OH
Aremco Products Inc NY
Elcon Precision LLC CA **See ad on pg 107**
Fosbel Inc OH
Furnace Products & Services Inc PA
Fusion Ceramics Inc OH
Gwent Electronic Materials Ltd UK
Induceramic Canada
Magneco Metrel Inc IL
Plibrico Japan Co Ltd Japan
Rath Inc DE
Riverside Refractories Inc AL
Starfire Systems Inc NY
Thermal Products Co Inc GA
Unifrax I LLC NY
Vitcas Ltd UK
Zibo Guangtong Chemical Co Ltd China
Zircar Refractory Composites Inc NY
ZYP Coatings Inc TN

Cordierite
Advanced Ceramic Technology CA
Akron Porcelain & Plastics Co OH
Astral Material Industrial Co Ltd China
CoorsTek CO
Du-Co Ceramics Company PA
ER Advanced Ceramics Inc OH
Industrial Ceramic Products Inc OH
IPS Ceramics LTD UK
Maryland Refractories Co OH
Rauschert Industries Inc GA **See ad on pg 69**
Saint-Gobain Ceramics & Plastics MA

Crucibles
AdValue Technology LLC AZ **See ad on pg 43**
Allied Mineral Products Inc OH
APC International Ltd PA
Aremco Products Inc NY
Blasch Precision Ceramics Inc NY
Bucher Emhart Glass SA Switzerland
Ceramco Inc NH
CeramTec-ETEC Germany
Furnace Products & Services Inc PA
Industrial Ceramic Products Inc OH
Ipsen Ceramics IL
LECO Corp MI
Magneco Metrel Inc IL
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Progressive Technology Inc CA
Selee Corp NC
Silicon Carbide Products Inc NY
Zhengzhou Mission Ceramic Products Co Ltd China
Zircoa Inc OH

Dead-Burned
Fluid Energy Processing & Equipment Co PA

Fiber Products
Allied Mineral Products Inc OH

Chiz Bros. Inc See ad pg 109
Furnace Products & Services Inc PA
LECO Corp MI
Thermal Products Co Inc GA
Unifrax I LLC NY
Vitcas Ltd UK

ZIRCAR Ceramics Inc NY
Zircar Zirconia Inc NY

Fillers
Refratechnik Ceramics GmbH Germany

Filters, Molten Metal
Akron Porcelain & Plastics Co OH
Induceramic Canada
Industrial Ceramic Products Inc OH
Selee Corp NC

Foundry
Allied Mineral Products Inc OH
Blasch Precision Ceramics Inc NY
Capital Refractories Ltd UK
Fosbel Inc OH
H.C. Starck GmbH Germany
Industrial Ceramic Products Inc OH
Ipsen Ceramics IL
LECO Corp MI
Magneco Metrel Inc IL
Plibrico Company IL See ad on pg 105
Riverside Refractories Inc AL
Selee Corp NC
Silicon Carbide Products Inc NY
Zircar Refractory Composites Inc NY

Fused Cast
Fosbel Inc OH
Furnace Products & Services Inc PA
Monofrax LLC NY
Saint-Gobain Ceramics & Plastics MA

Fused Spinel Refractories
Dalmia Inst of Scientific & Industrial Research India

Glass Furnace
Deltech Inc CO See ad on pg 85
Fosbel Inc OH
Furnace Products & Services Inc PA
HarbisonWalker Intl PA
Ipsen Ceramics IL
Magneco Metrel Inc IL
RHI US Ltd NY
RISE Research Institutes of Sweden, RISE Glass Sweden
Vesuvius SC

Graphite
Applied Ceramics Inc CA
Furnace Products & Services Inc PA

Grog
Alsey Refractories Co MO
Maryland Refractories Co OH

Gunning
Allied Mineral Products Inc OH
Blastcrete Equipment Co AL
Capital Refractories Ltd UK
Fosbel Inc OH
Plibrico Company IL See ad on pg 105
Plibrico Japan Co Ltd Japan
Reno Refractories Inc AL
Riverside Refractories Inc AL
Unifrax I LLC NY
Velco GmbH The Netherlands

High-Alumina
Advanced Ceramic Technology CA
Allied Mineral Products Inc OH
Applied Ceramics Inc CA
Astral Material Industrial Co Ltd China
Blasch Precision Ceramics Inc NY
Bucher Emhart Glass SA Switzerland
Ceramco Inc NH
CeramTec-ETEC Germany
Custom Processing Services PA
Dalmia Inst of Scientific & Industrial Research India
ER Advanced Ceramics Inc OH
Fosbel Inc OH
IPS Ceramics LTD UK
Ipsen Ceramics IL
LECO Corp MI
Magneco Metrel Inc IL
Maryland Refractories Co OH
Monofrax LLC NY
Plibrico Company IL See ad on pg 105
Plibrico Japan Co Ltd Japan
Precision Ferrites and Ceramics Inc CA
Rath Inc DE
RHI US Ltd NY
Riverside Refractories Inc AL
Selee Corp NC
Sunrock Ceramics Co IL
Tethon 3D NE
Xiamen Innovacera Advanced Materials Co Ltd China See ad on pg 93
Zhengzhou Mission Ceramic Products Co Ltd China
ZIRCAR Ceramics Inc NY
Zircar Refractory Composites Inc NY

Insulating Brick
Dalmia Inst of Scientific & Industrial Research India
Furnace Products & Services Inc PA
General Material Industrial Co China
Insulating Firebrick Inc PA
Laguna Clay Co CA
PSH Kilns & Furnaces Canada
RHI US Ltd NY
Zircoa Inc OH

Insulation
Agni Fiber Boards Pvt Ltd India
Capital Refractories Ltd UK
Du-Co Ceramics Company PA
Furnace Products & Services Inc PA
General Material Industrial Co China
HarbisonWalker Intl PA
Induceramic Canada
Plibrico Company IL See ad on pg 105
Plibrico Japan Co Ltd Japan
PSH Kilns & Furnaces Canada
Rath Inc DE
Refratechnik Ceramics GmbH Germany
Reno Refractories Inc AL
RHI US Ltd NY
Thermal Products Co Inc GA
Unifrax I LLC NY
Vesuvius SC
Wistra GmbH Germany

ZIRCAR Ceramics Inc NY
Zircar Refractory Composites Inc NY

Zircar Zirconia Inc NY

Insulation Board
Agni Fiber Boards Pvt Ltd India
Thermal Products Co Inc GA
Unifrax I LLC NY
ZIRCAR Ceramics Inc NY
Zircar Refractory Composites Inc NY
Zircar Zirconia Inc NY

Insulation Slabs, Calcium Silicate
Furnace Products & Services Inc PA
Zircar Refractory Composites Inc NY

Insulation Slabs, Vermiculite
Insulating Firebrick Inc PA

Insulation, Microporous
Furnace Products & Services Inc PA
Thermal Products Co Inc GA
Unifrax I LLC NY
ZIRCAR Ceramics Inc NY

Kiln Car Insulation
Refratechnik Ceramics GmbH Germany
Sunrock Ceramics Co IL
Thermal Products Co Inc GA
ZIRCAR Ceramics Inc NY

Kiln Furniture
Advanced Ceramic Technology CA
American Art Clay Co Inc IN
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
Induceramic Canada
Industrial Ceramic Products Inc OH
Ipsen Ceramics IL
L&L Kiln Mfg Inc NJ
Laguna Clay Co CA
Magneco Metrel Inc IL
Nutec Bickley Mexico
Paragon Industries LP TX
PSH Kilns & Furnaces Canada
Refratechnik Ceramics GmbH Germany
RHI US Ltd NY
Saint-Gobain Ceramics & Plastics MA
Saint-Gobain High Performance Ceramics & Refractories MA
Selee Corp NC
Silicon Carbide Products Inc NY

Sunrock Ceramics Co IL
Texers Technical Ceramics Inc Canada
Zircar Refractory Composites Inc NY
Zircoa Inc OH

Magnesite

Allied Mineral Products Inc OH
Astral Material Industrial Co Ltd China
Dalmia Inst of Scientific & Industrial Research India
Fluid Energy Processing & Equipment Co PA
Furnace Products & Services Inc PA
RHI US Ltd NY

Monolithic

Allied Mineral Products Inc OH
Blasch Precision Ceramics Inc NY
Cancarb Limited Canada
Ceramco Inc NH
Furnace Products & Services Inc PA
Magneco Metrel Inc IL
Plibrico Company IL **See ad on pg 105**
Plibrico Japan Co Ltd Japan
RHI US Ltd NY
Riverside Refractories Inc AL
Saint-Gobain Ceramics & Plastics MA
Selee Corp NC
Zili USA LLC PA

Mortars

Allied Mineral Products Inc OH
Alsey Refractories Co MO
CoorsTek CO
Monofrax LLC NY
Pacific Refractories Ltd India
Plibrico Company IL **See ad on pg 105**
Plibrico Japan Co Ltd Japan
Refratechnik Ceramics GmbH Germany
Reno Refractories Inc AL
RHI US Ltd NY
Riverside Refractories Inc AL
Vitcas Ltd UK

Mullite

Advanced Ceramic Technology CA
Akron Porcelain & Plastics Co OH
Allied Mineral Products Inc OH
Astral Material Industrial Co Ltd China
Atlantic Equipment Engineers NJ
Bharat Heavy Electricals Ltd NY
Bucher Emhart Glass SA Switzerland
Ceramco Inc NH
CeramTec-ETEC Germany
Dalmia Inst of Scientific & Industrial Research India
ER Advanced Ceramics Inc OH
Fosbel Inc OH
General Material Industrial Co China
Industrial Ceramic Products Inc OH
IPS Ceramics LTD UK
Magneco Metrel Inc IL
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Reade Advanced Materials RI
RHI US Ltd NY
Robocasting Enterprises LLC NM
Unifrax I LLC NY

Nozzles

Advanced Ceramic Technology CA
Blasch Precision Ceramics Inc NY
Blastcrete Equipment Co AL
CeramTec-ETEC Germany
FELDCO Intl CA
Industrial Ceramic Products Inc OH
Jyoti Ceramic Industries Pvt Ltd India
LECO Corp MI
Magneco Metrel Inc IL
Reed Gunite & Shotcrete Equipment CA
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**
Zircoa Inc OH

Paper

Thermal Products Co Inc GA
Unifrax I LLC NY
ZIRCAR Ceramics Inc NY
Zircar Zirconia Inc NY

Plastic

Allied Mineral Products Inc OH
Capital Refractories Ltd UK
Maryland Ceramic & Steatite Co Inc MD
Plibrico Company IL **See ad on pg 105**
Plibrico Japan Co Ltd Japan
RHI US Ltd NY
Riverside Refractories Inc AL

Precast Shapes

Allied Mineral Products Inc OH
Blasch Precision Ceramics Inc NY
Bucher Emhart Glass SA Switzerland
Capital Refractories Ltd UK
Ceramco Inc NH
CeramTec-ETEC Germany
Fosbel Inc OH
Industrial Ceramic Products Inc OH
Magneco Metrel Inc IL

Plibrico Company IL **See ad on pg 105**
Plibrico Japan Co Ltd Japan
RHI US Ltd NY
Riverside Refractories Inc AL
Selee Corp NC
Silicon Carbide Products Inc NY
Zircar Refractory Composites Inc NY

Ramming Mixes

Allied Mineral Products Inc OH
Alsey Refractories Co MO
Monofrax LLC NY
Plibrico Company IL **See ad on pg 105**
Plibrico Japan Co Ltd Japan
RHI US Ltd NY
Riverside Refractories Inc AL
Selee Corp NC

Rods

AdValue Technology LLC AZ **See ad on pg 43**
Blasch Precision Ceramics Inc NY
CerCo LLC OH
Du-Co Ceramics Company PA
Industrial Ceramic Products Inc OH
LECO Corp MI
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY

Rollers

Keith Co CA
Recco Furnaces CA
Saint-Gobain High Performance Ceramics & Refractories MA

Saggers

AdValue Technology LLC AZ **See ad on pg 43**
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
IPS Ceramics LTD UK
Ipsen Ceramics IL
LECO Corp MI
Magneco Metrel Inc IL
Selee Corp NC
Sunrock Ceramics Co IL

Setters

AdValue Technology LLC AZ **See ad on pg 43**
Blasch Precision Ceramics Inc NY
Ceramco Inc NH
Industrial Ceramic Products Inc OH
Ipsen Ceramics IL
LECO Corp MI
Magneco Metrel Inc IL
Maryland Ceramic & Steatite Co Inc MD
Saint-Gobain High Performance Ceramics & Refractories MA
Selee Corp NC
Sunrock Ceramics Co IL
Zircar Zirconia Inc NY

Silica

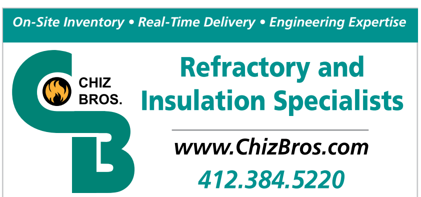
Allied Mineral Products Inc OH
Astral Material Industrial Co Ltd China
Blasch Precision Ceramics Inc NY
Bucher Emhart Glass SA Switzerland
Dalmia Inst of Scientific & Industrial Research India
Fosbel Inc OH
Ipsen Ceramics IL
Maryland Refractories Co OH
RHI US Ltd NY
Selee Corp NC
Sibelco Benelux Belgium

Silicon Carbide

Allied Mineral Products Inc OH
Astral Material Industrial Co Ltd China
Bharat Heavy Electricals Ltd NY
Blasch Precision Ceramics Inc NY
Cancarb Limited Canada
CoorsTek CO
Custom Processing Services PA
Electro Abrasives Corp NY
Fosbel Inc OH
IPS Ceramics LTD UK
Magneco Metrel Inc IL
Momentive Performance Materials Inc NY
Plibrico Company IL **See ad on pg 105**
Plibrico Japan Co Ltd Japan
Precision Ferrites and Ceramics Inc CA
Reade Advanced Materials RI
Saint-Gobain High Performance Ceramics & Refractories MA
Selee Corp NC
Silicon Carbide Products Inc NY
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**

Specialty
Allied Mineral Products Inc OH
Alsey Refractories Co MO
Blasch Precision Ceramics Inc NY
Bucher Emhart Glass SA Switzerland
Ceramco Inc NH
CeramTec-ETEC Germany
CoorsTek CO
Goceram AB Sweden
Industrial Ceramic Products Inc OH
Magneco Metrel Inc IL
McDanel Advanced Ceramic Technologies LLC PA **See ad on pg 61**
Refrac Systems AZ
Riverside Refractories Inc AL
Zircar Zirconia Inc NY

Tap Hole Clays
Cancarb Limited Canada
Riverside Refractories Inc AL
Vitcas Ltd UK

Textile


Chiz Bros. Inc **See ad pg 109**
Thermal Products Co Inc GA
ZIRCAR Ceramics Inc NY
Zircar Zirconia Inc NY

Tubes


AdValue Technology LLC AZ **See ad on pg 43**
Bucher Emhart Glass SA Switzerland
Ceramco Inc NH
CeramTec-ETEC Germany
Industrial Ceramic Products Inc OH
Jyoti Ceramic Industries Pvt Ltd India
LECO Corp MI
Saint-Gobain High Performance Ceramics & Refractories MA
Silicon Carbide Products Inc NY
Texers Technical Ceramics Inc Canada
Zhengzhou Mission Ceramic Products Co Ltd China
Zircar Refractory Composites Inc NY

Zircon
Custom Processing Services PA
Dalmia Inst of Scientific & Industrial Research India
Fosbel Inc OH
RHI US Ltd NY
Vitcas Ltd UK
Zircoa Inc OH

Zirconia
Astral Material Industrial Co Ltd China
Ceramco Inc NH
CeramTec-ETEC Germany
CerCo LLC OH
CoorsTek CO
Custom Processing Services PA
Dalmia Inst of Scientific & Industrial Research India
Fosbel Inc OH
Lithoz GmbH NY
Precision Ferrites and Ceramics Inc CA
Refractron Technologies Corp NY
RHI US Ltd NY
Selee Corp NC
Texers Technical Ceramics Inc Canada
Xiamen Innovacera Advanced Materials Co Ltd China **See ad on pg 93**
Zhengzhou Mission Ceramic Products Co Ltd China
Zibo Guangtong Chemical Co Ltd China

Zircar Zirconia Inc NY
Zircoa Inc OH

RESEARCH ORGANIZATIONS
Academic
Alfred University NY
Applied Research Center SC
Cerinnov France
Cerlase France
Inst for Applied Materials-Ceramics in Mechanical Engineering, Karlsruhe Inst of Technology Germany
Israel Ceramic & Silicate Inst Israel
Universidad Autonoma de Nuevo Leon Mexico

Certification, ISO
GE Global Research NY
Lucideon UK

Government Contract/Independent
Advanced Ceramics Manufacturing AZ
Applied Research Center SC
CelSian Glass & Solar BV The Netherlands
Central Glass & Ceramic Research Institute UK
Ceramitec Germany
CHEMIR - A Division of Evans Analytical Group MO
GE Global Research NY
Inst for Applied Materials-Ceramics in Mechanical Engineering, Karlsruhe Inst of Technology Germany
Israel Ceramic & Silicate Inst Israel
Japan Fine Ceramics Center Japan
Korea Inst of Industrial Technology The Republic of Korea
Lucideon UK
Maryland Ceramic & Steatite Co Inc MD
Sandia National Laboratories NM

Semiconductor Energy Laboratory Co Ltd Japan **See ad on pg 91**
SRI International CA
Technology Assessment and Transfer Inc (TA&T) MD
Viridis3D LLC MA

TESTING/EVALUATION INSTRUMENTS & EQUIPMENT
Acoustic Instruments
BuzzMac Intl LLC ME
James Instruments IL
Matmatch Germany

Chemical Analysis Instruments
Ocean Optics Inc FL

Color Measurement Equipment
HunterLab VA
Lucideon UK

Compression Testing Equipment
Advanced Ceramics Manufacturing AZ
Applied Test Systems Inc PA
CSC Force Measurement Inc MA
Dalmia Inst of Scientific & Industrial Research India

Computer Software
Applied Test Systems Inc PA
CelSian Glass & Solar BV The Netherlands
CSC Force Measurement Inc MA
Datapaq Inc NH
General Glass Equipment Co NJ

Object Research Systems Inc Canada **See ad on pg 81**
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

Couplants, Ultrasonic Instruments
James Instruments IL

Density Analyzers
Micromeritics Instrument Corp GA
Particle Technology Labs IL **See ad on pg 99**
Quantachrome Instruments FL
RocCera LLC NY

Differential Scanning Calorimetry Instruments
Dalmia Inst of Scientific & Industrial Research India
Datapaq Inc NH
Linseis Inc NJ
Netzsch Instruments NA LLC MA
Particle Technology Labs IL **See ad on pg 99**
Setaram Instrumentation France
TA Instruments DE

Differential Thermal Analysis Instruments
Linseis Inc NJ
Neoptix Canada
Netzsch Instruments NA LLC MA
Setaram Instrumentation France
TA Instruments DE

Dilatometers
Edward Orton Jr Ceramic Foundation OH
Haiku Tech Inc FL
Linseis Inc NJ
Netzsch Instruments NA LLC MA
TA Instruments DE

Dye Penetrant Equipment & Supplies
RocCera LLC NY
Spectronics Corp NY

Eddy-Current Testing Instruments
ETher NDE UK

Electrochemical Analysis Instruments
Gamry Instruments PA
Haiku Tech Inc FL
Nanoscience Instruments AZ
Ocean Optics Inc FL

Electromechanical Analysis Instruments
APC International Ltd PA
CSC Force Measurement Inc MA
James Instruments IL
norECs AS Norway

Electronic Analysis Instruments
ETher NDE UK
James Instruments IL

Flexural Analysis Instruments
Advanced Ceramics Manufacturing AZ
RocCera LLC NY
TA Instruments DE
Taber Industries NY

Gas Analysis Instruments
CelSian Glass & Solar BV The Netherlands
Control Instruments Corp NJ
Dalmia Inst of Scientific & Industrial Research India
Horiba Instruments Inc CA
Ocean Optics Inc FL
Setaram Instrumentation France

Image Analysis Instruments
Buehler Ltd IL **See ad on pg 99**
Carl Zeiss MircoImaging Inc NY
Cilas Particle Size WI
Fritsch Milling & Sizing Inc NC
Horiba Instruments Inc CA
LECO Corp MI
Micromeritics Instrument Corp GA
Nanoscience Instruments AZ
Particle Technology Labs IL **See ad on pg 99**
TA Instruments DE

Infrared Spectroscopy Instruments
Ocean Optics Inc FL

Interferometers
OptiPro Systems LLC NY

Leak Detectors
Spectronics Corp NY

Microfocus X-Ray Imaging Instruments
Horiba Instruments Inc CA

Moisture Analyzers
James Instruments IL
Mettler-Toledo Inc OH
Micromeritics Instrument Corp GA
MoistTech Corp FL
Ocean Optics Inc FL
Penn Tool Co NJ
Quantachrome Instruments FL

Nondestructive Evaluation Instruments
American Stress Technologies Inc PA
BuzzMac Intl LLC ME
Dalmia Inst of Scientific & Industrial Research India
Datapaq Inc NH
ETher NDE UK
James Instruments IL
Nanoscience Instruments AZ
Spectronics Corp NY
Thermal Wave Imaging Inc MI

Oxygen Analyzers
Ocean Optics Inc FL
Verder Scientific Inc PA **See ad on pg 101**

Particle Size Analysis Instruments
Brookhaven Instruments Corp NY
Cilas Particle Size WI
Dalmia Inst of Scientific & Industrial Research India
Fritsch GmbH - Milling and Sizing Germany
Fritsch Milling & Sizing Inc NC
Horiba Instruments Inc CA
Micromeritics Instrument Corp GA
Microtrac Inc PA
Particle Technology Labs IL **See ad on pg 99**
Quantachrome UK- Anton Paar VA
Verder Scientific Inc PA **See ad on pg 101**

Pore Size Analyzers
Dalmia Inst of Scientific & Industrial Research India
Micromeritics Instrument Corp GA
Particle Technology Labs IL **See ad on pg 99**
Quantachrome Instruments FL

Pressure Sensors
Rockwell Automation, Inc WI
Siemens Process Industries and Drives GA

Raman Spectroscopy Instruments
Horiba Instruments Inc CA
Ocean Optics Inc FL

Sonic Testing
James Instruments IL
Penn Tool Co NJ

Spectroscopy Instruments
Cilas Particle Size WI
Horiba Instruments Inc CA
LECO Corp MI
Ocean Optics Inc FL
Optocon AG Germany

Surface Analysis Instruments
Carl Zeiss MircoImaging Inc NY
Dalmia Inst of Scientific & Industrial Research India
Euro Support Advanced Materials The Netherlands
Horiba Instruments Inc CA
Hysitron Inc MN
Nanoscience Instruments AZ
OptiPro Systems LLC NY
Particle Technology Labs IL **See ad on pg 99**
Quantachrome Instruments FL
Taber Industries NY

Tensile Testers
Applied Test Systems Inc PA
CSC Force Measurement Inc MA
TA Instruments DE

Thermal Diffusivity/Conductivity Analysis Instruments
Dalmia Inst of Scientific & Industrial Research India
Linseis Inc NJ
Netzsch Instruments NA LLC MA
Setaram Instrumentation France
TA Instruments DE
Thermal Wave Imaging Inc MI

Thermal Imaging
CelSian Glass & Solar BV The Netherlands
Neoptix Canada
Thermal Wave Imaging Inc MI

Thermogravimetric Analysis Instruments
BuzzMac Intl LLC ME
LECO Corp MI
Linseis Inc NJ
Mettler-Toledo Inc OH
Netzsch Instruments NA LLC MA
Setaram Instrumentation France
TA Instruments DE

Thermomechanical Analysis Instruments
Edward Orton Jr Ceramic Foundation OH
Linseis Inc NJ
Optocon AG Germany
Setaram Instrumentation France
TA Instruments DE

Ultrasonic Instruments
APC International Ltd PA
James Instruments IL
APC International Ltd PA
James Instruments IL
Technisonic Research Inc CT

Visual & Optical Testers
Haiku Tech Inc FL
Optocon AG Germany
Penn Tool Co NJ
RISE Research Institutes of Sweden, RISE Glass Sweden
TA Instruments DE
Taber Industries NY

X-Ray Diffraction Instruments
American Stress Technologies Inc PA
Dalmia Inst of Scientific & Industrial Research India
Horiba Instruments Inc CA
MSE Supplies AZ
RocCera LLC NY

X-Ray Instruments
American Stress Technologies Inc PA

X-Ray Spectroscopy Instruments
Cilas Particle Size WI

Zeta Potential Analyzers
Brookhaven Instruments Corp NY
Cilas Particle Size WI
Fritsch GmbH - Milling and Sizing Germany
Horiba Instruments Inc CA
Micromeritics Instrument Corp GA
Particle Technology Labs IL **See ad on pg 99**

A123 SYSTEMS INC 734-772-0300
39000 Seven Mile Rd
Livonia MI 48152

http://www.a123systems.com

A TS-16949 and ISO9001-certified supplier of advanced lithium-ion cells and systems designed to help customers quickly and cost-effectively take engineering breakthroughs from conception to commercialization.

AADVANCED MACHINERY INC 586-790-1717
35044 Automation Dr Fax: 586-790-1871
Clinton Township MI 48035

http://aadvancedmach.com
service@aadvancedmach.com

Buy, sell, trade, and liquidate new and rebuilt machinery for the whitewares, refractories, abrasives, dinnerware, structural clay products, electrical porcelain, and technical ceramics industries.

ACCCO INC/BURLEY CLAY PRODUCTS CO 740-697-2005
451 Gordon St
Roseville OH 43777

http://www.accco-inc.com
remmert@accco-inc.com

Manufacturer of high quality ceramic products and consumer-based ceramic products. Mines and processes rich clay deposits.

ACCURATUS CORP 908-213-7070
35 Howard St Fax: 908-213-7069
Phillipsburg NJ 08865

http://accuratus.com
info@accuratus.com

Provides precision ceramic grinding and machining service. Offers ceramic component design and material selection assistance. Manufactures Accuflect light-reflecting ceramic. Distributes rods and tubes.

ACTIVATION LABORATORIES LTD 905-648-9611
41 Bittern St Fax: 905-648-9613
Ancaster ON L9H 4V5 Canada

http://actlabs.com
hoffman@actlabs.com

Contract laboratory for physical, chemical, and failure analysis. Exceptionally equipped for complete inorganic and organic analysis. Methods include most analytical methods available but also neutron activation and laser ablation high-resolution ICP/MS.

ADAMANT NAMIKI PRECISION JEWEL CO, LTD
3-8-22 Shinden +81 3-5390-7600
Adachi-ku Tokyo 123-8511 Japan Fax: +81 3-5390-7650

https://www.ad-na.com/en
adamant@adamant.co.jp

Combines the value of core expert precision technologies with other values such as advanced development, solutions, quality, and reliability to deliver unprecedented value to customers.

ADTECH CERAMICS 423-755-5400
511 Manufacturers Rd Fax: 423-755-5438
Chattanooga TN 37405

http://adtechceramics.com
sales@adtechceramics.com

Produces custom cofired HTCC (alumina) and AIN microelectronic packaging, ceramic injection molded products, and etched metal products for medical, military, and high rel industrial application. Microware modeling and custom design center.

ADVALUE TECHNOLOGY LLC 520-514-1100
3158 S Chrysler Ave Fax: 520-747-4024
Tucson AZ 85713

http://www.advaluetech.com
sales@advaluetech.com

A leading supplier of high-temperature ceramic products made of fused quartz, alumina, sapphire, and zirconia.

ADVANCED CERAMIC TECHNOLOGY 714-538-2524
803 W Angus Ave Fax: 714-538-2589
Orange CA 92868-1307

http://advancedceramictech.com
ceramic@prodigy.net

Since 1983, ACT manufactures precision ceramic components to customer specifications. Materials include alumina, zirconia, glass, ferrite, cordierite, silicon carbide, and silicon nitride.

ADVANCED CERAMICS MANUFACTURING
7800A S Nogales Highway 520-547-0850
Tucson AZ 85756 Fax: 520-547-0851

http://www.acmtucson.com
info@acmtucson.com

ACM is a supplier of custom technical ceramics, machining services, toll firing, and mechanical testing. We have expertise in custom formulations: nitrides, carbides, borides, and oxides. Patented gel casting. In addition, we conduct sponsored R&D.

ADVANCED ENERGY 800-446-9167
1625 Sharp Point Dr Fax: 970-407-5296
Fort Collins CO 80525

http://www.advanced-energy.com

Advanced Energy devoted more than three decades to perfecting power-enabling design breakthroughs and driving growth for leading semiconductor and industrial customers.

ADVANCED MATERIALS ASSOCIATES 970-453-1221
91 Adams Way Cr Ste No 915
PO Box 809
Breckenridge CO 80242

http://www.advancedmaterialsassoc.com
jjs.ama@comcast.net

Consulting in ceramics, CMCs, MMCs, forming, and synthesis, including hot pressing, sintering, and SPS wear/corrosion/elevated temperature coating applications and technologies with two companies, and lightweight armor materials and structures.

AGNI FIBER BOARDS PVT LTD +91 265 264 6121
990/3/4 GIDC Fax: +91 265 263 4531
Makarpura Vadodara Gujarat
390010 India

http://www.agnipultrusion.com
info@agnipultrusion.com

Manufacturer and dealer of high-temperature structural insulation boards, mold platen insulation boards, and thermal insulation boards for various industrial applications.

AIR FORCE CIVIL ENGINEER CENTER 866-725-7617
Technical Information Center
139 Barnes Dr Ste 2
Tyndall AFB FL 32403-5323

http://www.afcec.af.mil
AFIMSC.PA.Workflow@us.af.mil

The Air Force Civil Engineer Center, headquartered at Joint Base San Antonio-Lackland, is a 1,900-person primary subordinate unit assigned to Air Force Materiel Command and attached to the Air Force Installation and Mission Support Center-Provisional. The Center is responsible for providing responsive, flexible, full-spectrum installation engineering services. AFCEC missions include facility investment planning, design and construction, operations support, real property management, readiness, energy support, environmental compliance and restoration, and audit assertions, acquisition, and program management.

AIR PRODUCTS 800-654-4567
7201 Hamilton Blvd Fax: 800-272-4449
Allentown PA 18195-1501

http://airproducts.com/glass
info@airproducts.com

Air Products is a global leading industrial gas supplier (oxygen, nitrogen, hydrogen, helium and rare gases) with patented technologies and equipment (oxy-fuel burners, flow controls), and CFD modeling and services (feasibility studies, start-up/commissioning).

AKRON PORCELAIN & PLASTICS CO 330-745-2159
2739 Cory Ave Fax: 330-745-6688
PO Box 15157
Akron OH 44314-0157

http://akronporcelain.com
sales@akronporcelain.com

Established 1890. Manufactures custom ceramic parts to customers' specification using compression and injection molding. Produces glazed and unglazed ceramics. Products include special electrical porcelain insulators and refractory shapes.

ALFA AESAR JOHNSON MATTHEY 888-343-8025
2 Radcliff Rd Fax: 978-521-6350
Tewksbury MA 01876

http://alfa.com
specialquotes@alfa.com

Manufactures and supplies complete line of rare-earth oxides and salts for making ceramics, glass, and superconductor-type materials. Also offers a wide range of chemicals, including inorganic, organic, and precious-metal compounds.

ALFRED UNIVERSITY 607-871-2425
2 Pine St Fax: 607-871-2392
Alfred NY 14802

http://engineering.alfred.edu
wightman@alfred.edu

Kazuo Inamori School of Engineering/New York State College of Ceramics: BS and MS degrees in ceramic engineering, glass, biomaterials, materials science and engineering, and mechanical engineering. PhD degrees in ceramics, glass, and materials science.

ALL WASTE MATTERS 227-280-777
Unit 1 Joseph Wilson Industrial Estate
Millstrood Rd
Whitstable CT5 3PS UK

http://www.allwastematters.co.uk
info@allwastematters.co.uk

The waste management specialists.

ALLIED HIGH TECH PRODUCTS INC 310-635-2466
2376 E Pacifica Pl Fax: 310-762-6808
Rancho Cordova CA 90220

http://alliedhightech.com
info@alliedhightech.com

Supplies products for metallographic and SEM/TEM sample preparation, including polishing, grinding and sectioning equipment, and consumables. Online ordering available as well as MSDS information and catalog.

ALLIED MINERAL PRODUCTS 205-338-3366
201 Truss Ferry Rd Fax: 205-338-7456
Pell City AL 35128

http://riversiderefractories.com
jwilli@riversiderefractories.com

Established 1929. Mines and processes gunning fireclay for steel and foundry markets. Produces taphole clays, monolithic refractories, and precast shapes. Offers installation, construction, and maintenance services for a wide range of industrial furnaces.

ALLIED MINERAL PRODUCTS INC 614-876-0244
2700 Scioto Pkwy Fax: 614-876-0981
Columbus OH 43221-4660

http://alliedmineral.com
info@alliedmin.com

Manufactures refractory monolithics and specialties, including alumina, magnesia, silica, mullite, zircon, and fireclay for the foundry and basic-steel industries.

ALMATIS INC 800-643-8771
501 West Park Rd Fax: 412-630-2900
Leetsdale PA 15056

http://almatis.com
info@almatis.com

Almatis is a global specialty alumina producer, serving customers from 16 sales, research, and manufacturing sites. Almatis premium alumina products establish the benchmark for quality and consistency.

ALSEY REFRACTORIES CO 314-963-7900
1600 S Brentwood Blvd Ste 210
Saint Louis MO 63144

http://www.alsey.com
info@alsey.com

Alsey Refractories Co specializes in the private branding of high-duty and medium-duty firebrick as well as wet and dry specialties for major manufacturers with the refractory industry.

A NEW WORLD OF ALUMINA

ALTEO NA LLC 440-460-2640
46 Ravenna St Unit B3 Fax: 216-460-2602
Hudson OH 44236

http://www.alteo-alumina.com
sales.specialty-alumina@alteo-alumina.com

Formerly Rio Tinto Alcan Specialty Aluminas, Alteo owns four production plants in Europe and a global sales network. Extensive product range from alumina trihydrate and calcined aluminas to fused alumina (white/brown) and tabular alumina.

ALUCHEM INC 513-733-8519
1 Landy Ln Fax: 513-733-0608
Cincinnati OH 45215

http://www.aluchem.com
aluchem@aluchem.com

AluChem is a leader in the manufacture of specialty alumina and dedicated to producing the highest quality alumina products in our industry, as well as providing unmatched customer service.

AMERICAN ART CLAY CO INC 317-244-6871
6060 Guion Rd Fax: 317-248-9300
Indianapolis IN 46254

http://www.amaco.com
customercare@amaco.com

For 100 years we specialized in custom material blends of glaze and enamel slurries, formulated industrial modeling clay, built custom kilns, developed ceramics equipment, and much more. Contact us to discuss your project ideas.

AMERICAN CERAMIC SOCIETY BULLETIN
550 Polaris Pkwy Ste 510 614-890-4700
Westerville OH 43082 Fax: 614-899-6109

https://ceramics.org/publications-resources/the-bulletin-of-the-american-ceramic-society

Published by The American Ceramic Society, the *Bulletin* is the official in-print and online voice of the organization, covering ACerS events, governance news, awards, and member achievements. This nine-issues-per-year publication has regular news department.

AMERICAN CHEMET CORP 847-948-0800
740 Waukegan Rd Ste 202 Fax: 847-948-0811
Deerfield IL 60015

http://www.chemet.com
KKlatt@Chemet.com

Manufacture zinc and copper oxides for colorants and copper granules for iron spot brick and tile. Supply cupric oxide for thermistors, ferrites, and conductors as well as metallic copper powders for thick-film electronic production.

AMERICAN ELEMENTS
THE ADVANCED MATERIALS MANUFACTURER®

AMERICAN ELEMENTS INC 310-208-0551
10884 Weyburn Ave Fax: 310-208-0351
Los Angeles CA 90024

http://www.americanelements.com
customerservice@americanelements.com

American Elements is the world's manufacturer of engineered and advanced materials with corporate offices and primary research and laboratory facilities in the US, and manufacturing and warehousing in the US, China, and Mexico.

AMERICAN ISOSTATIC PRESSES 614-497-3148
1205 S Columbus Airport Rd Fax: 614-497-3407
Columbus OH 43207-4304

http://aiphip.com
sales@aiphip.com

Manufactures hot and cold isostatic presses, warm isostatic presses, sinter-HIP systems pressure-sintering furnaces, and high-temperature thermocouples. Also supplies replacement furnaces, service, and parts for all makes and models of HIP systems.

AMERICAN SCIENTIFIC PUBLISHERS 661-799-7200
26650 The Old Rd Ste 208 Fax: 661-799-7230
Valencia CA 91381-0751

http://www.aspbs.com
order@aspbs.com

We publish journals, books, and encyclopedias about nanotechnology, chemistry, physics, engineering, medicine; and computer, materials, polymer, and bio sciences.

AMERICAN STRESS TECHNOLOGIES INC 412-784-8400
540 Alpha Dr Fax: 412-784-8401
Pittsburgh PA 15238-2912

http://www.astresstech.com
info@astresstech.com

Manufacture X-ray diffraction residual stress analyzer.

APC INTERNATIONAL LTD 570-726-6961
PO Box 180 Fax: 570-726-7466
Mackeyville PA 17750

http://americanpiezo.com
sales@americanpiezo.com

Manufactures and supplies piezoelectric ceramics and piezo devices. Capabilities include design, custom machining, and custom electroding of piezo ceramics. APC performs piezo device and transducer assembly, soldering, and contract manufacturing.

APF RECYCLING INC 330-395-8354
2610 N Park Ave Fax: 330-395-0059
Warren OH 44483-2210

http://www.apfrecycling.com/
jamesp@apfrecycling.com

Go green with APF Recycling! Our goal as professionals is to minimize your waste, increase profits with effective raw material substitutes, and pay a premium for byproducts of value. We proudly serve the ceramic, steel, cement, and glass industries.

APPLICON CO 317-635-7843
450 N Somerset Ave
Indianapolis IN 46222

http://www.appliconco.com
sales@appliconco.com

Applicon designs and builds turnkey, compact systems for batching and blending major, minor, and micro ingredients; systems to produce very fine powders and to granulate powders; and portable bin systems and conveyors to move products in plant.

APPLIED CERAMICS INC 510-249-9700
48630 Milmont Dr Fax: 510-249-9797
Fremont CA 94538

http://www.appliedceramics.net
victor@apceramics.com

Applied Ceramics' exclusive material technology and sophisticated manufacturing capabilities provide outstanding performance benefits to the global semiconductor, solar, fuel cell, oil drilling, and nuclear industries. The company works with a wide variety of materials, including alumina, zirconia, and quartz.

APPLIED RESEARCH CENTER 803-641-3300
PO Box 462
Aiken SC 29802-0462

http://www.discoverarc.com

From sustainable energy to effective healthcare to security at home, our nation is counting on rapid developments of practical new technologies. At South Carolina's Applied Research Center (ARC), many of America's most skilled researchers are working daily to advance our knowledge and use of technology.

Established as a hydrogen energy research facility in 2006, ARC's mission expanded to encompass the broader needs of government, academia, and the private sector. This 60,000-square-foot facility, combining state-of-the-art laboratories and a conference center, is home to many organizations, including the Department of Energy,Âôs Savannah River National Laboratory.

APPLIED TEST SYSTEMS INC 800-441-0215
154 East Brook Ln Fax: 724-283-6570
Butler PA 16002

http://www.atspa.com
sales@atspa.com

Design and manufacture furnace ovens, furnace heating elements, temperature controls, and extensometers. Also manufacture materials-testing systems, including tension-compression, creep/stress rupture, stress relaxation, constant stress, and universal.

ARBURG GMBH + CO KG +49 7446 330
Arthur-Hehl Strasse Lossburg Fax: +49 7446 333365
Baden-Wurttemberg 72290 Germany

http://www.arburg.com/info/pim/en
pim@arburg.com

ARBURG is a PIM pioneer with more than 50 years of experience in the industry and one of the world's leading manufacturers of plastic processing machines. The portfolio includes ALLROUNDER injection moulding machines with clamping forces between 125 and 6,500 kN, the freeformer for industrial additive manufacturing, robotic systems, customer- as well as sector-specific turnkey solutions, and further peripherals. ARBURG offers also application consulting, training, and a well-equipped PIM laboratory for all relevant production steps.

An international sales and service network guarantees first-class, local customer support. ARBURG has its own organizations at 34 locations in 26 different countries; together with its trading partners, it is present in more than 100 countries. The machines are produced exclusively at the parent factory in Lossburg, Germany.

ARBURG has triple certification according to ISO 9001 (quality), ISO 14001 (environment) and ISO 50001 (energy).

US headquarters in Rocky Hill, CT.

Tel. +1 860 667 6500; Fax +1 860 667 6522

https://www.arburg.us; usa@arburg.com

ARCH MAINTENANCE SERVICES 912-996-0156
162 Key Circle Dr
Brunswick GA 31520

http://www.jpechin.com
info@jpechin.com

Providing custom spray drying services on laboratory and pilot scales.

AREMCO PRODUCTS INC 845-268-0039
707-B Executive Blvd Fax: 845-268-0041
Valley Cottage NY 10989

http://aremco.com
info@aremco.com

Established 1964. Specializes in ceramic raw materials for production and research. Supplies ceramic adhesives, coatings, and castable ceramics for encapsulation work, and machinable ceramics for components, development, and tooling, including brazing boats.

ARIZONA STATE UNIVERSITY 480-965-3291
699 S Mill Ave Fax: 480-727-9321
Tempe AZ 85281

http://semte.engineering.asu.edu
semte@asu.edu

ARKEMA INC 610-205-7000
900 First Ave Fax: 610-205-7913
King of Prussia PA 19406

http://www.arkema-americas.com
arkema.usph-general@arkema.com

Arkema is a world-class producer of industrial chemicals including acrylic monomers, emulsion systems, fluorochemicals, fluoropolymers, functional additives, hydrogen peroxide, PMMA, specialty polyamides and thiochemicals.

ARLIMIN INDUSTRIES 832-280-9980
PO Box 271497 Fax: 970-494-0206
Fort Collins CO 80526

http://www.arlimin.com
info@arlimin.com

Wholesale provider of raw materials to the ceramics, glass, and coatings industries.

ART ON CERAMIC 855-918-5506
PO BOX 1625 Fax: 855-918-5506
Plattsburgh NY 12901

https://www.custom-ceramic-tile.com
contact@artonceramic.com

We developed an exclusive ceramic printing technology that will fit your personal project or your business branding. We also do tile reproduction. It is simple; your imagination is the limit of what we can do for you. You create, we print!

ASSOC OF AMERICAN CERAMIC COMPONENT MANUFACTURERS (AACCM) 614-794-5894
550 Polaris Pkwy Ste 510 Fax: 240-396-5637
Westerville OH 43082

http://www.aaccm.org
kthompson@ceramics.org

AACCM's member companies manufacture components from ceramic powders at U.S. operating facilities. Its purpose is to expand the market for U.S.-manufactured components by enhancing processes and quality and to increase awareness of ceramic applications.

AssociatedCeramics
an Advanced Technology Company

ASSOCIATED CERAMICS & TECHNOLOGY INC
400 North Pike Rd 724-353-1585
Sarver PA 16055 Fax: 724-353-1050

http://www.associatedceramics.com
sales@associatedceramics.com

Associated Ceramics & Technology Inc is a custom manufacturer of ceramics composed of alumina, steatite, cordierite, spinel, wollastonite, mullite, and high performance materials such as zirconia and yttria-stabilized zirconia. Its engineers' knowledge of the physical and chemical properties of a finished product allow the company to provide excellent quality in applications pertaining to chemical, electrical, wear-resistant, automotive, appliances, and many others. The expansive production capabilities at ACT include more than 155 dry and isostatic presses, seven extrusion presses, 10 kilns, and pre- and post-sintered machining capabilities that are sure to satisfy a customer's every need.

ASTRAL MATERIAL INDUSTRIAL CO LTD
Rm 2303 Block 1 JunNing Bldg +86 757 8266 7101
No 213 FuNing Rd Fax: +86 757 8270 1478
ChanCheng Dist FoShan 528000 China

http://www.amic.biz
sales@amic.biz

AMI produces thermal ceramics, technical ceramics for tile factories, sanitaryware factories, and tableware factories. We also supply to new energy industry, precision casting, chemical industry, and environmental protection industry. We are an ISO9001:2015 certified enterprise. AMI is dedicated to provide products and service with good quality and assist customers with cost.

ASTRO MET ADVANCED CERAMICS INC 513-772-1242
9974 Springfield Pike Fax: 513-772-9080
Cincinnati OH 45215

http://astromet.com
fgorman@astromet.com

Established 1961. Manufacturers precision toleranced advanced ceramic components on a custom order basis per customer design with a focus on wear and corrosion applications. Materials include alumina, zirconia, ZTA, and Macor machinable ceramic.

ATLANTIC EQUIPMENT ENGINEERS 201-299-6476
24 Industrial Ave Fax: 201-387-0291
PO Box 181
Upper Saddle River NJ 07458

http://micrometals.com
info@micronmetals.com

Manufactures and distribute high-purity metals, metal powders, oxides, and other compounds to meet the needs and material requirements of the R&D community.

AVALON ADVANCED MATERIALS INC 416-364-4938
130 Adelaide St W No 1901 Fax: 416-364-5162
Toronto ON M5H 3P5 Canada

http://www.AvalonAM.com
ilondon@avalonventures.com

Emerging Canadian producer of petalite concentrates well-suited for specialty glass/ceramic formulations demanding high purity lithium minerals. Avalon developed proprietary process technology to produce petalite products from its Separation Rapids mineral resource (near Kenora, Ontario, Canada). Avalon's standard petalite product (4.0-4.2% Li2O) is notable for its low iron content and consistent SiO2:Al2O3 ratio. The super petalite (>4.5% Li2O) product also achieves exceptionally low levels of alkalis.

AVEKA 651-730-1729
2045 Wooddale Dr
Woodbury MN 55125

https://www.aveka.com
aveka@aveka.com

AVEKA is a contract manufacturing and R&D company specializing in particle toll processing. Processing capabilities include drying, milling, blending, screening, and particle characterization. AVEKA is an ISO 9001:2015 registered company providing processing solutions from lab-scale samples to full-scale production for a wide variety of industries.

AVS INC 978-772-0710
60 Fitchburg Rd Fax: 978-772-6462
Ayer MA 04132

http://avsinc.com
sales@avsinc.com

Manufactures standard and custom vacuum furnaces. Debinding, sintering, hot isostatic or axial pressing, diffusion bonding in lab to production scale units. Vacuum to 2,500 psig. Specializes in custom-designed systems for advanced materials processing.

AVX CORP 843-448-9411
1 AVX Blvd Fax: 843-448-2106
Fountain Inn SC 29644-9039

http://avx.com
inquiry@avx.com

Established 1972. Manufactures multilayer ceramic capacitors for the electronics industry, including microminiature, multilayer monolithics in chips; radial- and axial-leaded, molded and conformal coated capacitors and tantalum capacitors.

B&P LITTLEFORD 800-365-8555
1000 Hess Avenue Fax: 859-525-1446
Saginaw MI 48601

https://www.bplittleford.com
sales@littleford.com

Manufactures processing equipment, including mixers, granulators, agglomerators, vacuum dryers, liquid dispersers, and pressure reactors. Also provides pilot-plant and lab equipment. Maintains a completely equipped test center to assist customers.

BAIKOWSKI MALAKOFF INC 704-587-7100
6601 Northpark Blvd Ste H
Charlotte NC 28216

http://www.baikowskimalakoff.com
info@baikowskimalakoff.com

Subsidiary of Baikowski Intl. Corp. Produces Bayer-derived intermediate and high-purity (99.8–99.99%) calcined alpha- and gamma-alumina.

BASIC MACHINERY CO INC 888-522-7420
1220 Harold Andrews Rd Fax: 919-663-2172
PO Box 688
Siler City NC 27344

http://www.basicmachinery.com
ceramic-sales@basicmachinery.com

Design automated machinery and systems for ceramic industries as well as complete plants. Specialize in materials handling, crushing, grinding, screening, reclaiming, automatic transfer cars, cable haulages, and specialized equipment for brick shapes.

BASSTECH INTL 201-569-8686
400 Kelby St Fax: 201-569-7511
Fort Lee NJ 07024

http://basstechintl.com
info@basstechintl.com

Supplies chemicals and other raw materials to the ceramics industry in North America and Europe. Materials inventoried in warehouses strategically located throughout the United States, Europe, and Asia to guarantee continuity of supply.

BAYVILLE CHEMICAL SUPPLY CO INC 631-586-4309
70-G E Jefryn Blvd Fax: 631-254-5591
Deer Park NY 11729

http://www.bayvillechemical.net
info@bayvillechemical.net

Bayville Chemical is a supplier of ultrahigh-purity chemicals (organic and inorganic), ceramics, metals, optics, crystals, sputtering targets, evaporation and coating materials, and vitreous carbon. The company services small research, R&D, and production facilities.

BEIJING CERAMETEK MATERIALS CO LTD
A3 No 9 YongChun St +86 10 6156 6641
Ste No 501 GuangMing Fax: +86 10 6156 1674
ShenZhen GD518106 China

http://www.cerametmaterials.com
sales@cerametmaterials.com

Cerametek materials (Al-Zr): metal(s) oxide, carbide, nitride, boride, fluoride, sulfide, diamond, graphite, quartz, metal, alloys, and rare-earth compounds. Also, 98%-5N grade, submicron to mesh (mm), powder/rods/tube/foil/porous, complex compounds.

BELDEN BRICK CO 330-456-0031
PO Box 20910 Fax: 330-456-2694
Canton OH 44701

http://beldenbrick.com
info@beldenbrick.com

Established 1885. Company operates seven plants in Ohio and produces more than 240 million brick annually.

BHARAT HEAVY ELECTRICALS LTD +91 80 2218 2244
BHEL House Siri Fort Fax: +91 80 2334 4231
New Delhi 110049 India

http://www.bhel.com
kumar@bhelepd.com

Ceramic Technological Institute, Corporate R&D, Bharat Heavy Electricals Ltd is engaged in industrial process and product development in ceramics, such as microwave sintering, ceramic membranes, coatings, nanomaterials, and CSP for energy sector.

BLASCH PRECISION CERAMICS INC 518-436-1263
580 Broadway Fax: 518-436-0098
Albany NY 12204

http://blaschceramics.com
tconnors@blaschceramics.com

Manufactures complex ceramic shapes requiring closely controlled tolerances and uniform composition and structure. Products include alumina, fused silica, and SiC items.

BLASTCRETE EQUIPMENT CO 800-235-4867
Anniston AL 36202

http://www.blastcrete.com
info@blastcrete.com

For 60 years, Blastcrete Equipment Co manufactures safe, reliable, and user-friendly solutions for the refractory and shotcrete industries. The company offers a complete product line of concrete mixers, pumps, and related products.

BOCA BEARING COMPANY 561-998-0004
1420 Neptune Dr Ste A Fax: 561-998-0119
Boynton Beach FL 33426-8420

http://www.bocabearings.com
info@bocabearings.com

Boca Bearing Company is a proud supplier of bearings and lubricants catered toward the robotics, automation, and advanced manufacturing industries. Boca Bearing's ceramic bearings can be used in manufacturing environments ranging from extreme temperatures to high speeds and heavy loads. Full ceramic bearings can be used in robotic applications underwater, in vacuum, and space environments. Ceramic bearings are nonmagnetic, nonconductive, noncorrosive, and can operate without lubrication.

BOMAS MACHINE SPECIALTIES INC 617-628-3831
334 Washington St Fax: 617-628-6108
Somerville MA 02143

http://www.bomas.com
jannese@bomas.com

Since 1959, we provide advanced ceramics machining for wear applications in all types of environments. Servicing the aerospace, automotive, dental, electronic, government, medical, nuclear, education, semiconductor, and wind and solar industries.

BOSAI MINERALS GROUP CO LTD +86 23 6388 6666
46-47TH F World Trade Center Fax: +86 23 6388 6582
131 Zourong Road
Yuzhong District Chongqing China

http://cqbosai.com
info@nanchuanminerals.com

A Chinese raw-material-group that concentrates on mining (bauxite), fusion manufacturing (brown-fused alumina and metallurgical alumina), and mineral processing (calcined bauxites, flint clays, kaolin and barites). U.S. sales office.

BRICK INDUSTRY ASSN 703-620-0010
12007 Sunrise Valley Dr Ste 430 Fax: 703-620-3928
Reston VA 20191-1525

http://www.gobrick.com
brickinfo@bia.org

Promotes use of brick through marketing, education, engineering, research, advertising, and public relations. Serves on committees of national construction and technical organizations. Safeguards the industry against regulations and monitors legislation.

BROOKHAVEN INSTRUMENTS CORP 631-758-3200
750 Blue Point Rd Fax: 631-758-3255
Holtsville NY 11742

https://www.brookhaveninstruments.com
info@bic.com

Manufactures quality instrumentation for colloid and polymer characterization, quality control, and research applications. Particle-size measurements are obtained utilizing dynamic light scattering or discentrifugation.

BUCHER EMHART GLASS SA +41 41 749 42 00
Hinterbergstrasse 22 Fax: +41 41 749 42 71
PO Box 2251
Cham 2 CH-6330 Switzerland

http://bucheremhartglass.com
webmaster@bucheremhartglass.com

Leading international supplier of equipment, controls, and parts to glass container industry. Broad-based expertise in glass container forming, glass conditioning, gob forming, ware handling, cold end inspection, refractory parts, and quality assurance.

BUEHLER 800-283-4537
41 Waukegan Rd Fax: 708-295-7979
Lake Bluff IL 60044

https://buehler.com
info@buehler.com

Manufactures sample preparation equipment and supplies for metallographic, petrographic, and ceramics labs, including cutoff machines, low-speed diamond saws, coarse and fine grinders, lab presses, polishing machines, and automatic polishers.

BULLEN 937-456-7133
1301 Miller Williams Rd Fax: 937-456-2779
Eaton OH 45320

http://www.bullentech.com
sales@bullentech.com

Precision custom grinding and finishing of hard, brittle materials including glass, sapphire, alumina, silicon nitride, CVD silicon carbide, ceramic matrix composites, and other technical ceramics. Unique and innovative ultrasonic machining. ISO 9001.

BUZZMAC INTL LLC 414-352-5419
638 Congress St No 202
Portland ME 04101

http://www.buzzmac.com
support@buzzmac.com

Nondestructive-testing equipment/services for measuring the damping and dynamic elastic properties (Young's modulus, shear modulus, Poisson's ratio) of materials using the impulse-excitation technique (Ping test) as described in ASTM E1876/C1259.

C&L DEVELOPMENT CORP 408-864-0680
1821 Saratoga Ave Ste No 210 Fax: 408-864-0930
Saratoga CA 95070

http://candldevelopment.com
info@candldevelopment.com

Manufactures and imports oxides, compounds, and metals, including rare earths, zirconium, molybdenum, tungsten, indium, germanium, chromium, and barium.

CANCARB LIMITED 403-527-1121
1702 Brier Park Crescent NW Fax: 403-529-6093
Medicine Hat AB T1C 1T9 Canada

http://www.cancarb.com
customer_service@cancarb.com

Cancarb is the only company dedicated to manufacturing Thermal Carbon Black. In addition to our standard Thermax N990 and N991 grades for steel refractories, we offer a number of specialty thermal blacks, such as Ultra-Pure N990UP and N991UP carbon black for the advanced ceramics and metallurgical industries.

CAPITAL REFRACTORIES LTD +44 1246 811163
Station Road
Clowne Chesterfield
Derbyshire S43 4AB UK

http://capital-refractories.com
enquiries@capital-refractories.com

Capital Refractories specializes in supplying refractory linings and associated products to metal melting, foundry, and cement industries around the world.

CARBO CERAMICS 281-921-6400
5050 Westway Park Blvd Suite 500
Houston TX 77041

https://carboceramics.com
customerservice@carboceramics.com

CARBO creates innovative, industry-leading technologies and products engineered to significantly improve our customers' performance and deliver value across a diverse range of industries and applications. We collaborate closely with our customers to understand their needs and apply over 40 years of material science, technology development and manufacturing expertise to create technology-based solutions

CARBOLITE GERO +44 1433 620011
Parsons Ln
Hope Valley S33 6RB UK

http://www.carbolite-gero.com/company
info@carbolite-gero.com

Manufactures high-temperature furnace and other products for the lab and production environment. Offers a comprehensive range of box, tube and bottom-loading furnaces to 1,800°C and ovens to 600°C. Also offers refractory-testing and custom-built furnaces.

CARL ZEISS MICROSCPYH LLC 800-233-2343
One North Broadway Fax: 914-681-7446
White Plains NY 10601

https://www.zeiss.com/microscopy/int/home.html
micro@zeiss.com

Offers all types of high-performance microscope systems for the inspection and measurement of ceramics, plastics, and other substrates. Offers upright, inverted, stereo, and the latest in confocal microscopes.

CAROLINA MATERIAL TECHNOLOGIES 704-846-3737
1801 Kilmonack Ln
Charlotte NC 28270

http://www.cmtnc.com
info@cmtnc.com

Carolina Material Technologies offers engineering and consulting services, as well as providing turnkey bulk material handling system solutions.

CASE WESTERN RESERVE UNIVERSITY 216-368-4230
White Bldg 10900 Euclid Ave
Cleveland OH 44106

http://case.edu
jxc41@cwru.ed

CELSIAN GLASS & SOLAR BV +31 40 249 0100
PO Box 7051
Eindhoven North Brabant 5605 JB The Netherlands

http://www.celsian.nl
infodesk@celsian.nl

CelSian Glass & Solar BV provides industrial contract research, technological solutions, and consultancy to the global glass and solar market; assists companies in optimization glass and silicon production and innovation of related products.

CENTERLINE TECHNOLOGIES 978-568-1330
577 Main St Ste 270 Fax: 978-568-1334
Hudson MA 01749-3096

http://www.centerlinetech-usa.com
sales@centerlinetech-usa.com

Capabilities include precision lapping, polishing, laser machining, diamond sawing, edge/diamond machining, tumbling, and a filled via planarity process. Materials include AlN; 99.6%, 99.5%, and 96% alumina; BeO; fused silica; sapphire; quartz; and titanate.

CENTORR VACUUM INDUSTRIES 603-595-7233
55 Northeastern Blvd Fax: 603-595-9220
Nashua NH 03062

https://vacuum-furnaces.com/
sales@centorr.com

Centorr Vacuum Industries is a manufacturer of custom vacuum and controlled atmosphere furnaces for the sintering, debinding, and heat treatment of advanced ceramics, such as SiC, Si3N4, AlN, BN, and B4C; stainless steels; refractory metals; cermets; and hardmetals. Available in laboratory to production size at temperatures to 3,000? and pressures to 1,500 psig, with graphite or refractory metal hot zones and optional Sweepgas binder removal systems to handle any binder or lubricant.

CENTRAL GLASS & CERAMIC RESEARCH INSTITUTE +91 33 2473 3469
196 Raja S C Mullick Rd
Kolkata West Bengal 700 032 India
Fax: +91 33 2473 0957

http://cgcri.res.in
brmandal@cgcri.res.in

Provides scientific industrial research and development in the area of glass, ceramics, and related materials that maximizes the economic, environmental, and societal benefit for the people of India.

CERADYNE INC, A 3M CO 800-831-0658
2416 Merchant St
Lexington KY 40511

http://www.3m.com/specialtyglass
specialtyglass@mmm.com

From manufacturing a new generation of precision electronics to enabling a world powered by clean, renewable energy, specialty glasses from Ceradyne Inc, a 3M Co, are inspiring innovation in electronic, solar power, and semiconductor applications. 3M specialty glass compounds and solar metallization paste additives are vital to many groundbreaking electronic and mechanical components. These versatile materials are precision-manufactured for unmatched consistency, batch after batch,Äîand they are backed by Ceradyne's 50 years of insight and experience. From glass design and engineering, to in-house analytical support and quality control, to scale-up and full-scale production, Ceradyne has the breadth and depth of knowledge to help customers make tomorrow's breakthroughs today.

CERAKOTE CERAMIC COATINGS 866-774-7628
7050 6th St
White City OR 97503

https://www.cerakote.com
info@cerakote.com

Founded in 1984, Cerakote is a division of NIC Industries Inc that focuses on developing and manufacturing the highest performing line of ceramic coatings available anywhere in the world. Cerakote is a world leader in ceramic coatings.

CERALINK INC 518-283-7733
105 Jordan Rd No 2
Troy NY 12180

http://ceralink.com
patricia@ceralink.com

Comprehensive microwave testing center staffed to assist customers in implementing and optimizing microwave processing in the ceramics, glass, and metal industries.

CERAMCO INC 603-447-2090
1467 E Main St Fax: 603-447-3906
PO Box 300
Center Conway NH 03813

http://ceramcoceramics.com
sales@ceramcoceramics.com

A manufacturer of near-net shape technical ceramics by ceramic injection molding from prototype to high-volume production. Diamond grinding for high precision components. Ceramic fasteners in stock.

CERAMIC ARTS NETWORK 866-721-3322
550 Polaris Pkwy Ste No 510
Westerville OH 43082

http://ceramicartsnetwork.org
editor@ceramicartsdaily.org

Inspiration and instruction from ceramic artists and leading professionals in the field. The Ceramic Arts Network is an online community serving active potters and ceramic artists worldwide, as well as those who are interested in finding out more about this craft. The Ceramic Arts Network includes *Ceramics Monthly*, *Pottery Making Illustrated*, *CLAYflicks*, the *International Ceramic Artists Network* (*ICAN*), and *Ceramic Recipes*.

CERAMIC COLOR & CHEMICAL MFG CO 724-846-4000
1100 13th St Fax: 724-846-4123
New Brighton PA 15066

http://ceramiccolor.com
info@ceramiccolor.com

Manufactures ceramic colors and inorganic pigments. Producer of custom chemicals and compounds. Melts specialty frits and glasses. Distributor of raw materials.

CERAMIC POWDER TECHNOLOGY AS +47 916 71 332
Kvenildmyra 6
Tiller N-7093 Norway

http://www.cerpotech.com
sales@cerpotech.com

CerPoTech manufactures advanced ceramic powders for applications such as fuel cells, batteries, membranes, piezoceramics, and many more. With its unique process, CerPoTech synthesizes high quality ceramic powders that are tailored to specific requirements of customers and partners.

CERAMIC SERVICES INC 215-245-4040
1060 Park Ave
Bensalem PA 19020

http://www.kilnman.com
kilns@kilnman.com

Builds premium quality kilns and dryers. Provides experienced consulting for drying and firing problems. A fresh source for replacement parts and service for all makes of kilns and dryers.

CERAMITEC +49 89 94911378
Messegelande 1 Eingang Ost
Munchen 81823 Germany

http://www.ceramitec.com
info@ceramitec.com

Ceramitec is a leading trade fair for the ceramics industry—hub for sector-wide expertise and technology that brings the industry together.

CERAMTEC NORTH AMERICA CORP 864-682-3215
1 Technology Pl Fax: 864-682-1140
Laurens SC 29360-0089

http://www.ceramtec.us
sales@ceramtec.com

Produces a wide range of ceramics in 11 worldwide manufacturing locations, including a state-of-the-art laser facility in the U.S. Products include alumina and aluminum nitride substrates (pressed, stamped, lasered) and piezoceramics.

CERAMTEC-ETEC +49 2205 9200169
An der Burg Sülz 17 Fax: +49 2205 9200144
Lohmar 53797 Germany

https://www.ceramtec.com/subsidiary/ceramtec-etec
info@etec-ceramics.de

CeramTec-ETEC is a CeramTec subsidiary that offers solutions made from ALOTEC advanced ceramics for wear and corrosion protection; ceramic armor for ballistic protection of personnel, vehicles, and assets; ALOSLIDE inrun track systems for ski jumping events; and PERLUCOR transparent ceramics.

CERANOVA CORPORATION 508-460-0300
85 Hayes Memorial Dr
Marlborough MA 01752

http://www.ceranova.com
info@ceranova.com

CeraNova is an industry leader in product / process development and pilot-scale manufacturing of advanced ceramics. We specialize in near net shape, controlled microstructure, transparent ceramics, with superior optical and mechanical properties that provide unique, cost effective solutions for defense, aerospace, and commercial customers.

CERCO INC 330-567-2145
453 W McConkey St Fax: 330-915-4925
Shreve OH 44676

http://www.CerCoCorp.com
diamonite@cercollc.com

Supplies advanced structural ceramics for custom-engineered and designed machine parts, electrical/electronic components, fluid-handling equipment, machine wear parts, and welding-thermal equipment. Armor ceramics. CAD-CAM, CNC-equipped prototype lab.

CERINNOV +33 5 55 04 24 54
Parc d'Ester 2 Rue Columbia Fax: +33 5 55 04 24 55
Limoges 87068 France

http://www.cerinnov.com
j.daems@cerinnov.com

Cerinnov specializes in the manufacturing of production and decoration machines for the ceramic and glass industries: shaping and decorating machines, laser marking, engineering, turn-key plants for tableware, tools, and after sales services.

cerion nanomaterials
Custom Design & Manufacturing

CERION NANOMATERIALS 585-271-5630
1 Blossom Road
Rochester NY 14610

http://www.cerionnano.com
sales@cerionnano.com

Cerion is a leader in the science of designing, scaling and manufacturing metal, metal oxide and ceramic nanomaterials for commercial, defense and life science companies developing products or systems. The cost of developing advanced expertise in nanomaterials is prohibitively expensive and time intensive, resulting in a significant barrier to entry for companies considering its adoption. Cerion provides companies with access to this expertise through all phases of the product lifecycle including applied research, development, scale-up, commercialization and manufacturing. Cerion's position in the market is enabled by three strategic competitive advantages: deep and demonstrated capability in a.) precision design and customization of both nanoparticle size and technical attributes, b.) robust processes to scale materials from prototype to low and high-volume production rates, and c.) industry-leading, cost-effective manufacturing systems and production capacities.

CERITHERM +33 5 55 33 23 13
Hotel d'entreprises des Garennes
Rue de Pouloueix Fax: +33 5 55 33 23 14
Oradour sur Vayres 87150 France

http://ceritherm.org
contact@ceritherm.com

Part of the Ceric group, manufactures kilns for the production of fine ceramics. Also provides advanced systems for automatic handling and production monitoring.

CERIX - GROW PLATFORM GMBH +49 0831 54075342
Albert Einstein Strasse 6
Kempten 87437 Germany

http://www.cerix-ceramics.de
info@cerix-ceramics.de

CERIX grow platform GmbH is a start-up company from Robert Bosch GmbH. We produce high-tech ceramics for various markets and offer functional components for sensors, medical products, consumer goods, automotive components, and industrial products made of alumina and zirconia. CIM in combination with in-mold labelling and 3D printing enable us to manufacture complex functional components with the highest degree of precision.

CERLASE +33 5 55 04 24 54
Parc d'Ester 2 Rue Columbia Fax: +33 5 55 04 24 55
Limoges 87068 France

http://www.cerinnov.com
q.joly@cerinnov.com

Cerlase is an officially certified R&D center. Primary research lines are lasers for ceramics, glass and metal (sintering, melting, cutting), shaping processes for ceramics, decoration (laser sintering, total transfer, heat decal), and heat treatment.

CHEMICAL ABSTRACTS SERVICE 614-447-3751
2540 Olentangy River Rd Fax: 614-447-3600
Columbus OH 43210-0012

http://cas.org
help@cas.org

Established 1907. Publish Chemical Abstracts. Produces online information services to identify research studies and patents relating to chemistry, biotechnology, engineering, materials science, physics, and other scientific fields.

CHEMIR - A DIVISION OF EVANS ANALYTICAL GROUP
2672 Metro Blvd — 314-291-6620
Maryland Heights MO 63043 — Fax: 314-291-6630

http://www.chemir.com
info.chemir@eag.com

Testing lab provides investigative analytical chemistry to solve challenging problems. Services include deformulation (reverse engineering), material/contaminant identification, polymer analysis, failure analysis, and litigation support. ISO 9001:200

CHIZ BROS: REFRACTORY AND INSULATION SPECIALISTS
2117 Lincoln Blvd — 412-384-5220
Elizabeth PA US 15037

mrhoajr@chizbros.com
http://www.chizbros.com

Chiz Bros. is committed to providing personalized solutions for refractory applications and installations. We are dedicated to supplying high-quality, competitively-priced products and on-time delivery. At Chiz Bros., we promise immediate response and superlative customer service while meeting regulatory, safety and environmental industry requirements. Chiz Bros. has served the metals, power, glass and ceramics industries for nearly 50 years. We have vast knowledge of product applications and installation specifications. Our customers represent a wide array of companies ranging from international, publicly-traded major manufacturers to walk-in, small furnace operators. Our on-site warehouse is fully-stocked to meet most customer needs. We carry Fiberfrax® ceramic fiber products, non RCF soluble fiber products, fire protection products, castables, gunite mixes, firebrick, silica fiberglass products and heating elements. We have a large inventory of miscelLnous refractory-related needs including

CHRISTY MINERALS LLC — 636-585-2214
833 Booneslick Rd — Fax: 636-585-2220
PO Box 159
High Hill MO 63350

http://www.christyco.com/minerals
sbower@christyminerals.com

Christy Minerals LLC is a premier producer of alumina silicate clays and calcines. We service the refractory, ceramic art, investment casting, ceramic tile, and cement industries. We provide toll calcining, toll grinding, and screening services.

CIDRA PRECISION SERVICES LLC — 203-774-4422
50 Barnes Park N
Wallingford CT 06492

http://www.cidraprecisionservices.com
jsirkis@cidracps.com

Specializes in custom manufacturing of micron level precision machined mechanical, optical, and fluidic components and assemblies made from hard materials such as sapphire, quartz, ceramics, glass, and hard metals.

CILAS PARTICLE SIZE — 608-274-7719
2984 Triverton Pike Dr Ste No 104
Fitchburg WI 53711 — Fax: 608-270-3801

http://particle-size.us
info@particle-size.com

Provides high-performance state-of-the-art laser particle-size analyzers. Products allow analysis of particle-size distribution and viewing of particle shape. Offers a wide range of instruments capable of analyzing samples from 0.04–2,500 micrometers.

CINCINNATI GASKET & INDUSTRIAL GLASS — 513-761-3458
40 Illinois Ave
Cincinnati OH 45215

https://cgindustrialglass.com
ueckerm@cincinnatigasket.com

A leading U.S. manufacturer specializing in a wide range of machined glass products for use in nearly every major industry in the world from steel and chemical industries to machine tool and power generation.

CLEVELAND VIBRATOR CO — 800-221-3298
2828 Clinton Ave — Fax: 216-241-3480
Cleveland OH 44113

http://www.clevelandvibrator.com
sales@clevelandvibrator.com

Since 1923, the Cleveland Vibrator Company provides material flow and processing solutions to over 15,000 customers through a broad range of industrial vibrators and vibratory equipment components, including pneumatic and electric bin and hopper vibrators, vibratory feeders, vibratory tables, and vibratory screeners and sieves.

CM FURNACES INC — 973-338-6500
103 Dewey St — Fax: 973-338-1625
Bloomfield NJ 07003-4237

http://www.cmfurnaces.com
info@cmfurnaces.com

Established 1946. Manufactures lab and production furnaces for a wide variety of ceramics applications and services a temperature range to 2,000°C in air, inert, and reducing atmospheres. Batch and continuous furnaces offered in a variety of sizes.

CMC LABORATORIES INC — 480-496-5000
7755 S Research Dr Ste 115
Tempe AZ 85284

http://cmclaboratories.com
info@cmclaboratories.com

CMC Laboratories Inc is a failure analysis laboratory located in Tempe, Arizona, that focuses on root cause analysis and failure mode identification. CMC's analysis goal is to provide customers with the root cause of a failure and work closely with the customer to identify process or control changes that can eliminate failure.

COBER MUEGGE LLC — 203-855-8755
30 Moffatt St — Fax: 203-855-7511
Stratford CT 06615

http://cobermuegge.com
sales@cobermuegge.com

Designs and manufactures microwave ovens for ceramic heating, sintering, and more.

COMTRUST ARCHITECTURAL MESH CO LTD
No 323 Weimin St of Anping County — +86 318 706 3609
Hebei 053600 China — Fax: +86 318 706 1960

http://www.coildrapery.com
sales@coildrapery.com

Produce a variety of styles of architectural mesh, architectural mesh panels, mesh facade, and decorative mesh.

CONTROL INSTRUMENTS CORP — 973-575-9114
25 Law Dr — Fax: 973-515-0013
Fairfield NJ 07004

http://www.controlinstruments.com
sales@controlinstruments.com

Manufactures detection systems for hazardous gases and vapors. Products include LFL analyzers, BTU analyzers, infrared analyzers, flame-ionization detectors, and gas sensors.

COORSTEK — 303-271-7100
14143 Denver West Pkwy Ste 400
Golden CO 80401

https://www.coorstek.com
info@coorstek.com

With manufacturing locations across four continents, CoorsTek is the international partner of choice for companies requiring the unique, high-performance properties of engineered technical ceramics. CoorsTek partners with customers to design, test, and manufacture standard and custom components for virtually every industry in the global marketplace. Materials include aluminas, carbides, nitrides, quartz, silicates, yttrias, and zirconias. Visit CoorsTek.com.

CORNING INCORPORATED — 607-974-9000
1 Riverfront Plaza
Corning NY14831

http://corning.com
inquiries@corning.com

Corning combines its expertise in specialty glass, ceramic materials, polymers, and the manipulation of the properties of light, with strong process and manufacturing capabilities to develop, engineer, and commercialize significant innovative products.

CRODA — 732-417-0800
300A Columbus Circle
Edison NJ 08837-3907

http://www.crodaindustrialchemicals.com/
Patricia.vanee@croda.com

For advanced ceramics, Croda offers a selection of polymeric dispersing/suspending agents. The Hypermer KD range is specifically designed to provide superior dispersion of particles. Croda also offers versatile nonphthalate plasticizers, such as Pycal 94.

CSC FORCE MEASUREMENT INC — 413-789-3086
84 Ramah Cir N — Fax: 413-789-3598
PO Box 887
Agawam MA 01001-0887

http://www.cscforce.com
linda@cscforce.com

Stocking distributor of force/torque measurement products by Amatek/Chatillon/Lloyd Testers, CDI, Dillon, Larson, MSI, Mark-10, Seekonk, Tohnicki and others. Repairs and calibration lab with ISO/IEC 17025 certification, accredited by L-A-B.

CUSTOM PROCESSING SERVICES — 610-779-7001
2 Birchmont Dr
Reading PA 19606-3266

http://www.customprocessingservices.com
hway@customprocessingservices.com

Submicron- and nano-range ceramic particles, silicon carbide, boron carbide, alumina, and more. Custom toll manufacturing for submicron particles and wet grinding. Small batch manufacturing (kilograms) to large scale (tons).

CYCLONAIRE CORP — 800-445-0730
2922 N Division — Fax: 402-362-2001
York NE 68467

http://cyclonaire.com
sales@cyclonaire.com

Manufactures and supplies custom-designed pneumatic conveying systems. Offers vacuum-, pressure-, and vacuum/pressure-based technology; conveyors; and allied components. Typical applications involve bulk transfer (storage or in-plant).

DALMIA INST OF SCIENTIFIC & INDUSTRIAL RESEARCH
Post- Rajgangpur — +91 6624 678 507
Dist- Sundargarh (Odisha) 770017 India
Fax: +91 6624 220 933

http://www.dalmiainstiture.in
info@dalmiainstitute.in

A modern industry group with boron carbide as its leading product, integrating the scientific research, manufacture and sale of boride and carbide. Boron carbide is widely used in military, science, industry, and more.

DATAPAQ INC — 603-537-2680
3 Corporate Park Dr Unit 1
Derry NH 03038

http://datapaq.com
websales@datapaq.com

Manufactures in-process thermal profiling systems and software. Kiln Tracker system is accurate and reliable and used to optimize firing process. System features a data logger with up to 130,000 readings, rugged thermal barrier, and Insight software.

DCM TECH — 507-452-4043
4455 Theurer Blvd — Fax: 507-452-7970
Winona MN 55987

http://dcm-tech.com
info@dcm-tech.com

DCM designs and manufactures blanchard style rotary grinders for ceramic grinding applications. Servo drive, Z-axis, and programmable automatic feed provides process repeatability. DCM is a U.S. manufacturer that sells and services factory direct.

DELKIC & ASSOCIATES 904-285-0200
PO Box 1726 Fax: 904-273-1616
Immokalee FL 32004

International ceramic consultants specializing in energy-saving ceramic coatings and fiber modules.

DELTECH INC (DELTECH FURNACES) 303-433-5939
1007 E 75th Ave Unit E Fax: 303-433-2809
Denver CO 80229

http://www.deltechfurnaces.com
mary@deltechfurnaces.com

Manufacturer of standard and custom electric lab and production scale furnaces, including glass melt and rotary models for 1,500–2,000°C operation in air, inert atmospheres, and under positive pressures. ISO 9001:2015 certified. NQA-1 compliant. Control systems certified by Intertek UL508A compliant.

DELTECH KILN AND FURNACE DESIGN, LLC
1007 E 75th Ave Unit E 303-433-5939
Denver CO 80229-6442 Fax: 303-433-2809

http://www.dkfdllc.com
mary@dkfdllc.com

Custom design and optional build of electric kilns and furnaces for nuclear materials research, development, and production. ISO 9001:2015 certified. NQA-1 compliant.

DENKA CORP 212-688-8700
780 3rd Ave 8th Floor Fax: 212-688-8727
New York NY 10017-2024

http://www.denka.co.jp/eng
Sales@denka.us.com

Denki Kagaku Kogyo Kabushiki Kaisha (Denka) is a chemical company operating in a wide range of business fields, including organic and inorganic materials for industrial manufacturing, materials for construction and civil engineering, electronic materials, food packaging materials, and pharmaceuticals.

DETROIT PROCESS MACHINERY 248-858-8380
560 Fox Pointe Ct Fax: 248-858-8405
Bloomfield Hills MI 48304

http://www.detroitprocessmachinery.com
sales@detroitprocessmachinery.com

Buys and sells powder presses, isostatic presses, piston extruders, mixers, blenders, attritors, spray dryers, pulverizers, and process mills.

DIACUT INC 719-481-4205
773 Hwy 105 Fax: 719-481-0872
PO Box 217
Palmer Lake CO 80133

http://diacut.com
sales@diacut.com

Supplies diamond Thinwheel used for slicing, dicing, precision grinding, and cutoff operations. Thinwheels are used in single-wheel applications as well as in gang assemblies. Manufactures slicing and dicing blades with customized resin bonds.

DIAMOND INDUSTRIAL TOOLS INC 800-227-5905
6712 Crawford Ave Fax: 800-441-7771
Lincolnwood IL 60712

http://todit.com
hgsachsel@gmail.com

Manufactures and distributes precision-grinding systems and related diamond abrasive products.

DIAMORPH AB +44 161 872 2181
c/o Tenmat Ltd Ashburton Road
West Manchester M17 1TD UK

http://www.diamorph.com
sales@diamorph.com

Diamorph AB is an advanced material company dealing with especially demanding industrial applications.

DIGITAL PRESS INC 610-758-9680
90 S Commerce Way Ste 340 Fax: 610-758-8510
Bethlehem PA 18017-8611

http://www.digitalpressusa.com/index.php

Digital Press is leading the industry when it comes to hydraulic powder compacting presses.

DORST AMERICA INC 610-317-2000
64 S Commerce Way Fax: 610-317-6416
Bethlehem PA 18017

https://www.dorst.de/en/dorst-america.html
info@dorstamerica.com

Designs and manufactures machinery, systems, and fully integrated plants for dinnerware, sanitaryware, advanced ceramics, soft and hard ferrite, and powder-metal industries. Program includes spray dryers, hydraulic presses, and isostatic dry presses.

DOW CORNING CORP 989-496-6000
2211 H.H. Dow Way Fax: 989-496-8026
Midland MI 48686

http://www.dowcorning.com
product.info@dowcorning.com

Worldwide supplier of additives, adhesives, coatings, reinforcing fillers, process aids, and release agents.

DOWA HIGH TEMP FURNACES +91 80 2839 5917
1C 2nd Phase Peenya Industrial Area
Bangalore Karnataka 560058 India
Fax: +91 80 2839 0490

http://www.dowahightemp.com
sales@dowahightemp.com

Manufacturer and supplier of industrial heat treatment furnaces with Japanese technology, including batch type integral sealed quench and soft nitriding furnaces, mesh belt furnaces, decarb annealing and blueing, and controlled atmosphere brazing.

DU-CO CERAMICS COMPANY 724-352-1511
155 S Rebecca St Fax: 724-352-1266
PO Box 568
Saxonburg PA 16056

http://www.du-co.com
sales@du-co.com

Dry-press, roll compaction, and extruded forms in steatite, cordierite, MgO, forsterite, porcelain, mullite, and alumina. High purity materials are also available in MgO and alumina. Secondary operations include machining, glazing, grinding, and tumbling. Toll spray drying services are also available. Facilities in Saxonburg, Pa. (main) and Monroe, N.C.

DUNHUA ZHENGXING ABRASIVE CO LTD +86 433 634 0878
No 4 Industry Rd Fax: +86 433 634 0868
Development Zone
Dunhua Jilin 133700 China

http://boroncarbide.cn
rula@boroncarbide.cn

Manufacturer of boron carbide since 1987. ISO 9001 and ISO 14001 certified. Major products: boron carbide powder, boron carbide sand nozzle, boron carbide plate, boron carbide neutron-absorbing material.

DYNACUT INC 610-346-7386
3425 Funk Mill Rd Fax: 610-346-6770
Springtown PA 18081

http://dynacut.com
rplatt@dynacut.com

Established 1965. Manufactures precision cutoff machines for glass, ceramics, metallurgical, composite, and geological applications. Designs and manufactures custom production cutting and grinding machinery.

EBL PRODUCTS INC 860-290-3737
91 Prestige Pk Cir Fax: 860-291-2533
E Hartford CT 06108

http://www.eblproducts.com
sales@eblproducts.com

Provides standard, application-specific, and industrial piezoceramic transducer elements to researchers as well as manufacturers of piezoelectric transducers according to their terms and specifications.

EDWARD ORTON JR CERAMIC FOUNDATION
6991 Old 3C Hwy 614-895-2663
Westerville OH 43082 Fax: 614-895-5610

http://ortonceramic.com
info@ortonceramic.com

The Edward Orton Jr Ceramic Foundation manufactures and markets pyrometric cones, TempCHEKs, TempTab's, electronic temperature controllers, thermoanalytical instruments, and provides materials testing services.

EIRICH MACHINES, INC 847-336-2444
4033 Ryan Rd Fax: 847-336-0914
Gurnee IL 60031

http://www.eirichusa.com
eirich@eirichusa.com

EIRICH offers innovative technologies for the preparation of raw materials and bodies in the ceramic industry. EIRICH develops and manufactures equipment (stand-alone machines and complete systems) for material processing, including grinding, mixing, granulating, kneading, and suspending. The equipment is used for preparing refractory mixes for shaped and unshaped products, tap hole clay, silicate ceramics slurries for table and sanitary ware, technical ceramics for dental and ballistic protection application, proppants, and much more. The unique design of the EIRICH Mixer allows for mixing, granulating, kneading, and dispersing in one single machine, which saves on costs, energy, time, and space. The tool speed can easily be adjusted and guarantees short batch times and homogenization. The mixer sizes for ceramics applications range from 1 liter to 7,000 liters and can be combined with vacuum drying technology. EIRICH also offers mills for grinding and size reduction.

ELAN TECHNOLOGY 912-880-3526
169 Elan Ct
Midway GA 31320

http://www.elantechnology.com/
info@elantechnology.com

As one of the largest glass and ceramics manufacturers in the United States, Elan Technology produces glass preforms from hundreds of proprietary electronic glass compositions, commonly matched for glass-to-metal seals. Glass materials are also offered as milled or spray dried powders. Elan Technology also offers a variety of ceramic materials, such as alumina ceramic, steatite, zirconia, and cordierite. Ceramic materials are used for wear-resistant parts, insulators, and ceramic inserts for industrial applications.

For more than 70 years, Elan Technology develops and manufactures advanced ceramics and glass materials. Its expert team of engineers can offer custom compositions to fit the most demanding applications.

ELCAN INDUSTRIES INC 800-283-5226
20 Marbledale Rd
Tuckahoe NY 10707-3420

http://elcanindustries.com
info@elcanindustries.com

Elcan sells advanced screening equipment that is unmatched in quality and performance. The company owns a large toll manufacturing facility in New York, where it sieves powders for companies and also does extensive testing for companies from all around the world.

ELCON PRECISION LLC 408-292-7800
1009 Timothy Drive
San Jose CA 95133

https://www.elconprecision.com/
sales@elconprecision.com

With more than 50 years of experience, Elcon Precision is a trusted provider of photochemically machined parts, metallized sapphires & ceramics, and vacuum & atmosphere brazed assemblies.

ELECTRO ABRASIVES CORP 800-284-4748
701 Willet Rd Fax: 716-822-2858
Buffalo NY 14218

http://electroabrasives.com
info@electroabrasives.com

Manufacture black SiC, green SiC, and boron carbide. Also makes SiC grains and water-classified fine powders to ANSI and FEPA F sizes, submicron, as well as refractory and custom splits. Applications include ceramics, abrasives, refractories.

ELECTROSCIENCES LTD
Farnham Surrey UK

https://www.electrosciences.co.uk
markys.cain@electrosciences.co.uk

Electrosciences Limited provides specialized scientific and technical consultancy to industry and academia in the technical discipline of multifunctional materials research and development. The company's technical director is professor Markys G Cain, who has over 30 years of experience in applied R&D in both academic and industrial environments.

Our business is modeled on the supply of scientific consultancy services. Expertise ranges from scientific strategy development for small business to bespoke scientific measurement solutions to your scientific and technical problems. Experience of over 30 years in the field of materials science and physics of the solid state lends itself to delivery of competent solutions to your scientific needs. Our specialist capabilities in the measurement of the properties of ferroelectric, piezoelectric, and multifunctional materials, films, crystals, and devices is offered with unique access to in situ synchrotron X-ray diffraction studies of these materials.

ELKEM METALS INC 304-552-9266
Airport Office Park Bldg 2 Fax: 412-299-7238
400 Rouser Rd Moon Township PA 15108

http://www.silicon.elkem.com
siliconinfo@elkem.com

Elkem products that may be of interest in the advanced ceramics field are the Silgrain line of silicon powders. Silicon powder is often used as a raw material for manufacturing silicon nitride and silicon carbide ceramics.

EMPOWER MATERIALS INC 302-225-0100
91 Lukens Drive Fax: 302-225-0101
New Castle DE 19720

http://www.empowermaterials.com
customerservice@empowermaterials.com

Manufactures and sells QPAC polyalkylene carbonate binders worldwide. QPAC features excellent green strength and processability, and extremely clean burnout in a variety of atmospheres. Available in solids, solutions, and water-based emulsions.

ENDICOTT CLAY PRODUCTS COMPANY 402-729-3315
57120 707th Rd Fax: 402-729-5804
Endicott NE 68350

http://www.endicott.com
endicott@endicott.com

Endicott Clay Products Company, celebrating our 100th anniversary in 2020 is a leading family owned manufacturer of face brick, pavers, and thin brick. Producing over 100 millions bricks a year from our four Kiln process our 300 employees are proud of our quality and customer service. Endicott continues to grown in numbers, robotics and automation by striving to be the very best.

ENGIS CORP 847-808-9400
105 W Hintz Rd Fax: 847-808-9430
Wheeling IL 60090

http://www.engis.com
kwerner@engis.com

Manufactures a wide range of superabrasive tools, supplies, and equipment for grinding, lapping, polishing, and honing of difficult-to-machine materials to close tolerances. Process development services are offered.

ENRG INC 716-873-2939
155 Chandler St Ste 5 Fax: 716-873-3196
Buffalo NY 14207-2132

http://www.enrg-inc.com
kolenick@enrg-inc.com

Manufacturer of ultrathin, durable, flexible, and high temperature tolerant ceramic foils. Substrate applications include solid state devices, portable electronics, lightweight solar PV, durable labels, displays, sensors, protective cladding, and bio-compatible devices.

ER ADVANCED CERAMICS INC 330-426-4500
600 E Clark St Fax: 330-426-1859
East Palestine OH 44413

http://www.usrefractories.com
info@usrefractories.com

Comprised of US Stoneware, US Refractories, and US Pumps. US Stoneware is a designer and manufacturer of process equipment for milling, grinding, and blending.

ESL ELECTROSCIENCE 610-272-8000
416 E Church Rd Fax: 610-272-6759
King Of Prussia PA 19406

http://www.electroscience.com
sales@electroscience.com

ESL ElectroScience specializes in providing solutions to enable customers to take technologies from concept through high volume production. A global supplier of customized thick film pastes and ceramic tapes.

ETHER NDE +44 1582 767912
Endeavour House Fax: +44 1582 767912
3 Roundwood Lane
Harpenden Hertfordshire AL5 3BW UK

http://ethernde.com
sales@ethernde.com

Manufacturer of eddy current instruments, probes, and accessories. Vantage handheld dual frequency inspection instrument; SigmaCheck eddy current electrical conductivity meter; Veritor USB-attached battery-operated eddy current instrument; and more.

EURO SUPPORT ADVANCED MATERIALS +31 413 283 911
Liessentstraat 9f Fax: 31 413 283 369
Uden 5405 AH The Netherlands

http://www.eurosupport.nl
eurosupport@eurosupport.nl

Euro Support Advanced Materials is an inorganic specialty materials producer, a.o. catalysts, dielectrics, and customized materials; including toll manufacturing. Over 20 years experience producing high purity barium titanate for the electronics industry.

EVANS ANALYTICAL GROUP LLC 408-530-3500
810 Kifer Rd 408-530-3501
Sunnyvale CA 94086

http://www.eaglabs.com
info@eaglabs.com

Evans Analytical Group is the global leader in materials characterization for ceramics and other advanced materials. We specialize in materials analysis using analytical techniques such as GDMS, ICPMS, TEM, and XRD.

EXOTHERMICS INC 603-821-5660
14 Columbia Dr
Amherst NH 03031

http://www.exothermicsinc.com
exo.info@exothermicsinc.com

Advanced materials company that specializes in the development of ultrahigh temperature refractory compounds and ceramics for demanding aerospace, defense, and other niche applications.

EZG MANUFACTURING INC 800-417-9272
1833 North Riverview Road
Malta OH 43758

https://ezgmfg.com/refractoryprecast-equipment
sales@ezgmfg.com

The quality of EZG's precast and refractory equipment is what sets the company apart from competing manufacturers. We work closely with our customers and listen to their needs before streamlining our equipment to better serve you.

This is why after nearly two decades of making model improvements our mixers are second to none. Our team is committed to pairing our customers with the equipment that suits their needs best.

EZG's Hog line is renowned for its longevity, customizable options and dedicated customer service team.

FCT INGENIEURKERAMIK GMBH +49 36766 86868
Gewerbepark 11 Frankenblick Fax: +49 36766 8680
Thuringia D-96528 Germany

http://fcti.de
k.berroth@fct-keramik.de

Produces customized components made of silicon nitride-based ceramics, sintered silicon carbide, C/C-SiC composites, and zirconia. Major applications are in light-metal casting, wear protection, chemical and mechanical process engineering, electronics, precision optics, testing equipment, metal forming, and brake pads.

FCT SYSTEME GMBH +49 36766 8240
Gewerbepark 16 Frankenblick Fax: +49 36766 824150
Thuringia D-96528 Germany

http://www.fct-systeme.de
info@fct-systeme.de

Develop and manufacture sintering systems, such as hot presses and systems for spark plasma sintering, gas-pressure sintering, and vacuum sintering up to ultrahigh temperatures for engineering ceramics, powder metallurgy, photovoltaics, and more.

FEDERAL-MOGUL 734-254-8313
27300 West 11 Mile Rd Fax: 734-254-8905
Southfield MI 48034

http://federal-mogul.com
CPTinfo@federalmogul.com

Global automotive supplier. Champion spark plugs, glow plugs, igniters, and spark ignition devices. Four ceramic manufacturing plants in North America and Europe. Ceramic development in Plymouth, Michigan. Produces high-volume alumina ceramic components.

FELDCO INTL 714-602-2415
12402 Circula Panorama Fax: 714-602-2417
Santa Ana CA 92705

http://feldcointernational.com
feldcointernational@gmail.com

Technical ceramic materials supplier, including boron carbide, boron carbide powder and sputtering targets, ceramics, metal, alloys, and others.

FERRO CERAMIC GRINDING INC 781-245-1833
5 Cornell Pl Fax: 781-246-1429
Wilmington MA 01887

http://ferroceramic.com
sales@ferroceramic.com

Established 1966. Advance ceramic component supplier and manufacturer specializing in precision machining. Materials include BN, Macor, alumina, SiC, sapphire, zirconia, quartz, ferrites, and related materials. Also provide CAD/CAM CNC machining.

FERROTEC CERAMIC PRODUCTS +86 571 8514 7487
2590 Nanhuan Rd Binjiang District
Hangzhou Zhejiang China 053600

http://ceramics.ferrotec.com/ceramics-home
lutt@ferrotec.com.cn

We are a Japanese company with manufacturing location in China. Our ceramics and quartz division is the largest manufacturer of semiconductor components in China since 2007.

FINEWAY CERAMICS 226-526-9785
367 Askin Ave
Windsor ON N9B 2X1 Canada

http://www.finewayceramics.com
info@finewayinc.com

Since 2008, Fineway Ceramics has been supplying advanced technical ceramics in North American markets. Fineway offers a range of industrial and advanced ceramics, including alumina, zirconia, silicon carbide, and silicon nitride. In addition, Fineway also provides ceramic raw materials, including silicon nitride, silicon carbide, and alumina powder.

FIREBIRD THERMAL PRODUCTS CO +86 371 6580 1713
Rm 4-39 Hongzhuan Rd No 111
Zhengzhou Henan 450002 China

http://firebirdindustry.en.ec21.com
firebirdcorp@yahoo.cn

Firebird Thermal Products Co is founded on the principle of quality, value, and service. We apply ourselves to meet our customer's various demands on high-temperature materials, including refractories, ceramics, and industry raw materials.

FIVES NORTH AMERICAN COMBUSTION INC
4455 E 71st St 216-271-6000
Cleveland OH 44105 Fax: 216-641-7852

https://combustion.fivesgroup.com
fna.sales@fivesgroup.com

Supplier of combustion systems, products, and controls.

FLUID ENERGY PROCESSING & EQUIPMENT CO
4300 Bethlehem Pike 215-721-8990
Telford PA 18969 Fax: 215-721-2355

http://fluidenergype.com
websales@fluidenergype.com

Established 1955. Designs and manufactures ultrafine grinding and flash-drying systems as well as contract toll grinding, crushing, coating, screening, blending, and micronizing of chemicals and refractory products.

FOSBEL INC 216-362-3900
20600 Sheldon Rd Fax: 216-362-3901
Brook Park OH 44142

http://www.fosbel.com
fosbel.inc@fosbel.com

Provides a range of furnace maintenance services, including ceramic-welding technology to repair all types of damaged refractories without furnace shutdown, rebricking services, checker cleaning and other hot repairs, inspections, and consulting.

FOUNDATION FLOORS 954-256-1447
4100 N Powerline Rd Ste B-3 Fax: 954-357-2151
Pompano Beach FL 33073

http://www.foundationfloors.com
matt@foundationfloors.com

Foundation Floors offers flooring materials from brands you know at the best prices. We carry bamboo, engineered, laminate, carpet, tile, vinyl, stone, and solid hardwood flooring. Visit FoundationFloors.com to learn more about our products.

FRAUNHOFER INSTITUTE FOR CERAMIC TECHNOLOGIES AND SYSTEMS IKTS +49 351 25537512
Winterbergstrasse 28 Dresden Fax: +49 351 2554300
Saxony 1277 Germany

http://www.ikts.fraunhofer.de/en.html
alexander.michaelis@ikts.fraunhofer.de

Covers advanced ceramics including the development and application of modern ceramic materials, production technologies, and components up to intelligent system solutions in many industry sectors for both structural and functional ceramics.

FRITSCH GMBH - MILLING AND SIZING +49 6784 700
Industriestrasse 8 Idar Oberstein Fax: +49 6784 7011
Rhineland-Palatinate D-55743 Germany

http://www.fritsch.de
info@fritsch.de

Internationally respected manufacturer of application-oriented laboratory instruments used in sample preparation and particle size analysis for industrial applications in process control, quality assurance, and high-precision research.

FRITSCH MILLING & SIZING INC 919-229-0599
57 Grant Dr Ste G
Pittsboro NC 27312

http://www.fritsch-us.com
info@fritsch-us.com

FRITSCH—an internationally respected German manufacturer of lab mills and particle size/shape instruments. Capabilities into the nano range. For size reduction, homogenization, mechanical alloying, mechano-chemistry, chemical activation, and more.

FURNACE PRODUCTS & SERVICES INC 724-285-3774
610 East Butler Rd Fax: 724-431-0944
Butler PA 16002

http://fpands.com
sales@fpands.com

Independent representative organization providing insulating firebrick, machining services, furnace rebuilds, combustion systems, forehearths, and more.

FUSE TECH/HOT TECH GROUP 419-841-9323
3400 Silica Rd Fax: 419-842-0693
Sylvania OH 43560

http://www.fusetech.com
sales@FuseTech.com

Performs ceramic welding and refractory services, including hot and cold repairs. The ceramic welding process was developed and originally designed for the in-situ repair of glass furnaces.

FUSION CERAMICS INC 330-627-2191
160 Scio Rd SE Fax: 330-627-2082
PO Box 127
Carrollton OH 44615

http://www.fusionceramics.com
info@fusionceramics.com

Manufactures glass and ceramic frits for whiteware, pottery, tile, vitrified abrasives, refractories and metallurgical applications, decorating enamels for glasses and ceramics, and specialty pigments and specks. Prepares custom, dry-blended glazes, engobes (including Brikote), bodies, and bonds. Sells Reimbold & Strick stains, BMQ precious metals, ICA organic coatings, and raw materials.

GAMRY INSTRUMENTS 215-682-9330
734 Louis Dr
Warminster PA 18974

http://www.gamry.com
jketter@gamry.com

For more than 20 years, Gamry Instruments provides high performance electrochemical instruments (potentiostat/galvanostat/ZRA). A wide variety of experimental techniques are available for electrochemical testing.

GARG PROCESS GLASS INDIA PVT LTD +91 22 2883 0309
2/222 New Sonal Link Ind Est Fax: +91 22 2888 3300
Link Rd Malad West
Mumbai Maharashtra 400064 India

http://gargglassindia.com
garg@gargglassindia.com

Manufacturer and exporter of scientific lab glassware and scientific equipment such as distillation unit and reaction unit.

GASBARRE
POWDER COMPACTION SOLUTIONS

GASBARRE PRODUCTS (PTX PENTRONIX)
590 Division St 814-371-3015
DuBois PA 15801

http://www.gasbarre.com
inquiries@gasbarre.com

Gasbarre Products Inc is an international designer, manufacturer, and marketer of capital equipment and related services. We focus on primary process equipment for powder metallurgy, particulate materials, and thermal processing industries worldwide. No matter what your challenging opportunity may be, we can supply the best technically engineered solution for your specific needs!

GASBARRE PRODUCTS INC 814-371-3015
590 Division St Fax: 814-371-6387
PO Box 1022
DuBois PA 15801

http://gasbarre.com
press-sales@gasbarre.com

Manufactures mechanical and hydraulic powder compaction presses for dry pressing of ceramic powders. Compaction presses incorporate the floating die table concept as well as a removable die set series, a lab series, and a standard series.

GE GLOBAL RESEARCH 518-387-6975
One Research Cir MB 159A
Niskayuna NY 12309

http://www.geglobalresearch.com

Making aircraft engines more efficient. Powering the world with flexible gas turbines. Crunching big data. Pioneering the Industrial Internet. Creating greener ground transportation. Refining medical imaging for the future. For more than a century, GE Global Research serves as the cornerstone of GE innovation. Currently, more than 3,000 of the world's brightest scientists, engineers, and researchers are working together to deliver technical breakthroughs for GE customers.

GELLER MICROANALYTICAL LABORATORY INC
426 E Boston St Rt 1 978-887-7000
Topsfield MA 01983 Fax: 978-887-6671

http://www.gellermicro.com
sales@gellermicro.com

Specializes in quantitative analysis of boron, carbon, nitrogen, oxygen, etc., in micrometer-size areas. Elemental mapping, diffusion studies, failure analysis, reverse engineering, and phase are determinations.

GENERAL GLASS EQUIPMENT CO 609-345-7500
General Glass Bldg Fax: 609-652-5700
900 W Leeds Ave
Pleasantville NJ 08232

http://generalglassequipment.com
genglass@generalglassequipment.com

Offers complete glass plants, engineering services, batch wetting systems, oscillating and standard nonoscillating batch chargers and controls, luminous furnaces, continuous glassmelting furnaces, automatic reversal systems, block cooling systems, and more.

GENERAL MATERIAL INDUSTRIAL CO +86 757 8270 1478
Rm 2303 Tower 1 Junning Bldg
No 213 Funing Rd
Foshan Guangdong 528000 China

http://www.amic.biz
info@gmico.net

GMIC mullite insulating brick are made of calcined mullite and imported calcined alumina. Various types of GMIC insulating brick can meet the requirements of heat-process and chemical-physical applications, and are used in industrial furnaces.

GENERAL SPRAY DRYING SERVICE INC 908-353-2477
1001 Newark Ave Fax: 908-353-0060
Elizabeth NJ 07208

http://gsds@optonline.net
waltreed@generalspraydrying.com

Custom spray drying of glass, ceramics, metals, and chemicals. Moisture and particle-size control. Dry blending, powder cooling, and wet milling available. Test runs to full production.

GERLING APPLIED ENGINEERING INC 209-527-8960
PO Box 580816 Fax: 209-527-5385
Modesto CA 95358-0015

http://www.2450mhz.com
sales@2450mhz.com

Engineers, designs, and manufactures industrial microwave-heating equipment. Standard and custom products include generators, waveguide components, applicators, and complete systems operating at 2.45 GHz.

GFS CHEMICALS INC 800-858-9682
851 McKinley Ave Fax: 740-881-5989
Columbus OH 43222

http://www.gfschemicals.com
service@gfschemicals.com

GFS Chemicals is a specialty chemicals manufacturer of bulk inorganics, organic intermediates, and analytical reagents including perchlorates, chlorates, nitrates, iodates, periodates, oxides, lithium salts, heavy metal, and precious metal compounds.

GLASS MFG INDUSTRY COUNCIL 614-818-9423
600 N Cleveland Ave Ste 210 Fax: 614-818-9485
Westerville OH 43082

http://gmic.org
boblipetz@gmic.org

A nonprofit trade association, the first organization to represent all sectors of the glass industry (container, flat, specialty and fiberglass). Dedicated to promoting the interests and economic growth, and sustainability of the glass industry.

GM Glen Mills INC.

GLEN MILLS INC 973-777-0777
220 Delawanna Ave Fax: 973-777-0070
Clifton NJ 07014

http://www.glenmills.com
staff@glenmills.com

Markets sample preparation equipment, including milling (wet and dry milling for size reduction), powder blending, sample dividing, and sample extraction.

NEW: Kakuhunter centrifugal planetary mixer for mixing viscous liquids and pastes; degassing.

Offers ceramic, glass, and steel beads and balls. Pilot-plant-sized equipment available. Laboratory tests and contract work.

GMA INDUSTRIES INC 734-595-7300
38127 Ecorse Rd Fax: 734-595-1310
Romulus MI 48174

http://www.gmaind.com
sales@gmaind.com

GMA Industries is a leading supplier of recycled abrasive media and virgin abrasive media for blasting operations and finishing applications. Specializing in aluminum oxide, steel shot, steel grit, and nu-soft.

GOCERAM AB +46 31 18 11 03
Svealiden 8
Vastra Gotaland County
Molndal S-431 39 Sweden

http://goceram.com
info@goceram.com

Develops, manufactures, and markets medium-pressure injection-molding systems, including low-cost mixers, injection-molding machines, and rate-controlled debinding furnaces as well as supercritical carbon dioxide binder extractors.

GOODFELLOW CORP 724-695-7060
125 Hookstown Grade Rd Fax: 724-695-7063
Coraopolis PA 15108-9302

http://www.goodfellowusa.com
info@goodfellowusa.com

Supplies ceramics and custom ceramic components as well as metals, polymers, and other materials to meet the R&D and specialist production requirements of science and industry worldwide.

GORKA CEMENT 312-772-0251
58 Lipcowa St
Trzebinia 32-540 Poland

http://www.gorka.us
R.HUNTER@GORKA.US

For more than 100 years, Gorka Cement has been manufacturing calcium aluminate and high alumina cements from our headquarters in Trzebinia, Poland. Our technical knowledge, experience and longevity in manufacturing help make the GORKAL brand of cements an excellent choice for all applications. We pride ourselves on the quality, consistency and purity of our products.

Since 2000, we have been part of the Mapei group. This affiliation has assisted us in expanding our customer base to new markets and applications in over 60 countries throughout the world.

GRAINBOUND LLC 855-472-4623
301 Broadway Ste M100G
Bethlehem PA 18015

http://www.grainbound.com
info@grainbound.com

GrainBound, LLC diagnoses and solves industrial processing and performance issues pertaining to ceramic parts and powders by examining grain boundaries. Our team calls upon decades of interface design experience, utilizes state-of-the-art experimental techniques, and big data analytics to optimize your process to create reliable, high-quality products.

GRAND POWER SYSTEMS FORMALLY WARNER POWER LLC
1500 Marion 844-383-8644
Grand Haven MI 49417

https://grandpowersystems.com/
support@grandpowersystems.com

Warner Power provides highly engineered power conversion products and services that improve process reliability and efficiency for a broad range of industries worldwide.

GREENLEE DIAMOND TOOL CO 866-451-3316
2375 Touhy Ave Fax: 847-593-3165
Elk Grove Village IL 60007-5330

http://www.greenleediamond.com
vpecis@greenleediamond.com

Full line of diamond and CBN products including resin, polyimide, metal, hybrid, vitrified, and electroplated. Diamond band saw blades for cutting a variety of materials, including silicon, quartz, sapphire, ceramics, graphite, glass, and carbides.

GWENT ELECTRONIC MATERIALS LTD +44 1495 7505
Mamhilad Park Monmouth House
Pontypool Gwent NP4 Fax: +44 1495 752121
NP4 0HZ UK

http://g-e-m.com
les@gwent.org

Manufactures pastes and inks for electronics, automotive, decorative and passive components industries, including conductive and insulating, particulate- and organometallic-based products. Provides full range of materials.

H&M ANALYTICAL SERVICES INC 609-758-5700
35 Hutchinson Rd Fax: 609-758-5708
Allentown NJ 08501

http://h-and-m-analytical.com
mail@h-and-m-analytical.com

Analytical testing lab providing X-ray diffraction, X-ray fluorescence, particle size distribution, and SEM/EDS services. Provides litigation support, such as patent infringement and expert witness testimony.

H.C. STARCK GMBH +49 9287 8070
Lorenz-Hutschenreuther-Str 81 Fax: +49 9287 807477
Selb Bavaria 95100 Germany

http://www.hcstarck.com
info@hcstarck.com

With almost 100 years of experience, H.C. Starck is a leading premium supplier of the technology metals tungsten, molybdenum, tantalum, niobium, and rhenium; high-performance ceramics; and thermal spray powders. With innovativeness, a clear commitment to quality, and extensive technological expertise, H.C. Starck works side-by-side with their customers along the entire value-creation chain, supporting them as an expert partner in development and solution creation.

H.C. STARCK NORTH AMERICAN TRADING LLC
45 Industrial Pl 617-630-5800
Newton MA 02461-1951 Fax: 617-630-5919

http://www.hcstarck.com
info@hcstarck.com

The H.C. Starck Group is a leading global supplier with 14 production sites in Europe, America, and Asia. It produces advanced ceramic and technology metal powders and processes these materials into mill products and fabricated parts.

H.C. STARCK SURFACE TECHNOLOGY AND CERAMIC POWDERS GMBH +49 5321 7510
Im Schleeke 78-91 Goslar Fax: +49 5321 7516191
Lower Saxony D-38642 Germany

https://www.hcstarck.com/en/hc_starck_group/about_hc_starck/divisions/surface_technology__ceramic_powders.html
info@hcstarck.com

The H.C. Starck Surface Technology & Ceramic Powders GmbH offers a wide variety of thermal spray powders and complementary coating technology materials, as well as the most extensive nonoxide ceramic powder portfolio for advanced ceramics and high-end applications and also atomized metal powders for a broad scope of innovative technologies, for example, additive manufacturing, hot isostatic pressing, metal injection molding, laser cladding, and plasma spraying.

HAIKU TECH EUROPE BV +31 43 457 8080
Spoorweglaan 16 Maastricht Fax: +31 43 457 8053
6221 BS The Netherlands

http://www.haikutech.com
sales@haikutech.com

Customized technical and equipment solutions for the manufacture of ceramic multilayer products. Portfolio includes: dielectric powders, binders, tape casters, sheet blankers, mechanical punches, screen printers, stackers, isostatic laminators, green chip (hot knife) dicers, termination equipment, furnaces, optical dilatometers, belt furnaces, and visual inspection equipment. We also offer ceramic tape development and manufacturing consulting services. Represent Keko Equipment, LONG Automatic Machinery, HengLi Eletek, and Polymer Innovations.

HAIKU TECH INC 305-463-9304
11025 NW 29th St Fax: 305-463-8751
Doral FL 33172

http://www.haikutech.com
sales@haikutech.com

Customized technical and equipment solutions for the manufacture of ceramic multilayer products. Portfolio includes: dielectric powders, binders, tape casters, sheet blankers, mechanical punches, screen printers, stackers, isostatic laminators, green chip (hot knife) dicers, termination equipment, furnaces, optical dilatometers, and visual inspection equipment. We also offer ceramic tape development and manufacturing consulting services. Represent Keko Equipment, LONG Automatic Machinery, Expert Systems Solutions, and Polymer Innovations.

HALDOR TOPSOE A/S +45 45 27 20 00
Haldor Tops??es All?© 1 Fax: +45 45 27 29 99
Lyngby DK-2800 Kgs Denmark

http://topsoe.com

Our scope is broad: from nanotechnology research and development of catalysts and catalytic processes to aftersales service of our customers' plants.

HARBISONWALKER INTL 412-375-6600
1305 Cherrington Pkwy Ste 100
Moon Township PA 15108

http://thinkhwi.com
customer-service@thinkhwi.com

With more than 150 years of industry leadership, HarbisonWalker International (HWI) is the largest supplier of refractory products and services in the United States. HWI serves virtually every major industry that requires refractory solutions to enhance production and protect assets.

HARPER INTERNATIONAL 716-276-9900
4455 Genesee St Ste 123 Fax: 716-810-9460
Buffalo NY 14225

http://www.harperintl.com
info@harperintl.com

Harper is the world leader in complete thermal processing solutions and technical services for the production of advanced ceramic materials, including custom designed rotary, pusher, and belt conveyor furnaces. Harper's experience spans a range of engineering ceramics, with extensive experience in designing for the production of silicon nitride, tungsten carbide, boron nitride, and aluminas. Additionally, Harper kilns are widely used to calcine powders and sinter components such as thermistors, varistors, and monolithic and multilayer capacitors.

HARROP INDUSTRIES INC 614-231-3621
3470 E 5th Ave Fax: 614-235-3699
Columbus OH 43219-3816

http://harropusa.com
sales@harropusa.com

Established 1919. Engineers and constructs kilns, dryers, and ceramic process plants. Comprehensive expertise with field-built and prefabricated designs. Serves all segments of the ceramic industry with belt furnaces, forced-air bakeout ovens, and more.

HEARTLAND WOOD FLOORING 754-600-9990
4100 North Powerline Rd Ste B-3
Pompano Beach FL 33073 Fax: 754-300-1488

http://www.heartlandwoodflooring.com
admin@heartlandwoodflooring.com

Heartland Wood Flooring supplies laminate, marble, tile, carpet, vinyl, solid and engineered wood, and cork flooring.

HED INTL INC 609-466-1900
PO Box 246 Fax: 609-466-3608
Ringoes NJ 08551

http://hed.com
info@hed.com

Manufactures and sells unique/pereny kilns and furnaces. Manufactures and supplies Isomax blue-flame burner systems. Specializes in tape-casting machines, custom-built equipment, and computer-controlled system integration. Import and export capabilities.

HERAEUS QUARTZ UK LTD +44 191 262 5311
Neptune Rd Fax: +44 191 263 8040
Wallsend Tyne & Wear NE28 6DD UK

http://www.heraeus-quarzglas.com
quarzglas@heraeus.com

Manufacture fused quartz and fused silica materials and products for semiconductor, optical, fiber-optics, and more. Products include fused quartz and synthetic fused silica ingots, optical components, tubes, and rods. Worldwide exporter. Manufacturing.

HEXION INC 614-986-2497
180 East Broad Street Fax: 877-443-9466
Columbus OH 43215

http://www.hexion.com
service@hexion.com

Based in Columbus, Ohio, Hexion Inc is a global producer of epoxy specialty resins, modifiers, and curing agents thermoset resins. Thermoset resins now encompass global operations that produce high performance phenolic, epoxy, and unsaturated polyester resin technologies.

HIGH TEMPERATURE MATERIALS LAB 865-574-5123
Building 4515 865-574-4913
PO Box 2008
Oak Ridge TN 37831-6062

http://www.html.ornl.gov
laracurzioe@ornl.gov

HTML is a DOE User Facility dedicated to solving materials problems that limit the efficiency and reliability of systems for power generation and energy conversion, distribution and use. Includes six user centers.

HINDALCO INDUSTRIES LIMITED +91 831 247 2739
Post Bag 1 +91 831 247 2738
Belagavi Karnataka 590 010 India

http://www.hindalco.com
hindalco@adityabirla.com

Established 1938 as part of Alcan Group Co. Manufactures metallurgical, ceramic, and special grades of alumina and hydrates, carbon/graphite shapes, and semifabricated aluminum products. Acquired by Aditya Birla Group in 2000.

HITACHI HIGH TECHNOLOGIES AMERICA, INC
22610 Gateway Center Dr Ste 100 800-253-3053
Clarksburg MD US 20871-2007 Fax: 301-990-0472

https://www.hitachi-hightech.com/us/
hta-microscopy@hitachi-hightech.com

Hitachi provides technologically advanced imaging solutions to the materials science, biological and academic research, and industrial manufacturing sectors. Our innovative and reliable instrumentation includes SEM, TEM, dedicated STEM, FIB, Ion Milling instrumentation, tabletop microscopes, and sample prep systems. Hitachi's new portfolio of SPM products offer extraordinary levels of performance and ease-of-use, including revolutionary environmental controls that support a variety of in-situ observations.

HITECH MATERIALS PTY LTD +61 419 991 930
60-62 Murray Park Rd
Figtree New South Wales 2525 Australia

http://www.hitechmaterials.com.au
Info@hitechmaterials.com.au

We investigate refractory and ceramic failures, offer testing and analysis services to any standard or nonstandard method, prepare expert witness reports, independently compare materials from different supplier, and validate material properties.

HOCKMEYER EQUIPMENT CORP 252-338-4705
6 Kitty Hawk Ln Fax: 252-338-6540
Elizabeth City NC 27909

https://hockmeyer.com
sales@hockmeyer.com

Hockmeyer Equipment is a leader in the wet grinding and dispersion industry and offers custom designed process equipment for mixing, blending, dispersing, and particle size reduction as fine as 25 nanometers.

HORIBA INSTRUMENTS INC 949-250-4811
9755 Research Dr Fax: 949-468-1790
Irvine CA 92618

http://www.horiba.com
labinfo@horiba.com

Offering a wide range of analytical instruments, including particle-size and shape analysis, particle composition, surface area, water quality, ICP, Raman, X-ray microscopy, process gas analysis, and gloss metering.

HOTEK ALLIANCE LTD +86 533 381 1405
Century Rd Fax: +86 533 381 1827
Zhangdia Zibo Shandong 255000 China

http://www.hotekalliance.com
hoteksales@163169.net

Established in 1988, Hotek Alliance Limited is a leading manufacturer of heating elements in China. 90% of its products are sold internationally to Europe (U.K., Poland, Germany, France), U.S., Canada, South Africa, Australia, Russia, South Korea, and Japan.

HUNTER CHEMICAL LLC 215-461-1900
220 Commerce Dr Ste 405 Fax: 215-461-1919
Fort Washington PA 19034

http://www.hunterchem.com
greg@hunterchem.com

Hunter Chemical is an ISO9001:2015 certified supplier of nickel, cobalt, and chrome-based raw materials, including oxides and carbonates used in ceramic, refractory, and related applications. Materials are stocked at multiple locations across the U.S. for prompt delivery.

HUNTERLAB 703-471-6870
11491 Sunset Hills Rd Fax: 703-471-4237
Reston VA 20190

http://hunterlab.com
sales@hunterlab.com

Manufactures systems that measure reflected and transmitted color, and quantify how color appears to the human eye. Measures incoming material as well as in-process and final product inspection. Systems measure color, achromaticity, whiteness, and more.

HYSITRON INC 952-835-6366
9625 W 76th St Fax: 952-835-6166
Minneapolis MN 55344

https://www.hysitron.com
info@hysitronindia.com

Hysitron is the world leader in developing nanomechanical test instruments and designs cutting edge technology for the scientific community since 1992. As the pioneers of in situ imaging with nanomechanical property measurement capabilities, Hysitron grew with the nanotechnology market for over two decades.

II-VI AEROSPACE & DEFENSE 951-926-2994
36570 Briggs Road
Murrieta CA 92563

http://iiviad.com
sales@iiviad.com

II-VI Aerospace & Defense (II-VI A&D) brings together several leading optical brands under II-VI Inc. Our expanding and extensive capabilities cover a wide range of products and applications making us the most advantageous supplier of optical and laser components and subassemblies, engineered materials, and specialty solutions. As an integrated provider, II-VI A&D is uniquely positioned to offer critical and complex design, engineering, and production requirements of customers in the aerospace and defense industries. From concept design development through production, we collaborate with our customers to integrate the design and manufacture of systems that consistently exceed expectations. We are transforming our ideas into cutting edge solutions for a safer tomorrow.

I SQUARED R ELEMENT CO 716-542-5511
12600 Clarence Center Rd Fax: 716-542-2100
Akron NY 14001

http://www.isquaredrelement.com
sales@isquaredrelement.com

Established 1964. Manufacturer of Starbar SPC and Moly-D $MoSi_2$ heating elements for use in a wide range of atmospheres up to 1,800°C element temperature. Offers free furnace design consultation.

IFB INSULATING FIREBRICK INC 724-282-1012
899 Bedford St Fax: 724-431-0944
Claysburg PA 16625

http://insulatingfirebrick.com
sales@insulatingfirebrick.com

Offers a complete line of high-temperature insulating firebrick and in-house capabilities to provide arches, keys, wedes, and skews. Most grades and straights are stocked.

IMERYS 770-645-3705
100 Mansell Court East Ste 300 Fax: 770-645-3460
Roswell GA 30076

http://imerys.com
karla.smith@imerys.com

Imerys Ceramics, a business unit of Imerys, produces and supplies performance minerals for the ceramics and glass industries. A premier worldwide supplier of kaolin and ball clays, feldspar, ceramic bodies, glazes, mica, and silica sands.

IMERYS FUSED MINERALS MURG GMBH +49 7763 933500
Ferroweg 1 Fax: +49 7763 933989
Laufenburg D79725 Germany

http://www.imerys-fusedminerals.com
ifm-mu@imerys.com

Manufacturer of zirconia and other oxide powders and grains for refractories, engineering ceramics, and coatings

IMERYS REFRACTORY MINERALS 229-924-4461
PO Box 37 Fax: 229-924-4461
Andersonville GA 31711

http://imerys-refractoryminerals.com
irmusa_inquire@imerys.com

Imerys Refractory Minerals is the world leader in minerals for refractory, investment casting, and other industrial applications. Products include calcined aluminosilicates, chamottes, andalusites, fused silicas, refractory clays, and fused minerals.

INDIAN CERAMIC SOCIETY +91 33 2413 88
CSIR - Central Glass & Ceramic Fax: +91 33 2413 8878
Research Institute 196 Raja S.C Mullick Rd
Jadavpur PO Opposite of Jadavpur Police Station
Kolkata West Bengal 700 032 India

http://incers.org
info@incers.org

Established 1928. Promotes the advancement of technical and scientific information, education, and research in ceramics in India. Membership confined to individuals who are scientists, technologists, partners, or proprietors of a firm.

INDO US MIM TEC +91 80 2204 8800
No 45 P KIADB Industrial Area Fax: +91 80 2797 1624
Hoskote Bangalore Karnataka 562 114 India

http://indo-mim.com/home.html
infohq@indo-mim.com

Indo-Mim is a leading global supplier of metal injection molded products and is a fully integrated MIM parts producer with capabilities and proficiency in design, tooling, and materials, and a full range of finishing and assembly operations.

INDUCERAMIC 226-476-1298
285 Erb St W Unit 106 Fax: 226-666-7122
Waterloo ON N2L 1W5 Canada

http://www.induceramic.com
info@induceramic.com

Induceramic, founded in Canada in 2006, specializes in industrial ceramic products and equipment. Induceramic focuses on applications and uses its broad experience to ensure excellent production capabilities for industrial ceramic products.

INDUSTRIAL CERAMIC PRODUCTS INC 800-427-2278
14401 Suntra Way Fax: 937-644-2646
Marysville OH 43040

http://industrialceramic.com
sales@industrialceramic.com

Established 1936. Manufactures refractory specialties for ceramics, heat-treating, foundry and investment-casting industries. Diverse product line includes pottery pins, gating components, pouring cups, and filters for molten metals.

INDUSTRIAL HARD CARBON LLC 800-752-7629
771 Crosspoint Dr Fax: 704-489-2177
Denver NC 28037

http://industrialhardcarbon.com
gbarr@industrialhardcarbon.com

Hard carbon deposition services.

INGREDIENT MASTERS INC 513-231-7432
377 East Main Street Fax: 513-457-5708
Batavia OH 45103

http://www.ingredientmasters.com
im@ingredientmasters.com

Precision Batching Systems for major, minor and micro ingredients.

If you use dry powder, flake or granular materials in paper bags, drums, or even 4,000 lb. bulk sacks and you want to shorten process cycles, improve consistency, reduce fuel costs, or eliminate product waste, call us today. Our custom dry bulk batching solutions and expert controls capability have increased capacity, reduced labor costs, and improved bottom line results for customers worldwide. Custom turnkey systems are engineered to meet the requirements of processors of all types, from small, manual systems to very large, automated systems.

INNOVNANO - ADVANCED MATERIALS SA
iParque Lote 13 +351 239 002 850
Apartado 7030 Antanhol Fax: +351 239 002 869
3040-570 Portugal

http://www.innovnano-materials.com
info@innovnano-materials.com

Innovnano is a specialist manufacturer of high quality nanostructured zirconia-based powders and alumina zinc oxide (AZO) sputtering targets. Using a unique synthesis technology—emulsion detonation synthesis (EDS)—Innovnano guarantees small grain sizes and excellent chemical homogeneity for high performance powders that support high-tech industries.

INSTITUTE FOR APPLIED MATERIALS-CERAMICS IN MECHANICAL ENGINEERING +49 721 60844246
Haid-und-Neu-Str 7 Karlsruhe Fax: +49 721 60848891
Baden-Wurttemberg D-76131 Germany

http://www.iam.kit.edu/km/286.php
kontakt@ikm.uni-karlsruhe.de

Scientists in the Institute of Ceramics in Mechanical Engineering within the Faculty of Mechanical Engineering deal with the development of engineering ceramics for various high-tech applications.

INTERNATIONAL CENTRE FOR DIFFRACTION DATA
12 Campus Blvd 610-325-9814
Newtown Square PA 19073 Fax: 610-325-9823

http://www.icdd.com
marketing@icdd.com

The International Centre for Diffraction Data (ICDD) and Materials Data (MDI) focus on the needs of the materials characterization scientific community by providing the Powder Diffraction File (PDF) and JADE analysis software. PDF Release 2020 contains over 1,000,000 entries for phase identification and JADE Pro software provides the best in X-ray powder diffraction data analysis. These material identification databases are interfaced with diffractometers and data analysis systems of the world's leading software developers and manufacturers of X-ray equipment.

INTERNATIONAL CERAMIC ENGINEERING 508-853-4700
235 Brooks St
Worcester MA 01606

http://www.intlceramics.com

International Ceramic Engineering specializes in the design and manufacture of unique components. Our primary objective is to provide these components and associated services in a manner that ensures consistent and reliable performance. Quality is our commitment to our customers. The quality process is monitored from design to completion to guarantee an integrated and controlled process. This process yields components of the highest precision, accuracy, repeat-ability and quality. ICE offers a broad range of advanced ceramic and performance plastic materials. Our materials experts are available to help determine the most cost-effective geometry for your advanced material requirements.

IPS CERAMICS LTD +44 1782 711511
Unit 6 High Carr Business Park Fax: +44 1782 717078
Decade Close
Newcastle under Lyme ST5 7UH UK

http://www.ipsceramics.com
enq@ipsceramics.com

IPS Ceramics is a manufacturer of specialist high-temperature ceramics. Its products are largely based on cordierite-mullite systems that result in aluminosilicate refractory products that are strong and stable at high temperatures.

IPSEN CERAMICS 815-239-2385
325 John St Fax: 815-239-2387
PO Box 420
Pecatonica IL 61063

http://ipsenceramics.com
Ceramics@IpsenUSA.com

Produces a wide variety of standard and custom refractory shapes, and toll firing services. Typical ceramic shapes include plates, saggers, crucibles, and kiln furniture. Formulas include high-percentage alumina and fused silica. Also, toll firing services.

ISOFORM LTD +44 1630 652772
Maer Lane Ind Est Market Drayton
Shropshire TF9 1QS UK Fax: +44 1630 652518

http://www.isoform.co.uk
info@isoform.co.uk

Designs and manufactures high-performance dry-bag isostatic presses (CIP), associated tooling, polyurethane molds, powder-filling devices, and unloading systems. A wide range of product shapes can be produced from most free-flowing powdered materials.

ISRAEL CERAMIC & SILICATE INST +972 4-822-2107
Technion City Fax: +972 4-832-5339
Haifa 32000 Israel

http://isracer.org
isracer@actcom.co.il

Performs contract and technological research in the field of ceramics and glass. Objective is the development of new products or fabrication technologies. Focus is on solid-state lasers, piezoceramics, ceramic armor, transparent ceramics, and glass.

IVOCLAR VIVADENT, INC. +423 235 35 35
Bendererstrasse 2
9494 Schaan
Principality of Liechtensteinen

www.ivoclarvivadent.com
John.Isherwood@ivoclarvivadent.com

Ivoclar Vivadent is a global leader in innovative materials and processes for quality, esthetic dentistry. The company employs over 3200 people and operates in over 120 countries throughout the world. Ivoclar Vivadent is headquartered in Schaan, Liechtenstein.

J RETTENMAIER USA 269-679-2340
16369 US Highway 131 S
Schoolcraft MI 49087-9150

http://www.jrs.eu/jrs_en
tradeshows@jrsusa.com

The J Rettenmaier & Söhne Group (JRS) dedicates itself to research, development, and processing of high quality organic fibers derived from vegetable raw materials. JRS makes many features of these valuable natural substances available for industrial purposes, including products made of cellulose, cereal, and fruit fibers or woodfibers, processed into microfibers, compacts, granules, mixtures, or special dosage forms as needed. The basis of these concepts is an innovative enhanced process technology (EPT) with JRS's unique, innovative process engineering modular system.

JAMES INSTRUMENTS 773-463-6565
3727 N Kedzie Ave Fax: 773-463-0009
Chicago IL 60618

http://www.ndtjames.com
info@ndtjames.com

Manufactures nondestructive test equipment for concrete and other coarse-grained materials. Supplies ceramic materials testing instruments that measure and analyze strength, structure, corrosion, and moisture in concrete, and more.

JAPAN FINE CERAMICS CENTER +81 52-871-3500
2-4-1 Mutsuno Atsuta-ku Fax: +81 52-871-3599
Nagoya Aichi 456-8587 Japan

http://www.jfcc.or.jp

Established 1985. R&D-based organization for standardization, quality improvement, and expansion of uses and applications of advanced ceramics, engineering ceramics, and electronic ceramics. Offers contract-basis tests and research.

JENIKE & JOHANSON 978-649-3300
400 Business Park Dr
Tyngsboro MA 01879

https://jenike.com/
info@jenike.com

Jenike & Johanson specializes in solids handling with expertise in storage, feeding, conveying, and processing. Our skilled, highly technical team of experts and industry-leading innovations has successfully delivered engineering solutions for 50 years. We are the world's leading technology company in this field. Our solutions achieve reliable solids flow with minimized variations based on proven theories and extensive project experience.

Typical project focuses include raw material storage and metering, mixed batch handling and process/furnace feeding, root cause investigation of mixed batch variations due to segregation, as well as finished powder storage and packing.

Understanding material flow properties is at the core of all our work, including the effects of temperature, storage times, humidity/moisture migration and other process conditions.

JEOL USA INC 978-535-5900
11 Dearborn Rd Fax: 978-536-2205
Peabody MA 01960-3823

http://www.jeolusa.com
salesinfo@jeol.com

Since 1949, the JEOL legacy is one of outstanding innovation in developing instruments used to advance scientific research and technology. JEOL has 60 years of expertise in the field of electron microscopy, more than 50 years in mass spectrometry and NMR spectrometry, and more than 40 years of e-beam lithography leadership.

JET EDGE WATERJET SYSTEMS 763-497-8700
12070 43rd St NE
St Michael MN 55376

http://jetedge.com
sales@jetedge.com

Jet Edge manufactures precision waterjet cutting machines, water jet intensifier pumps, and waterjet parts. Jet Edge also makes mobile waterjet cutting systems and ultrahigh pressure water blasting systems for cleaning and surface preparation applications.

JIFFY MIXER CO INC 951-272-0838
1691 California Ave Fax: 951-279-7651
Corona CA 92881-3375

http://jiffymixer.com
sales@jiffymixer.com

Produces a portable, nonelectrical, all-purpose mixer hand tool.

JOHNSON MATTHEY TECHNOLOGY CENTRE
Blounts Court Rd +44 118 924 2000
Sonning Common Fax: +44 118 924 2254
Reading RC4 9NH UK

http://www.matthey.com
group.info@matthey.com

Johnson Matthey is a speciality chemicals company focused on its core skills in catalysis, precious metals, fine chemicals, and process technology.

JOURNAL OF THE AMERICAN CERAMIC SOCIETY
550 Polaris Pkwy Ste 510 866-721-3322
Westerville Ohio 43082 Fax: 614-794-5892

http://ceramics.org
customerservice@ceramics.org

This publication is one of the top sources for ceramic and glass science research, providing scientists, engineers, and students with critically assessed, original research for over 100 years.

JTF MICROSCOPY SERVICES, LLC 607-292-6808
9064 Wixson Rd
Hammondsport NY 14840-9334

http://www.jtfmicroscopy.com
terry@jtfmicroscopy.com

JTF Microscopy Services LLC is an independent company that provides microscopic defect analysis and glass technology services to glass manufacturers around the world and related industries such as raw materials, refractory, furnace repair and cullet/recycling, as well as pharmaceutical & automotive components.

JYOTI CERAMIC INDUSTRIES PVT LTD +91 253 235 0120
C-21 N.I.C.E Fax: +91 253 235 0023
Satpur Nashik Maharashtra
422007 India

https://www.jyoticeramic.com
info@jyoticeramic.com

Manufactures standard and custom-made industrial ceramics in a variety of ceramic compositions such as aluminum oxide, zirconium oxide, zirconia-toughened alumina, mullite, cordierite, steatite, and forsterite. Exports worldwide

KEITH CO 800-545-4567
8323 Loch Lomond Dr Fax: 562-949-3696
Pico Rivera CA 90660-2507

http://www.keithcompany.com
info@keithcompany.com

Provides furnace systems for processing electronics and advanced materials, as well as specialty metals from 500–1,800°C. Fifty-four years of experience providing furnaces for high temperature, precise temperature, and atmosphere control.

KERNEOS INC 877-527-6367
1316 Priority Ln Fax: 757-284-3333
Chesapeake VA 23324

http://kerneosinc.com
kus.info@kerneos.com

Manufactures six refractory cements with alumina content (purity level) ranging from 40–80%.

KOREA INST OF INDUSTRIAL TECHNOLOGY
7-47 Songdo-dong Yeonsu-gu +82 10-7633-0902
Incheon Sudogwon Korea Fax: +82 32-850-0230

http://www.kitech.re.kr
master@kitech.re.kr

A government research institute to help develop technologies for the domestic industry, with focus on export competitiveness and SMEs. Receives government and private funding; distributes its research grants to private companies.

KOYO BEARINGS NORTH AMERICA 864-770-2100
7 Research Dr
Greenville SC 29607

http://www.jtekt-na.com
Sales.Inquiries@jtekt.com

Manufactures and supplies ball and roller bearings, including bearings for extreme special environments.

KYANITE MINING CORP 434-983-2085
30 Willis Mountain Plant Ln Fax: 434-983-3579
Dillwyn VA 23936

http://kyanite.com
hankjamerson@kyanite.com

Mines and markets raw and calcined kyanite (mullite), domestically and internationally. Available in grain sizes of 35, 48, 100, 200, and 325 mesh. Six plants in Virginia. Provides alumina silicate mineral.

KYOCERA INTERNATIONAL INC 619-576-2600
8611 Balboa Ave
San Diego CA 92123-1580

http://global.kyocera.com
fcsales@kyocera.com

Established in 1959, Kyocera's track record in Fine Ceramics is unmatched. Expanding its reach into everyday products and fostering discoveries into uncharted territories, we utilize our extensive resources in research, development and production to select the optimal raw materials and manufacturing methods for each application. Breakthroughs and improvements in a wide range of industries are facilitated by the unique qualities of Kyocera's Fine Ceramics.

L&L KILN MFG INC 856-294-0077
505 Sharptown Rd Fax: 856-294-0070
Swedesboro NJ 08085

http://hotkilns.com
sales@hotkilns.com

Manufactures ceramic electric kilns for more than 70 years. Services the industrial, professional, institutional, and hobby ceramics markets with top-loading, bell-lift, car bottom, and front-loading kilns that use ceramic Dyna-Glow element holders. Temperatures up to 2,350°F.

L&L SPECIAL FURNACE CO INC 610-459-9216
20 Kent Rd Fax: 610-459-3689
PO Box 2129
Aston PA 19014

https://llfurnace.com
sales@llfurnace.com

Manufactures industrial electric and gas-fired furnaces and kilns up to 1,700°C maximum temperature. Features include car bottom, bottom loader, box furnace, controlled atmosphere (including hydrogen), pusher, and continuous types.

LAEIS GMBH +352 27 61 21 09
Am Scheerleck 7 Wecker
L-6868 Luxembourg

http://laeis.eu+352 27 61 20

info@laeis.eu Produces high-performance hydraulic presses, dryers, and kilns, mainly for refractories, advanced and technical ceramics, fine ceramics, building material, and other applications.

LAGUNA CLAY CO 626-330-0631
14400 Lomitas Ave Fax: 626-333-7694
City Of Industry CA 91746

http://lagunaclay.com
info@lagunaclay.com

Manufactures dry, pugged, and slip clay (custom and stock), powder and liquid glazes (custom and stock), Pacifica potter's wheels, Laguna kickwheels, gas kilns, banding wheels, and ware racks. Supplies raw materials, hydraulic presses, jiggers, and mixers.

LANCASTER PRODUCTS 717-273-2111
920 Mechanic St
LebanonPA 17046

https://www.lancasterproducts.com
info@lancasterproducts.com

Produces mixers (rotating pan, countercurrent, high-intensity, and muller mixer as well as pug mills), KT pneumatic conveyors with bulk-bag unloader, double-roll crushers, table feeders, AutoBrik molded brickmaking machines, and custom machines.

LASERAGE TECHNOLOGY CORP 847-249-5900
3021 N Delany Rd Fax: 847-336-1103
Waukegan IL 60087

http://laserage.com
sales@laserage.com

Laserage offers fast, flexible, and cost effective laser cutting, drilling, machining, and scribing for custom ceramics applications with guaranteed plug free substrates. Laser processing services for most metals, plastics, and composites are also available.

LECO CORPORATION 800-292-6141
3000 Lakeview Ave Fax: 269-982-8977
St Joseph MI 49085

http://www.leco.com
info@leco.com

Manufactures and sells lab instruments for the analysis of ceramic and refractory material, sample preparation equipment, microscopes, hardness testers, and image analysis equipment.

LEICO INDUSTRIES INC 212-765-5290
107 Stuyvesant Ave Flr 2 Fax: 212-582-5085
Lyndhurst NJ 07071

http://www.leicoind.com/index.html
leico@leicoind.com

Established 1966. Supplies alumina solid rod, tubing, and double- and four-bore insulators; calcia-stabilized, yttria-stabilized, and magnesia-stabilized zirconia; beryllium and thorium oxides in various forms; and clear fused quartz tubing.

LIBERTY MACHINERY CO 847-276-2761
111 Schelter Rd Fax: 847-276-2762
Lincolnshire IL 60069

http://www.libertymachinery.com
sales@libertymachinery.com

Liberty is a stocking dealer of used metalworking and fabricating equipment catering to the needs of the ceramics industry. Let us help you fulfill your machinery needs and turn your surplus equipment into liquid capital.

LIGNOTECH USA 715-359-6544
100 Grand Ave Fax: 715-355-3674
Rothschild WI 54474-1198

http://www.lignotech.com
lignotech@borregaard.com

Produces lignosulfonate-derived organic binders, densifiers, and dispersants for use in manufacturing refractories, structural clay products, whitewares, technical, and other ceramics. Worldwide manufacturing, sales, and technical support.

LINSEIS INC 609-223-2070
109 North Gold Dr Fax: 609-223-2074
Robbinsville NJ 08691

http://www.linseis.com
info@linseis.com

Manufactures thermal analysis instruments (DSC, TMA, DTA, TG, STA), dilatometers, thermal conductivity, and thermal diffusivity systems.

LITHOZ GMBH 518-224-3490
165 Jordan Road
Troy NY 12180

http://www.lithoz.com/en
sallan@lithoz-america.com

Lithoz is the system provider for additive manufacturing (3D-printing) of ceramics. As a technology provider, Lithoz covers the whole process chain, from the development of the machine and the material up to the application. Lithoz, based in Vienna, Austria, developed the LCM-technology, which is a slurry-based additive manufacturing-technology based on photopolymerisation with a very high resolution and very good reproducibility. It allows the production of very delicate structures and fine details directly from the CAD-data. Most sinterable powders can be processed by the LCM-technology. Additive manufacturing provides a new design freedom and allows geometries with nearly no limit.

LIXIL CORPORATION
3-77 Minatocyo
Tokoname Aichi 479-8588 Japan

http://global.lixil.co.jp
global-site@lixil.co.jp

Established in 1924. Manufactures all types of tile, bathroom fittings and fixtures, sanitaryware, plastic bathtubs, prefabricated bathrooms, and vanity cabinets.

LUCIDEON +44 1782 764428
Queens Road Penkhull Stoke-on-Trent
Staffordshire ST4 7LQ UK Fax: +44 1782 412331

http://www.lucideon.com
enquiries@lucideon.com

Lucideon, formerly Ceram, is a leading international provider of materials development, testing, and assurance.

LUCIFER FURNACES INC 215-343-0411
2048 Bunnell Rd
Warrington PA 18976

http://www.luciferfurnaces.com
info@luciferfurnaces.com

Manufacturer of industrial heat-processing furnaces, ovens, and kilns available in batch or continuous models with operation up to 1,700°C. Economical, energy-efficient models with protective atmospheres available.

LUXFER MEL TECHNOLOGIES 908-782-1669
500 Barbertown Pt Breeze Rd
Flemington NJ 08822

http://www.luxfermeltechnologies.com
Pat.jones@luxfer.com

Luxfer MEL Technologies is a leading developer and producer of highly engineered zirconium materials, including monoclinic and stabilized zirconias for technical ceramics, electronic ceramics, wear parts, fuel cells, and sensors. Manufactured in U.K.

M&M CLAYS INC 478-946-5533
159 Railroad St Fax: 478-946-3528
PO Box 119
McIntyre GA 31054

mmclays@alltell.net

Mine and process coarse- and medium-particle-sized airfloat and slurry kaolin clay used in ceramics, rubber, adhesives, and chemicals. Mine and plant in McIntyre, Georgia.

MACHINED CERAMICS INC 270-781-0512
629 N Graham St Fax: 270-781-9361
Bowling Green KY 42101

http://machinedceramics.com
sales@machinedceramics.com

Custom precision machining and prototype and production runs. Developmental engineering services available.

MAGNECO METREL INC 800-323-2511
223 W Interstate Road Fax: 630-543-1479
Addison IL 60101

http://www.magneco-metrel.com
marketing@magneco-metrel.com

A specialty refractory manufacturer supplying products and services for the smallest ceramic shapes to linings for the world's largest blast furnace. Product lines include colloidal silica sol-gel-bonded castables, pumpables, and shotcretes.

MARYLAND CERAMIC & STEATITE CO INC
PO Box 527 410-838-4114
Bel Air MD 21014 Fax: 410-457-4333

http://marylandceramic.com
madlava@erols.com

Etablished 1926. Produces industrial and technical ceramics. A large extrusion and dry-pretty business. Product line includes steatite, cordierite, lava, plastics, and tape casting.

MARYLAND REFRACTORIES CO 800-228-4672
Salisbury Rd Fax: 330-532-3224
Irondale OH 43932

http://mrcgrog.com
ccarlson@mrcgrog.com

Established 1926. Produces industrial and technical ceramics. A large extrusion and dry-pretty business. Product line includes steatite, cordierite, lava, plastics, and tape casting.

MASON COLOR WORKS INC 330-385-4400
250 E 2nd St Pox Box 76 Fax: 330-385-4488
East Liverpool OH 43920-5076

http://masoncolor.com

Established 1942. Manufactures high-quality ceramic colors. Services dinnerware, tile, sanitaryware, and artware industries with colorants for body, glaze, underglaze, engobe, and overglaze uses. Full lab services, including free plant-experienced technicians.

MASSACHUSETTS INST OF TECHNOLOGY 617-253-6889
77 Massachusetts Ave Rm 13-4037
Cambridge MA 02139-4307 Fax: 617-258-6275

http://www.mit.edu
admissions@mit.edu

Offers undergraduate curriculum in materials science and engineering that covers ceramics, metals, electronic materials, biomaterials engineering, materials science, archaeological materials, and polymers.

MASTER BOND INC 201-343-8983
154 Hobart St Fax: 201-343-2132
Hackensack NJ 07601

http://masterbond.com
mail@masterbond.com

Manufactures adhesives, sealants, epoxies, and conductive coatings.

MATERIALS RESEARCH FURNACES INC 603-485-2394
65 Pinewood Rd Fax: 603-485-2395
Allenstown NH 03275-2300

http://www.mrf-furnaces.com
mrf@interserv.com

Manufactures high-temperature, vacuum, and controlled-atmosphere furnaces. Specializes in custom-designed furnaces for the R&D community. Expertise includes lab and batch furnaces, hot presses, physical testing, and sintering furnaces.

MATERION ADVANCED MATERIALS 800-327-1355
2978 Main St
Buffalo NY 14214

http://www.materion.com/advancedmaterials
advancedmaterials@materion.com

Materion Advanced Materials Group is a global supplier of over 2,000+ inorganic chemicals manufactured to meet exact specifications. Among the company's offerings are: borides, carbides, fluorides, hydrides, nitrides, oxides, phosphides, selenides, silicides, sulfides, tellurides, plus customized compounds. Inorganic chemicals are available in a range of forms, from granules to pellets to powders, and can be produced in small R&D quantities to full production lots.

MATERION CERAMICS 520-741-3410
6100 S Tucson Blvd
Tucson AZ 85706

http://materion.com/ceramics
ceramics@materion.com

Leading supplier of beryllium oxide, a high thermal conductivity ceramic that offers heat dissipation. BeO ceramics are a critical component in automotive electronics.

MATMATCH +49 89 262075200
Leopoldstr 250A
Munich 80807 Germany

https://matmatch.com
info@matmatch.com

Matmatch is an online platform that helps engineers and product developers find, evaluate and source materials. With a free of charge database of thousands of materials, an intuitive search tool, and supplier listings, it changes the way product teams find materials for their projects.

For material suppliers, we offer a new way to reach customers online. As a go-to source of information for engineers, Matmatch is the perfect platform for suppliers to raise awareness of their products and brand. We offer insights, analytics and opportunities for material suppliers to promote their expertise.

MCDANEL ADVANCED CERAMIC TECHNOLOGIES LLC
510 Ninth Ave 724-843-8300
Beaver Falls PA 15010-4700 Fax: 724-843-5644

http://mcdanelceramics.com
sales@mcdanelceramics.com

Manufactures industrial and technical ceramics from alumina, mullite, zirconia, fused silica, and SiAlON. Specializes in developing custom prototypes to full-scale production of ceramic components.

MEMPRO MATERIALS CORP 888-868-9222

http://mempro.com
sales@mempro.com

MemPro manufactures ceramic nanofibers, polymeric nanofibers, and catalyst products. It continually works with customers to develop and supply new materials for innovative technologies. MemPro produces the highest quality materials backed by unrivaled knowhow.

MERKLE INTERNATIONAL INC 815-777-2100
9567 US Rte 20 W Fax: 815-777-2106
PO Box 312
Galena IL 61036

http://merkleintl.com
sales@merkleintl.com

Designs and supplies custom suspended refractory systems for glass melting, copper, aluminum, steel pelletizing, and reheat furnaces and incinerators. Manufactures blanket batch charger for glass-melting furnaces.

METTLER-TOLEDO INC 800-638-8537
1900 Polaris Pkwy Fax: 614-438-4900
Columbus OH 43240

http://www.mt.com
labinsidesales@mt.com

Offers a complete range of products to complement laboratory needs. Laboratory products include balances, titrators, pH meters, density meters, refractometers, moisture analyzers, and thermal analysis equipment.

MICROMERITICS INSTRUMENT CORP 770-662-3636
4356 Communications Dr Fax: 770-662-3696
Norcross GA 30093

http://www.micromeritics.com
ussales@micromeritics.com

Micromeritics materials characterization analytical instruments and contract services determine surface area, porosity, particle size, particle shape, zeta potential, material density, catalytic activity, vapor sorption, powder strength, and more.

MICRON INC 302-998-1184
3815 Lancaster Pike Fax: 302-998-1836
Wilmington DE 19805

http://micronanalytical.com
micronanalytical@compuserve.com

For over 50 years, Micron specializes in fourier transform infared testing (FTIR), scanning electron microscopy (SEM), energy dispersive

X-ray spectroscopy (EDS), optical microscopy, electron spectroscopy chemical analysis (ESCA), auger electron microscopy (AES), X-ray diffraction (XRD), thermal analysis (DSC,TGA), and metallography.

MICROTRAC INC 727-507-9770
215 Keystone Dr Fax: 727-507-9774
Montgomeryville PA 18936

http://microtrac.com
jay_s@microtrac.com

Supplies advanced laser-based particle-size systems. Measuring particle size from 0.0008 nanometers to 3,000 microns.

MIDWESTERN INDUSTRIES INC 330-837-4203
915 Oberlin Rd SW Fax: 330-837-4210
PO Box 810
Massillon OH 44648

http://midwesternind.com
info@midwesternind.com

Manufactures a complete line of durable screening products, including round and rectangular screening equipment, custom wire cloth, screens and panels, as well as replacement parts and motors. Offers free full-scale test facility.

MILESTONE DECAL ART LLC 914-908-2733
1872 Pleasantville Rd Ste No 113 Fax: 914-908-2734
Briarcliff Manor NY 10510

http://www.milestonedecalart.com
info@MilestoneDecalArt.com

We are committed to providing the highest quality glass fusing and ceramic decals available. We provide silkscreen waterslide decals as well as digital decals. Our custom decal printing service provides all available decal options on the market.

MINERAL RESEARCH PROCESSING +33 6 82 99 29 72
7 Rue Francis Garnier Meyzieu Fax: +33 4 78 31 11 78
Rhone-Alpes 69330 France

http://www.mineralresearchprocessing.com
francoissorrentino@sfr.fr

Research and development of synthetic minerals with controlled chemistry and mineralogy in the field of silicates, aluminates, phosphates, titanates. Synthetic minerals are devoted to labs in ceramic research.

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY
1400 N Bishop 573-341-4711
223 McNutt Hall Fax: 573-341-6934
Rolla MO 65409-0340

http://mse.mst.edu
matlsci@mst.edu

Offers BS, MS, and PhD in ceramic engineering as well as MS and PhD in materials engineering. Undergraduate curriculum emphasizes application of scientific principles to solve engineering problems and includes extensive hands-on experience.

MIXER SYSTEMS INC 262-691-3100
190 Simmons Ave Fax: 262-691-3184
PO Box 10
Pewaukee WI 53072

http://www.mixersytems.com
daveb@mixersystems.com

Mixer Systems designs and manufactures four different high & low shear mechanical batch mixers for the ceramic and glass industry. Turbin, planetary, twin shaft, and single shaft mixers give quick, homogeneous blending for wet or dry mixing.

MODERN TIMES LEGAL 617-401-2460
1 Broadway 14th Flr Fax: 617-401-3687
Cambridge MA 02142

http://mxlegal.com
contact@mxlegal.com

Law firm specializing in the drafting and prosecution of patent applications, particularly relating to ceramics, in the United States and internationally. Patent attorney Bob Sayre is a member-at-large of the New England Section of ACerS.

MOHR CORP 810-225-9494
7996 W Grand River Ave Fax: 810-225-4634
Brighton MI 48114

http://www.mohrcorp.com
service@mohrcorp.com

Machinery resellers, from one machine to entire factories, manufacturing advanced hi-tech products, including whitewares and abrasives. Mohr sales are global, with 50+ years experience helping buyers and sellers enhance their ceramic manufacturing operations. Call Mohr today.

MOISTTECH CORP 941-229-8096
6408 Parkland Dr Ste No 104 Fax: 941-727-1810
Sarasota FL 34243

http://www.moisttech.com
info@moisttech.com

MoistTech is a world leader in NIR moisture measurement technology for instant on-line, off-line, and laboratory moisture instrumentation. MoistTech near infrared (NIR) gauges and sensors provide the most accurate and repeatable measurements for manufacturing and quality control processes. Insensitive to material variations, such as particle size, material height, and color, MoistTech moisture sensors provide continuous, reliable readings. Sensors are one-time calibration, maintenance free, and have a nondrift optical design, allowing operating personnel to confidently make immediate process adjustments based on real-time measurements.

MOMENTIVE PERFORMANCE MATERIALS INC
260 Hudson River Rd 800-295-2392
Waterford NY 12188 Fax: 614-986-2496

https://www.momentive.com
commercial.services@momentive.com

Provide high-purity quartz and advanced ceramic materials for the semiconductor, telecommunications, lighting, electronics, personal care, water purification, and other industries. Ceramic products include boron nitride powder coatings/sprays and hot-pressed BN.

MONOFRAX LLC 716-483-7200
1870 New York Ave Fax: 716-665-2478
Falconer NY 14733-1740

http://monofrax.com
info@monofrax.com

For more than 70 years, Monofrax manufactured fused cast refractories for use in the glass, light metal, steel and chemical industries. Our recently expanded product line includes 12 fused cast refractory compositions, five fused grain compositions, and a new refractory machining service.

MORGAN ADVANCED MATERIALS 510-491-1100
2425 Whipple Road Fax: 510-491-1287
Hayward CA 94544

http://morgantechnicalceramics.com

Design and manufacture products for demanding applications in a variety of markets using a comprehensive range of advanced ceramic, glass, precious metal, piezoelectric, and dielectric materials.

MORGAN TECHNICAL CERAMICS AUBURN
13079 Earhart Ave 530-823-3401
Auburn CA 95602 Fax: 530-823-3410

https://www.morgantechnicalceramics.com

Morgan Technical Ceramics Auburn is a world leader in high-purity alumina and custom-made, high-precision ceramic components for a variety of applications and industries, such as medical, analytical, power generation, and aerospace.

MORGAN THERMAL CERAMICS 706-896-4200
2102 Old Savannah Rd
Augusta GA 30906

http://morganthermalceramics.com
wendy.evans@thermalceramics.com

Morgan Thermal Ceramics designs, manufactures, and installs a broad range of thermal insulation products that significantly reduce energy consumption and emissions in a variety of high temperature processing applications.

MO-SCI CORP 314-364-2338
4040 Hypoint Blvd Fax: 573-364-9589
Rolla MO 65401-8277

http://mo-sci.com
kgrayson@mo-sci.com

Manufactures microspheres ranging from submicrometer to larger than 150 micrometer in diameter in bioactive and custom glass compositions. Medical-grade glass production. R&D services include development of new glass compositions.

MSE SUPPLIES LLC **520-789-6673**
4400 E Broadway Blvd Ste 600
Tucson AZ 85711

http://www.msesupplies.com
info@msesupplies.com

MSE Supplies (msesupplies.com) is a US-based leading supplier of high quality materials and equipment for advanced materials research and production. We provide both standard and custom-made products to meet the specific requirements from our customers. With a global customer base of research universities, national labs, as well as Fortune 500 companies and technology start-ups, we support scientists and engineers to accelerate their innovations in materials research.

MULTI LAB **+44 191 264 6801**
Unit 1 Westway Industrial Park
Throckley UK

https://www.multi-lab.co.uk
multilab45@gmail.com

Multi lab is a globally renowned, trusted supplier and fabricator of quartz glass and high purity technical ceramics at competitive prices and with a level of customer service. Contact us for more information about our services.

MURATA MANUFACTURING CO LTD **+81 77-586-8191**
Materials & Technology Center
2288 Oshinohara
Yasu-shi Shiga520-2393 Japan

https://www.murata.com
yuriko.tobita@murata.com

Established 1944. Manufactures integrated electronic components. Main products include MLCC, piezoelectric components, microwave devices, and module products. Conducts R&D in a broad spectrum of functional ceramics and their potential applications.

NABALTEC AG **+49 9431 530**
Alustrasse 50-52 Fax: +49 9431 61557
Schwandorf 92421 Germany

http://nabaltec.de
info@nabaltec.de

Produces a wide range of calcined aluminas modified for special applications in the ceramics and refractory industries. Also produces sintered mullite, a synthetic raw material with thermal shock-resistance.

NABERTHERM INC **302-322-3665**
54 Reads Way 302-322-3215
New Castle DE 19720Fax:

http://nabertherm.com
contact@nabertherm-usa.com

Offers a broad range of industrial kilns and furnaces for ceramics, glass, and metals up to 4,500°F (2,500°C), ranging from oxidation atmosphere to high-vacuum or protective-gas atmospheres. Catalytic exhaust systems to meet EPA requirements available.

NANOCEROX **734-741-9522**
712 State Circle Fax: 734-741-9533
Ann Arbor UT 48108

http://nanocerox.com
info@nanocerox.com

Leading nanotechnology company producing nanopowders and optical ceramics for a wide variety of markets.

NANOE **+33 9 81 98 33 64**
6 rue des Frênes Fax: +33 9 81 70 75 52
Ballainvilliers 91160 France

http://www.nanoe.fr
g.decalan@nanoe.com

Nanoe's mission is to bring the full potential of nanotechnlogy to advanced ceramics manufacturers. That is why it works hard to offer ready-to-sinter nanopowders on an industrial scale at competitive prices.

NANOFILM **216-447-1199**
10111 Sweet Valley Dr Fax: 216-447-1137
Valley View OH 44125-4249

http://www.nanofilmtechnology.com
info@nanofilmtechnology.com

Nanofilm UltraSEAL coatings for glass and ceramic provide a water- and grease-repellent surface with higher abrasion resistance than untreated surfaces. Treated surface is easier to clean. They are easy to apply and cure quickly at room temperature.

NANOSCIENCE INSTRUMENTS **480-758-5400**
10008 S 51st St Ste 110 Fax: 480-758-5401
Phoenix AZ 85044

http://www.nanoscience.com
info@nanoscience.com

Nanoscience Instruments sells and supports laboratory instrumentation for microscopy and surface science applications. Its team of scientists and engineers have backgrounds in chemistry, biochemistry, material science, physics, and engineering. Its portfolio includes desktop electron microscopes, atomic force microscopes, optical profilers, michromechanical testing systems, nanoindenters, and correlative microscopy systems.

NATIONAL CENTER FOR MANUFACTURING SCIENCES
3025 Boardwalk 800-222-6267
Ann Arbor MI 48108

https://www.ncms.org
contact@ncms.org

The National Center for Manufacturing Sciences (NCMS) is the nation's largest cross-industry technology development organization, dedicated to improving the competitiveness and strength of the U.S. industrial base. As a member-based consortium, NCMS leverages its network of members and partners to research, develop, demonstrate and transition innovative technologies more efficiently, with less risk, and at a lower cost than going it alone. NCMS connects industry, government, and education to work together on technology development and engage in unique growth opportunities for their businesses

NEOPTIX **418-687-2500**
1415 Boul Charest Ouest Ste 220 Fax: 418-687-2524
Quebec QC G1N 4N7 Canada

http://neoptix.com
info@neoptix.com

Designs and manufactures fiber-optic temperature sensors for temperature monitoring under microwaves and rf. Made of dielectric materials, these temperature sensors are immune to radiation and other interferences.

NETZSCH INSTRUMENTS NA LLC **781-272-5353**
129 Middlesex Turnpike Fax: 781-272-5225
Burlington MA 01803

http://www.netzsch-thermal-analysis.com
NIB_sales@netzsch.com

Thermal analysis and thermal properties measurement instruments, plus contract testing services; DSC; DTA; DSC-TGA; DTA-TGA; coupling for FTIR and MS dilatometers; laser flash thermal diffusiving, thermal conductivity, and more.

NETZSCH PREMIER TECHNOLOGIES LLC
125 Pickering Way 800-676-6455
Exton PA 19341 Fax: 610-280-1299

http://www.netzsch-grinding.com
info.npt@netzsch.com

Provides proven nanotechnology solutions for a broad range of industries. Manufactures grinding and dispersing machinery for media milling, powder processing, dispersing, de-aerating, and filling. Comprehensive global resources in engineering and R&D.

NEVZ-CERAMICS, CLOSE JSC **+7 383 225-82-75**
220 Krasny Prospect Fax: +7 383 225-82-75
Novosibirsk 630049 Russia

http://www.nevz.ru
international@nevz.ru

NEVZ-Ceramics is one of the leading manufacturers of technical advanced ceramics in Russia. The product range includes armor ceramics, ceramic substrates, bioceramics from alumina, steatite, forsteririte, and nitride ceramics.

NEW TECH CERAMICS INC **515-868-0055**
1923 Industrial Park Rd Fax: 515-864-0034
PO Box 387
Boone IA 50036

http://www.newtechceramics.com
sales@newtechceramics.com

Supplier of $AlMgB_{14}^{+}$. Processing service for powders, thin films, thick films, and sintered solids. All materials have extreme high hardness and low coefficient of friction that are thermally insulating and electrically conductive.

NEXCERIS LLC **614-842-6606**
404 Enterprise Dr
Lewis Center OH 43035

http://nexceris.com
info@nexceris.com

Nexceris LLC provides product and process solutions to the energy and environmental markets, including materials, catalysts, sensors, and solid oxide fuel cells.

NGIMAT LLC **859-259-3637**
2436 Over Drive Ste B Fax: 855-705-7295
Lexington KY 40511

http://www.ngimatllc.com
gvenugopal@ngimat.com

nGimat brings together innovative materials science, talented and motivated employees, and strategic collaborators and customers to develop cost-effective and profitable nanopowder and thin-film materials to address critical problems faced by the world.

NGK SPARK PLUG CO LTD **+81 568-76-5953**
2808 Iwasaki Komaki Fax: +81 568-76-1295
Aichi 485-8510 Japan

https://www.ngkntk.co.jp
info@mg.ngkntk.co.jp

Manufactures and sells spark plugs and related products for internal-combustion engines. Also manufactures advanced ceramics and applicable products.

NIOKEM INC **828-926-0199**
237 Handsome Dr
Waynesville NC 28785

http://www.niokem.com/
stephen.cox@niokem.com

Niokem is a chemical and mineral distribution company located in western North Carolina. Established in 2011, its range of products and services are expanding to meet customer needs.

NOL-TEC SYSTEMS INC **651-780-8600**
425 Apollo Dr
Lino Lakes MN 55014

http://nol-tec.com
sales@nol-tec.com

Worldwide single-source supplier of high-quality, custom-engineered pneumatic conveying, bulk material handling, and integrated process control systems. Expertise includes dense- and dilute-phase (pressure or vacuum) pneumatic conveying and weighing.

NORCROSS VISCOSITY CONTROLS **586-336-0700**
12427 31 Mile Rd
Washington MI 48095

http://viscosity.com
sales@viscosity.com

Manufactures process viscosity control equipment and viscosity monitors for use on ceramic slurries and other suspensions.

NORECS AS
Oslo Science Park
Gaustadalleen 21 Oslo 349 Norway

http://norecs.com
post@norecs.com

Manufactures high-temperature sample holder system for electrical and other characterization at high temperatures used in SOFC research and testing of ceramic membranes.

NORTH STAR EQUIPMENT INC 800-231-7896
1341 W First St 509-235-9203
Cheney WA 99004

http://www.northstarequipment.com
info@northstarequipment.com

American manufacturer of slab rollers, extruders, ware trucks, drying/damp cabinets, studio work tables, and throwing bats. North Star makes custom dies for any brand extruder or pugmill, any die material, and any shape or size. Custom dies are inexpensive and generally ship in 7–10 days.

NOVABONE PRODUCTS LLC 904-807-0140
1551 Atlantic Blvd Ste 105 Fax: 904-807-0141
Jacksonville FL 32207

http://www.novabone.com
information@novabone.com

Focused on developing bone grafting materials based on advancements in biomedical engineering to meet surgeons' needs; products are used in over a million patients with success demonstrating the safety and efficiency of our patented technology.

NOVOMER INC 781-672-2525
One Bowdoin Square Ste 300
Boston MA 02114

http://novomer.com
info@novomer.com

Novomer is a materials company pioneering a family of competitively priced high-performance green plastics, polymers, and other chemicals.

NSL ANALYTICAL SERVICES INC 216-438-5200
4450 Cranwood Pkwy Fax: 216-438-5050
Cleveland OH 44128

http://www.nslanalytical.com
nsl@nslanalytical.com

Commercial testing lab specializing in elemental chemistry, metallurgy, and polymer analysis. Certifications include ISO/IEC 17025 and NADCAP. Techniques include trace elemental analysis using ICP/MS and dc arc, classical wet chemistry, and ICP-OES.

NUTEC BICKLEY 855-299-9566
Carr Saltillo-Monterrey Km 62.5 No 100
66359 Ciudad Santa Catarina NL Mexico

http://www.nutecbickley.com
sales@nutec.com

Nutec Bickley designs and manufactures kilns to fire ceramics attending the following industries: sanitaryware, technical ceramics, electroporcelain insulators, refractories, heavy clay, and special applications. The company's kilns are designed in temperature ranges of 90–1,760°C (195–3,200°F).

Our highly-qualified engineers serve clients through the design, building and installation of combustion systems, thermal insulation and complete industrial furnaces and kilns.

Industrial kilns and furnaces with the best performance for firing refractories, technical ceramics, sanitaryware, electrical insulators, clay pipe and abrasives.

Industrial Furnaces with the best technology in insulation systems, combustion equipment, instrumentation & controls, and heat recovery systems.

NYACOL NANO TECHNOLOGIES INC 800-468-7657
211 Megunko Rd Fax: 508-881-1855
PO Box 349
Ashland MA 01721

http://www.nyacol.com
info@nyacol.com

Nyacol produces a wide variety of inorganic fine particles specializing in sub-200 nm metal oxides, including silica, alumina, antimony pentoxide, tin oxide, antimony tin oxide, ceria, titania, yttria, zirconia, zinc oxide, and barium titanate for use in structural, refractory, and electrical ceramics.

OBJECT RESEARCH SYSTEMS, INC 514-843-3861
760 rue St-Paul West Suite 101 Fax: 514-543-5475
Montreal Quebec Canada H3C 1M4

http://www.theobjects.com
info@theobjects.com

Designed for researchers and engineers in the fields of material and life sciences, geology, nanotechnology, and the environment, Dragonfly provides qualitative and quantitative data for material characterization, surface analysis, process evaluation, quality control testing, or any analysis function that requires a high-degree of accuracy. Already distributed with the high-end imaging products of renowned manufacturers such as Carl Zeiss Microscopy and TESCAN, Dragonfly's software architecture allows for extensible workflows and sophisticated 3D visualizations and robust analyses.

OCEAN OPTICS INC 727-733-2447
8060 Bryan Dairy Rd Fax: 727-733-3962
Largo FL 33777

http://oceanoptics.com
info@oceanoptics.com

Manufactures spectral instrumentation, precision optics, and optical components for online and lab UV-VIS-NIR applications. Optical-sensing systems also can be configured for testing a variety of ceramic materials, components, and coatings.

O'KEEFE CERAMICS INC 719-687-0888
845 Research Drive Fax: 719-687-0889
Woodland Park CO 80863

http://www.okeefeceramics.com
info@okeefeceramics.com

Precision Ceramic Machining since 1984. For over 30 years, O'Keefe Ceramics has served the aerospace, medical, energy, and semiconductor industries with high quality precision ceramic components. At O'Keefe Ceramics our mission is to continue to provide industries with a premier world class supplier of Precision Ceramic parts, with uncompromised quality, service, and value.

OLD HICKORY CLAY CO 270-247-3042
962 State Route 1241 Fax: 270-247-1842
Hickory KY 42051

http://oldhickoryclay.com
info@oldhickoryclay.com

Established 1918. Specializes in ball clays for dinnerware, refractories, sanitaryware, tile, porcelain, glazes, and other ceramics manufacturing. Clay products available in air-floated, shredded, mechanically dried, and slurry forms.

OPF ENTERPRISES 406-493-1102
5750 N Sam Houston Pkwy E Ste 109
Houston TX 77032

http://www.ontheplantfloor.com
info@ontheplantfloor.com

Worldwide consulting and management services specializing in ceramic raw materials, processing, and plant design. Physical and analytical testing of materials in our Houston laboratories. OPF stands for "On the Plant Floor" for our experience and approach to problem solving. Current clients range from individual start-ups to multinational corporations. Also provide custom marketing solutions and investigations for multiple markets. OPF also represents Eirich Machines in Arkansas, Louisiana, Texas, and Oklahoma.

OPTIPRO SYSTEMS LLC 585-265-0160
6368 Dean Pkwy Fax: 585-265-9416
Ontario NY 14519

https://www.optipro.com
sales@optipro.com

OptiPro Systems is a world leader in designing and manufacturing advanced equipment for ceramics machining and optical fabrication. OptiPro is dedicated to helping customers prosper through innovative manufacturing solutions, including CNC ultrasonic machining centers as well as CNC optical grinding and polishing machines. In addition, it provides state-of-the art contact and noncontact metrology systems.

OPTOCON AG +49 351 8435990
Washingtonstrasse 16/16a Fax: +49 351 8435991
Dresden Saxony D-01139 Germany

http://www.optocon.de/en/company
info@optocon.de

We are the specialist for your fiber optic temperature measurement needs, including fiber optic thermometers and fiber optic temperature sensors.

ORTECH INC 916-549-9696
6720 Folsom Blvd Ste 100 Fax: 916-404-7788
Sacramento CA 95819

http://www.ortechceramics.com
info@ortechceramics.com

Ortech Inc is a worldwide leader in the development and production of advanced technical ceramics. The company provides a wide selection of technical and advanced ceramics, including alumina oxide, zirconia oxide, silicon carbide, and silicon nitride, which improves and extends the performance of products, processes, or systems. Whether customers need high-temperature stability, hard and wear-resistant surfaces, improved stiffness to weight radiations, anticorrosive barriers, or low thermal expansion rates, Ortech can deliver. The company offers significant performance and cost advantages to meet customer needs. Search Ortech's selection of technical ceramics, including its technical ceramics materials and advanced ceramics standard products.

OSRAM SYLVANIA INC 978-570-3000
200 Ballardvale St Fax: 978-750-2152
Wilmington MA 01887

https://www.osram.us/cb
john.kelso@sylvania.com

Research, development, and manufacturing of advanced ceramics for lighting applications.

OUTOTEC RESEARCH OY +358 20 529211
Kuparitie 10 Fax: +358 20 5293203
PO Box 69
Pori Satakunta Finland

http://outotec.com/hsc
hsc@outotec.com

Provides plants, equipment, and services based mainly on its proprietary technologies. In-house-developed HSC chemistry software simulates chemical reactions and processes on a thermochemical basis.

OWENS-ILLINOIS INC 567-336-5000
1 Michael Owens Way
Perrysburg OH 43551-2999

http://www.o-i.com

Produces glass and plastic packaging systems for the food, beverage, and pharmaceutical industries for commercial and retail use. Consulting/purchasing agreements available for technical assistance to noncompetitive glass producers and users.

OXY-GON INDUSTRIES INC 603-736-8422
42 Old Rte 28 Fax: 603-736-8734
PO Box 40
Epsom NH 03234-0040

http://oxy-gon.com
Sales@oxy-gon.com

Manufacturer of high-temperature vacuum/controlled-atmosphere furnaces for laboratory and production applications as well as nitrogen and inert-gas gettering/purifying furnaces, hot presses, mechanical testing furnaces, and fiber-draw furnaces.

PACIFIC CERAMICS INC 408-747-4600
824 San Aleso Ave Fax: 408-745-6162
Sunnyvale CA 94085-1411

http://pceramics.com
info@pceramics.com

Manufacturer of advanced microwave ceramic materials. Our products include rare-earth iron garnets, calcium vanadium garnets, lithium and magnesium ferrites, and titanate dielectrics.

PACIFIC REFRACTORIES LTD +91 22 2761 2056
Door No C 16-3 Thane Belapur Rd Pawana Villege
T.T.C.M.I.D.C. Industrial Area
Vashi Navi Mumbai 400705 India

http://www.pacificrefractories.com

Pacific Refractories Ltd is an ISO 9001 QMS company and a leading manufacturer of quality refractories to BIS/ASTM standards. The company caters to a wide range of industries, including steel, cement, chemicals and petrochemicals, fertilizers, zinc, copper, alumina, power projects and glass, and other critical applications against stringent specifications.

PARAGON INDUSTRIES LP 800-876-4328
2011 S Town East Blvd Fax: 972-222-0646
Mesquite TX 75149-1122

http://www.paragonweb.com
info@paragonweb.com

Paragon manufactures electric glass and ceramic hobby and studio kilns, lab furnaces, dental furnaces, and asphalt-testing furnaces. Digital and manual kilns, customized and standard. Exports worldwide. Paragon kilns and furnaces are made in the U.S.

PARTICLE TECHNOLOGY LABS 630-403-0127
555 Rogers St
Downers Grove IL 60515

http://www.particletechlabs.com
sales@particletechlabs.com

Premier service laboratory, dedicated to particle size and characterization. Using over 20 different technologies, PTL holds significant capacity to measure particle size, concentration, and shape, as well as surface area, porosity, zeta potential, and more.

PENN TOOL CO 800-526-4956
1776 Springfield Avenue Fax: 973-761-1494
Maplewood NJ 07040

http://www.penntoolco.com
info@penntoolco.com

Penn Tool Co specializes in providing top quality industrial machine tools and accessories for sale. Choose from a wide selection of products from our online catalog, today! Shop our extensive selection to find products that suit your needs at the best prices! Get what you need faster with our easy-to-use, one-step checkout process. Fast shipping, guaranteed best price, huge online selection. GSA contract holder.

PETER PUGGER MFG INC 707-463-1333
3661 Christy Ln Fax: 707-462-5578
Ukiah CA 95482

http://peterpugger.com
info@peterpugger.com

Manufactures clay-processing and tile-cutting/forming equipment. Machines batch mix with pugmill output. Mix, recycle, de-air and pug in a single machine with variable speed. For studios, product development, lab, and test applications.

PETRO MOLD COMPANY 814-796-6635
12775 Donation Rd Fax: 814-796-6635
Waterford PA 16441

https://www.petromolds.com
petro@velocity.net

We offer custom mold-making and mold production services to all facets of the ceramics industry. Services include original sculpting, master mold design, and production mold manufacturing. We now offer architectural detail molds and ceramic bisque runs from molds we design for you.

PICOPARTS LTD +972 4-995-8638
PO Box 419 Fax: +972 4-995-8637
Gesher Haziv 22815 Israel

http://www.picoparts.com
sales@picoparts.com

Manufacturer of small precision products from ceramics (alumina/zirconia) and tungsten carbide. Custom made to client design/requirements. Over 25 years experience with materials technologies and innovative thinking of our staff, which allows us to meet even the most intricate, elusive technical challenges.

PIDC 800-382-3845
4788 Runway Blvd
Ann Arbor MI 48108

http://pidc.com
jgeyman@pidc.com

Established in 1992 as a trading company, PIDC is focused on finding better, safer, and more cost-effective ways to manufacture specialty chemicals. It has since transformed into a global manufacturer of world-class materials with manufacturing sites in the U.S. and China, as well as offices throughout the U.S., South America, Europe, and Asia.

PIDC's aluminas, rare earth materials, zeolites, and other customized proprietary formulated powders are used in various industries, including automotive, oil & gas, electronics, alternative energy, construction, chemical, pharmaceutical & medical, and security & authentication.

PIEZO TECHNOLOGIES 317-876-4670
8431 Georgetown Rd Ste 300 Fax: 317-876-4681
Indianapolis IN 46268

http://www.piezotechnologies.com
jane.haynie@meggitt.com

Piezo Technologies, a Meggitt PLC group, specializes in manufacturing specialized piezoceramic formulations and integrated ultrasonic systems, enabling hundreds of products requiring precision measurements and acoustic events.

P-KER ENGINEERING
1880 Waterport Rd
PO Box 26
Waterport NY 14571

http://pkerengineering.com
info@pkerengineering.com

Manufacture and metallize technical ceramics: alumina, beryllia, cordierite, forsterite, steatite, and zirconia. Metallize silicon nitride, SiC, and zirconia with refractory metals. Metal-ceramic joining and assemblies.

PLANSEE SE 508-553-3800
115 Constitution Blvd Fax: 508-553-3823
Franklin MA 02038

http://plansee.com
usa@plansee.com

Manufactures heating elements of molybdenum, tungsten, and tantalum for use in vacuum and protective atmosphere furnaces up to 4,350°F (2,400°C). Local production and sales in Asia, Europe, and U.S. Advanced material qualities available (ML, TZM, WVM).

PLIBRICO COMPANY 312-337-9000
1935 Techny Rd Unit 16 Fax: 312-337-9003
Northbrook IL 60062

http://www.plibrico.com
contact@plibrico.com

Plibrico Company - Refractories, Engineering, Construction - a leading supplier of monolithic refractories used in the processing of aluminum, steel, cement, waste, power generation, and other demanding thermal environments.

For over a century, organizations have trusted us to provide reliable refractory solutions that consistently increase efficiency, improve production uptime, and safely boost performance of thermal processing equipment.

PLIBRICO JAPAN CO LTD +81 3-3455-1359
6F Mita-NN Bldg 1-23 Shiba 4-chome
Minato-ku Tokyo 108-0014 Japan Fax: +81 3-3455-1362

http://plibrico.co.jp
k-hirasawa@plibrico.co.jp

Established in 1954 under technology transfer from Plibrico USA. Manufactures monolithic refractories in factory located in Yokohama, Japan. A wholly owned subsidiary in China produces the same range of products.

POLYMER INNOVATIONS INC 760-598-0500
2426 Cades Way Fax: 760-727-3127
Vista CA 92081

http://www.polymerinnovations.com
info@polymerinnovations.com

Polymer Innovations Inc is a consulting and manufacturing company focused on water-based tape casting technology and polymer solutions for the electronics and energy fields. We are a leading expert in tape casting, formulation of green tapes, and inks.

POWDER PROCESSING & TECHNOLOGY LLC
5103 Evans Ave 219-462-4141
Valparaiso IN 46383 Fax: 219-462-0367

http://www.pptechnology.com
sales@pptechnology.com

Developer and custom processer of inorganic chemical and ceramic powders. Production and pilot processing capability includes calcining, milling, spray drying, and sintering. Partnered with industry in electronics and advanced ceramics.

PRAXAIR SPECIALTY CERAMICS 425-487-1769
16130 Woodinville-Redmond Rd Ste 7
Woodinville WA 98071 Fax: 425-487-1859

http://www.praxairsurfacetechnologies.com
psti-info@praxair.com

Praxair Specialty Ceramics offers a range of specialty ceramics for diverse applications, markets, and industries. The company manufactures electronic-grade ceramic oxide powders and shapes with an advanced combustion spray pyrolysis process to overcome many of the drawbacks of traditional powder processing.

PRECISION CERAMICS USA 727-388-5060
711 South Howard Ave Ste 200
Tampa FL 33606

http://www.precision-ceramics.com
info@pcusinc.com

Precision Ceramics is a specialist in designing, manufacturing, and machining custom advanced technical ceramic parts. Since 1992, Precision Ceramics is dedicated to developing the world's best and most advanced ceramic solutions.

PRECISION FERRITES AND CERAMICS INC
5432 Production Dr 714-901-7622
Huntington Beach CA 92649 Fax: 714-901-2008

http://www.semiceramic.com
sales@semiceramic.com

Precision Ferrites and Ceramics (PFC) specializes in custom advanced ceramic products and services, machining the simplest to the most intricate of items, achieving smaller features and tighter tolerances than any competitors.

PRED MATERIALS INTERNATIONAL INC 212-286-0068
60 E 42nd St Ste 4000 Fax: 212-286-0072
New York NY 10165

http://www.predmaterials.com
steve@predmaterials.com

Supplier of top quality ceramic raw materials, including 99.99% Al_2O_3 for making transparent ceramics and aluminum nitride powders for flexible circuits and other applications.

PremaTech ADVANCED CERAMICS

PREMATECH ADVANCED CERAMICS 508-791-9549
160 Goddard Memorial Dr 508-793-9814
Worcester MA 01603-1260

http://www.prematechac.com
info@prematechac.com

PremaTech offers machining of technical ceramics and other ultrahard materials for many applications in the semiconductor, aerospace, life science, and industrial markets. We also perform in-house polishing. ISO certified and 40 years experience.

PRINCE INTERNATIONAL CORPORATION 646-747-4200
15311 Vantage Pkwy West Ste 350
Houston TX 77032 Fax: 217-228-0466

https://www.princecorp.com
info@princecorp.com

Produces and markets specialty mineral products with a focus on naturally occurring minerals and pigment applications. Products are used in brick, refractories, glass, ceramics, foundries, cement, steel, and numerous other industrial and agricultural applications.

PROGRESSIVE TECHNOLOGY INC 916-632-6715
4130 Citrus Ave Unit 17 Fax: 916-632-9348
Rocklin CA 95677

http://prgtech.com
sales@prgtech.com

Using the latest in CNC technology and with a combined experience of 150+ years in ceramic machining, we developed many ways to produce complex shapes and at high volume.

PSH KILNS & FURNACES 905-849-5540
1120 Speers Rd Fax: 905-849-0001
Oakville ON L6L 2X4 Canada

http://psh.ca
mail@psh.ca

Designs, builds, and services electrically heated, air-atmosphere furnaces for production and R&D applications in the ceramics, automotive, aerospace, pulp and paper, fuel cell, electrical, and chemical industries.

QUALITY THERMISTOR INC 800-554-4784
2108 Century Way Fax: 208-376-4754
Boise ID 83709

http://thermistor.com
qtisales@thermistor.com

Our ISO:09001:2000 and AS9100 certified manufacturing and testing facilities in Idaho enhances our ability to meet the needs of today's challenging temperature measurement and control applications.

QUANTACHROME INSTRUMENTS 561-731-4999
1900 Corporate Dr Fax: 561-732-9888
Boynton Beach FL 33426

https://www.anton-paar.com/corp-en/quantachrome
qc.sales@quantachrome.com

World leader in design and manufacture of laboratory instruments for characterizing properties of porous materials and powders. Specialize in instruments for the determination of surface area, pore size, pore volume, and density.

QUANTACHROME UK-ANTON PAAR 804-550-1051
10215 Timber Ridge Dr
Ashland VA 23005-8135

http://www.quantachrome.co.uk
info.us@anton-paar.com

From particle creation to particle characterization, Quantachrome UK offers the most advanced technological solutions to the particle technology community.

QUINTUS TECHNOLOGIES LLC 614-891-2732
8270 Green Meadows Dr N Fax: 614-891-4568
Lewis Center OH 43035

http://quintustechnologies.com
support@quintusteam.com

Quintus Technologies offers high-pressure sheet metal forming presses plus hot and cold isostatic presses for densification of advanced materials. Its systems are backed by an extensive service and support program.

RAM PRODUCTS INC 614-443-4634
1091 Stimmel Rd Fax: 614-443-4813
Columbus OH 43223

http://ramprocess.com
info@ramprocess.com

Manufacture Ram press, Ram process, power units, hydraulic presses, presses, ceramic dies, porous resign dies, models, and special tooling. Worldwide distribution. Sell replacement press parts and Ram process die-making supplies.

RATH INC 302-793-0283
501 Silverside Rd Ste 131 Fax: 302-793-0289
Wilmington DE 19809-1377

http://www.rath-usa.com
rathinfo@rath-usa.com

Manufactures and supplies high-temperature custom insulating materials and refractories, including ceramic-fiber insulation, coatings, adhesives, rigidizer and mastics for use up to 1,800°C as well as specialty dense and high-alumina refractories.

Rauschert

RAUSCHERT INDUSTRIES INC 949-421-9804
1170 Howell Mill Road Suite 300
Atlanta GA 30318

http://www.rauschert.com
c.brayman@rauschert.com

Manufacturer of custom advanced ceramic components, offering an extensive product range of ceramic materials used in applications requiring high corrosion, erosion and wear resistance, high-temperature capability, and low electrical conductivity.

RAYMOND BARTLETT SNOW — SCHNECK PROCESSING 630-836-7460

http://www.schenckprocess.com/rbs

The Raymond Bartlett Snow Division is a leader in the design, manufacture, and construction of size reduction, classification, and thermal processing equipment for over 130 years. The company works with customers from initial concept and development of equipment and systems, through pilot plant testing, equipment manufacturing, and commissioning, followed by the full capability to provide OEM replacement parts and technical services.

RD WEBB COMPANY INC 508-650-0110
6 Huron Dr Fax: 508-650-0555
Natick MA 01760

http://www.rdwebb.com
RDWEBB@ALUM.MIT.EDU

Manufactures air-cooled laboratory and small-production vacuum furnaces for use up to 2,200°C under vacuum or inert gas. Furnaces need no cooling water and consume 2kW of power. Furnace application include active metal brazing, sintering, and annealing.

RE CARROLL INC 609-695-6211
201 Acorn Dr Fax: 609-695-0102
Yardley PA 19067

http://recarroll.com
info@recarroll.com

Incorporated 1925. Distributes domestic china clays, ZnO, magnesium carbonate, soda ash, lubricants, alumina trihydrate, and limestone. Warehouses at Trenton, NJ; Akron, OH; Dalton, GA; and Dallas, TX.

READE ADVANCED MATERIALS 401-433-7000
850 Waterman Ave Fax: 401-433-7001
Providence RI 02914

http://www.reade.com
info@reade.com

A global distributor and value add toll chemical processor/packager of specialty chemical particle solids (metal, mineral, ceramic, composite) with four customer-care facilities in the Americas. Visit our 4,500 page website.

RECCO FURNACES 800-545-4567
8323 Loch Lomond Dr Fax: 562-949-3696
Pico Rivera CA 90660-2507

http://www.reccofurnaces.com
info@reccofurnaces.com

Provides furnace systems for processing electronics and advanced materials, as well as specialty metals from 500–1,800°C. Fifty-four years of providing furnaces for high temperature, precise temperature, and atmosphere control that may include automation.

REED GUNITE & SHOTCRETE EQUIPMENT 888-779-7333
13822 Oaks Ave Fax: 909-287-2140
Chino CA 91710-7008

http://reedpumps.com
mike.newcomb@reedmfg.com

Produces double-piston shotcrete pumps and feed-bowl-type gunite machines for a variety of applications, including refractory installation.

REFRAC SYSTEMS 480-940-0068
7201 W Oakland St Fax: 480-940-9366
Chandler AZ 85226-2434

http://refrac.com
service@refrac.com

Provides production vacuum hot-pressing up to 3,800°C; vacuum brazing for nickel, cobalt alloys, reactive, refractory, and noble metals and ceramics. Specializes in performing planar high-volume diffusion bonding tollway services.

REFRACTORY CONSULTING SERVICES 513-378-0190
121 Olde Farm Road Fax: 513-523-1384
Oxford OH 45056

http://refractoryexpert.com
ruthengel@refractoryexpert.com

Refractory consultant with more than 35 years experience specializing in comprehensive approach for improved refractory life, refractory failure analysis, expert witness, expert for insurance analysis, training, and more.

Extensive experience with many different industries such as iron, steel, aluminum, copper, silicon, power, and others.

REFRACTORY MACHINING SERVICES 724-285-7674
610 E Butler Rd Fax: 724-285-7673
Butler PA 16002

http://refrmachscrv.com
refmachserv@refrmachscrv.com

Produces CVI-based ceramic composites and CVD coatings of ceramics as well as precious and refractory metals. Component design, development, and manufacturing capability. Products for aerospace and energy conversion industries.

REFRACTORY MINERALS CO INC 610-869-3031
150 Jennersville Rd Fax: 610-869-9805
West Grove PA 19390

http://phosphatebonds.com
info@phosphatebonds.com

Manufactures and sell phosphate-based refractory binders and calcined alumina -325 mesh. Provides toll services, blending, fine grinding, calcining, and packaging.

REFRACTRON TECHNOLOGIES CORP 315-331-6222
5750 Stuart Ave Fax: 315-331-7254
Newark NY 14513

http://refractron.com
info@refractron.com

Refractron manufactures durable structural and porous ceramics for tough industrial applications. These ceramics are used in equipment that aerates wastewater, draws wire, filters minerals, and pumps oil.

REFRATECHNIK CERAMICS GMBH +49 5427 810
Barkhausener Str 55 Fax: +49 5427 81102
49328 Melle Germany

http://www.refra.com
ceramics@refra.com

Refratechnik Ceramics in Melle/Germany offers innovative refractory systems for industrial kilns in the heavy clay industry and for other industrial applications in the cement, aluminium and waste incineration industries. Our product portfolio for the ceramics industry includes wall, ceiling and kiln car systems with all necessary kiln furniture. All products are precisely matched to the technical and economic requirements of the customers.

RENO REFRACTORIES INC 800-741-7366
PO Box 201
Morris AL 35116

http://renorefractories.com
Garyh@r-ref.com

Reno Refractories Inc is recognized as a leader in the iron foundry industry. With the ability to monitor and satisfy growing demands placed on refractory products needed by today,Äôs manufacturers, the company offers a full line of quality refractory products and custom designed precast shapes that are sold and distributed worldwide, including hull forms and propulsors; structures and materials; signatures, silencing systems, and susceptibility; machinery systems; and vulnerability and survivability systems.

RENSSELAER POLYTECHNIC INST 518-276-6000
110 Eighth St Fax: 518-276-8554
Troy NY 12180

https://www.rpi.edu
doremr@rpi.edu

Offers an undergraduate major in materials engineering, with the possibility of emphasizing ceramics in elective courses. Offers MS and PhD in materials engineering with specialization in ceramics.

RESODYN ACOUSTIC MIXERS INC 406-497-5333
130 N Main St Ste 630 Fax: 406-497-5206
Butte MT 59701

http://resodynmixers.com
info@resodynmixers.com

Provides advanced solutions for a broad range of industrial mixing problems. Service and equipment solutions are based on the company's proprietary technology, ResonantAcoustic Mixing.

RHI US LTD 513-753-1254
1870 New York Ave Fax: 513-753-0984
Falconer NY 14733-1740

http://rhi-ag.com
fal_rhimonofrax@rhi-ag.com

Member of the RHI Group, manufactures bonded- and fused-cast refractories for supply to the glass industry.

RIO TINTO ENERGY AND MINERALS +61 3 9283 3333
Level 7 360 Collins S Fax: +61 3 9283 3707
Melbourne 3000 Australia

http://www.riotinto.com/energy-and-minerals-162.aspx
minerals.communications@riotinto.com

Mines, manufactures, and refines borax, boric acid, anhydrous borax, boric oxide, talc, and chlorite for the glass and ceramics industries.

RISE RESEARCH INSTITUTES OF SWEDEN
Lindholmspiren 7 A Box 857 +46 10 516 50 00
417 56 Goteborg Boras SE-501 15 Sweden

https://www.ri.se/en/what-we-do/our-areas/glass
info@ri.se

RISE Glass (former Glafo), within the polytechnical institute RISE Research Institutes of Sweden, provides industrial contract research, education, technical support, testing, property measurements, chemical analysis, consultancy, and innovative technical solutions to the global glass market, including glass manufacturers, glass processors, and users of glass. The expertise of RISE Glass covers the whole range from raw materials to glass melting, the finished product, recycling, and alternative applications for glass.

ROBOCASTING ENTERPRISES LLC 505-883-0555
5660 Pino Ave NE
Albuquerque NM 87109

http://www.robocasting.com
robocasting@robocasting.net

Robocasting specializes in 3D printing ceramics and composites, especially for production of lattice structures as alternatives to reticulated foams for filtration, catalysis, and mixing; custom labware and consumables for DSC/TGA thermal analysis.

ROBOVENT 877-959-7639
37900 Mound Rd Fax: 586-698-1801
Sterling Heights MI 48310

http://www.robovent.com

At RoboVent, clean air is more than a business—it is a passion. The company is driven by the knowledge that the work it does directly impacts the health, safety, and quality of life for thousands of manufacturing workers in the U.S. and around the globe. RoboVent already helped improve the lives of 110,000+ people with its clean air remedies, and this year it hopes to help 10,000 more.

ROCA SANITARIO SA +34 936 38 16 00
Rambla Lluch Gava
Barcelona 2 08250 Spain

http://www.roca.com

Roca is a worldwide reference in developing bathroom spaces. With almost a hundred years of experience as a company, Roca began producing vitreous china bathroom appliances in 1936. Today, Roca's commercial network spreads over 135 countries supplied by its 76 production plants and more than 20,000 employees worldwide.

ROCCERA LLC 585-426-0887
Rochester Technology Park Fax: 585-426-0884
771 Elmgrove Rd
Rochester NY 14624

http://roccera.com
info@roccera.com

Manufacturer and fabricator of advanced ceramic, polyurethane, and steel components. Designs, consults, manufactures, and markets customized advanced ceramic components for industrial, commercial, and domestic applications.

ROCKWELL AUTOMATION INC 414-382-2000
1201 S Second St Fax: 414-382-4444
Milwaukee WI 53204-2496

http://www.rockwellautomation.com
webmaster@rockwellautomation.com

Rockwell Automation, the world's largest company dedicated to industrial automation, makes its customers more productive and the world more sustainable.

ROMAN MANUFACTURING 616-530-8641
861 47th St SW Fax: 616-530-8953
Grand Rapids MI 49509-5103

https://www.romanmfg.com

As a manufacturer of high-current, low-voltage power sources, RoMan uses the finest materials available to offer thousands of design and customized options built to the highest quality standards and to specific industry and application requirements. RoMan also provides value-added, application-centric technical support and industry specific application engineering services.

SAINT-GOBAIN ABRASIVES 508-795-5000
1 New Bond St Fax: 888-284-9170
PO Box 15008
Worcester MA 01615-0008

http://sgabrasives.com
ian.r.manter@saint-gobain.com

Manufactures and markets coated-abrasive, bonded-abrasive, superabrasive, and nonwoven-abrasive products. Sells products under the Norton Abrasives, Winter Abrasives, and Amplex Abrasives brands.

SAINT-GOBAIN CERAMICS & PLASTICS 508-351-7100
9 Goddard Rd
Northboro MA 01532

https://www.saint-gobain.com/en

Saint-Gobain designs, manufactures, and distributes building and high-performance materials, providing innovative solutions to the challenges of growth, energy efficiency, and environmental protection.

SAINT-GOBAIN HIGH PERFORMANCE CERAMICS, REFRACTORIES & HEXOLOY¬Æ SIC MATERIALS
1 New Bond St 508-795-5577
Worcester MA 01606 Fax: 508-795-2051

https://www.ceramicsrefractories.saint-gobain.com
ceramicsrefractories@saint-gobain.com

Saint-Gobain High Performance Ceramics and Refractories partners with customers to develop innovative solutions with leading technology brands such as Hexoloy, N-Durance, Durafrax, Crystar, Silit, and Zirchrom. Our materials include alumina, silicon carbide, boron carbide, silicon nitride, zirconia, and chromium for applications involving high temperature, corrosion, abrasion, wear, or impact resistance.

SAINT-GOBAIN NORPRO 330-673-5860
3840 Fishcreek Rd
Stow OH 44224-4306

https://www.norpro.saint-gobain.com
norpro.ceramicsales@saint-gobain.com

Saint-Gobain NorPro's advanced ceramic technologies for fixed bed reactor processing and heat & mass transfer applications include custom catalyst carriers, bed topping and support media, mass transfer media and support assemblies, and regenerative thermal oxidation packings.

SAINT-GOBAIN RECHERCHE +33 1 48 39 58 00
Les Miroirs 18 avenue d'Alsace Fax: +33 1 48 34 74 16
Courbevoie 92400 France

http://saint-gobain-recherche.com
patrick.garnier@saint-gobain.com

Research on glass: flat glass, bottle glass, insulation glass fibers, and reinforcement glass fibers.

SAMPE 626-331-0616
21680 Gateway Center Dr Ste 300
Diamond Bar CA 91765-2454 Fax: 626-332-8929

http://www.sampe.org
sampeibo@sampe.org

Founded 1944. International educational and scientific membership association dedicated to the exchange of data on new materials and processes. Provides a unique and valuable forum. Sponsors technical conferences and exhibitions, and publishes proceedings.

SANDIA NATIONAL LABORATORIES 505-844-8066
1515 Eubank SE
PO Box 5800
Albuquerque NM 87185

http://sandia.gov
astapia@sandia.gov

Research, development, and application of glass and ceramics, includes developing glasses, glass-ceramics for hermetic seals, studying electro-optic effects, improving processes for making ferroelectric ceramics, and studying fracture of ceramics.

SAUEREISEN INC 412-963-0303
160 Gamma Dr Fax: 412-963-7620
Pittsburgh PA 15238

http://www.sauereisen.com
info@sauereisen.com

Sauereisen manufactures a diverse line of electrically insulating inorganic cements. Choose from over 20 different air-setting, hydraulic-setting, and chemical-setting products offering continuous high-temperature service up to 3,000°F.

SAXON GLASS TECHNOLOGIES INC 607-587-9630
200 N Main St Fax: 201-855-0643
PO Box 575
Alfred NY 14802

http://saxonglass.com
info@saxonglass.com

Saxon Glass Technologies Inc started in 1996 when a large glassmaker came to the New York State College of Ceramics at Alfred University in search of a solution to their glass strength problems. After the successful demonstration of trial runs, a shop was set up at the Ceramic Corridor Innovation Center to meet the new challenge from the New York State legislature to help with the economic growth of the region.

SCG CHEMICALS CO LTD +66 2 586 1111
1 Siam Cement Rd Fax: +66 2 586 5561
Bang Su Bangkok 10800 Thailand

https://www.scgchemicals.com/en/index

As one of SCG's three core businesses, SCG Chemicals manufactures and offers a full range of petrochemical products, ranging from upstream production of olefins and intermediate production of styrene monomers, purified terephthalic acid, and methyl methacrylate; to downstream production of four main plastic resins (polyethylene, polypropylene, polyvinyl chloride, and polystyrene), including fabricated products such as film, pipe and fittings, and acrylic sheet. To better serve customer requirements, SCG Chemicals assigns prime importance to the development of new technology and innovation for the creation of high value-added products and services.

SCHOTT NORTH AMERICA INC 914-831-2200
555 Taxter Rd Fax: 914-831-2201
Elmsford NY 10523

http://www.us.schott.com/
rina.dellavecchia@us.schott.com

SCHOTT is a leading international technology group in the areas of specialty glass and glass-ceramics. With more than 130 years of outstanding development, materials, and technology expertise, the company offers a broad portfolio of high-quality products and intelligent solutions. SCHOTT is an innovative enabler for many industries, including the home appliance, pharma, electronics, optics, life sciences, automotive, and aviation industries. SCHOTT strives to play an important part in everyone's life and is committed to innovation and sustainable success. The group maintains a global presence with production sites and sales offices in 34 countries.

SECO/WARWICK CORP 814-332-8400
180 Mercer St Fax: 814-724-1407
PO Box 908
Meadville PA 16335

http://seco-warwick.com
contact@secowarwick.com

Custom-engineered vacuum furnaces for most processes, including hardening, tempering, annealing, solution heat treating, brazing, sintering, carburizing, carbon/carbon composition, CVD-graphitizing, high-pressure quenching, and degassing.

SELEE CORP 828-364-0100
700 Shepherd St Fax: 828-693-1833
Hendersonville NC 28792-6400

http://www.selee.com/
cservice@selee.com

Manufactures technical ceramics for gas and liquid filtration/separation, heat and mass transfer, high-temperature mixing, catalysis, and metal filtration/treatment and transfer.

SEMCO CARBON 440-277-5860
3000 Leavitt Rd Fax: 440-277-5859
Lorain OH 44052

http://www.semcocarbon.com
mvozar@semcocarbon.com

Semco Carbon provides custom graphite machining services to produce components per customer specifications and drawings. We work with graphite and carbon composites exclusively and as a specialized graphite shop; large production quantities are not a requirement when placing an order. Semco Carbon handles small run jobs, such as prototype work or repair work, with no minimum order required and no minimum charge.

SEMICONDUCTOR ENERGY LABORATORY CO, LTD
398 Hase +81 46-248-1131
Atsugi-shi Kanagawa Fax: +81 46-270-7227
243-0036 Japan

http://www.sel.co.jp/en/
info@sel.co.jp

Semiconductor Energy Laboratory Co, Ltd (SEL) finds research topics pertaining to forthcoming needs of society, finds new principles by thorough research and development, and invents technologies to solve problems.

SEMTECH SOLUTIONS INC 978-663-9822
6 Executive Park Dr Fax: 978-663-9823
Analytical Testing Laboratory
Billerica MA 01862

http://www.atl.semtechsolutions.com
labmanager@semtechsolutions.com

SEMTech Solutions provides advanced analytical and R&D support to a wide array of customers. We use FE-SEMs, EDS, micro FTIR, and optical microscopy for materials testing and characterization. We have more than 25 years experience in this field.

SETARAM INSTRUMENTATION +33 4 72 10 25 25
7 Rue de l'Oratoire Fax: +33 4 78 28 63 55
Caluire 69300 France

http://www.setaram.com
sales@setaram.com

Setaram is a leading manufacturer and supplier of high-performance thermal analyzers, calorimeters, gas sorption, and high pressure mass spectroscopy instruments, and offers complete and dedicated solutions for your specific application.

SHAMROCK TECHNOLOGIES INC 973-242-2999
Foot of Pacific St Fax: 973-242-8074
Newark NJ 07114

http://www.shamrocktechnologies.com
marketing@shamrocktechnologies.com

Manufactures a broad line of micronized powders, dispersions, emulsions, and compounds, including PTFE, polyethylene, polypropylene, fluoro polymers, custom wax alloys, natural waxes, and specialty additives for the ceramics industry.

SHEFFIELD POTTERY 413-229-7700
US Rt 7 Fax: 413-229-0200
PO Box 399
Sheffield MA 1257

http://sheffield-pottery.com
sales@sheffield-pottery.com

Established 1946. Produces stock and custom moist-clay bodies. Huge selection of raw materials and chemicals. Distributes ceramics equipment, including kilns, wheels, slab rollers, and pugmills. Ceramics supply showroom open daily.

SHOEI CHEMICAL INC +81 3-3344-6661
Shinjuku Mitsui Bldg 1-1 Fax: +81 3-3344-6658
Nishi Shinjuku 2-chome
Shinjuku-ku Tokyo 163-0443 Japan

http://www.shoeichem.co.jp
info@shoeichem.co.jp

Established 1956. Manufactures conductive, resistive, and dielectric pastes and fine powders of metals and metal oxides for electronic application; precious metal/salt, precious-metal catalyst, and liquid precious metal for industrial applications.

SIBELCO BENELUX +32 14 83 72 11
De Zate 1 Fax: +32 14 83 72 32
Dessel 2480 Belgium

http://sibelco.be
sales@sibelco.be

Worldwide producer of various industrial ceramic minerals, including silica, cristobalite, clays, nepheline, and feldspar, both in sand and power form. Kindly consult with us on your specific requirements.

SICCO ENGINEERING WORKS +91 44 2625 4792
No 454 Sidco Industrial Estate Fax: +91 44 2625 0513
Ambattur Chennai
Tamil Nadu 600098 India

http://www.siccoengineering.co.in
kanmani@synchrony.co.in

Sicco developed several equipments for unit handling systems like range of gravity rollers, silent running live roller conveyors of our innovative single-chain design, load adjustable accumulation conveyors, and compact inline lifting tables.

SIEMENS PROCESS INDUSTRIES AND DRIVES
100 Technology Drive 770-740-3000
Alpharetta GA 30005-3900 Fax: 678-297-8316

http://www.usa.siemens.com/industry
helpline.sii@siemens.com

Siemens is a single source leader of automation technology products engineered and manufactured for all industrial sectors.

SIGMA ADVANCED MATERIALS 716-200-8618
2115 Old Union Rd Fax: 716-668-9800
Cheektowaga NY 14227

http://www.sigmaadvancedmaterials.com
cpilon@sigmaadvanced.com

Experience, dedication to excellence, and best-of-breed operational practices shape Sigma Advanced Materials. Sigma Advanced Materials offers custom-engineered solutions for each project it encounters. Clients enjoy personalized care and consultative assistance, resulting in the best possible deliverable for the best possible price.

SIGMADIAMANT +34 964 56 27 13
Polígono Industrial Supoi 8
Parcela M5 B1 Nave 17
(CV-10 - salida 12) Castellon 12550 Spain

http://www.sigmadiamant.com
info@sigmadiamant.com

Diamond tools and abrasives for polishing, lapping, cutting, mitering, beveling, squaring, and shaping ceramic tile, porcelain tile, marble, granite, and any natural stone. Hi-tech range, adapted to the type of material, available for any brand of machinery.

SILICON CARBIDE PRODUCTS INC 607-562-8599
361 Daniel Zenker Dr Fax: 607-562-7585
Horseheads NY 14845

http://scprobond.com
scp@scprobond.com

Manufacturer of custom silicon carbide specialty shapes for demanding industrial wear, corrosion, and high-temperature applications. SCP offers SCProbond 'N' Reaction Bonded SiC. ISO 9001: 2000 certified.

SOMANY CERAMICS LTD 800-103-0004
Kassar Bahadurgarh Fax: +91 1276 241 006
Haryana 124507 India

http://www.somanyceramics.com
ggt@somanytiles.co.in

$200 million company and leading tile manufacturer in India under renowned Somany brand. Company has certificate of registration under ISO 9001:2008; ISO 14001:2004; BS OHSAS 18001:2007; ISO 22000:2005; EN ISO 14411:2006; and IS 1515622:2006.

SONYA CERAMICS (EXPORT DIVISION) +91 79 2220 2588
711 Near Anil Starch Mill
Ahmedabad Gujarat 380025 India

http://www.sonyaceramics.com
info@sonyaceramics.com

We specialize in manufacturing and exporting technical ceramics made of porcelain, steatite, cordierite porcelain, cordierite refractory, alumina refractory, and high alumina of different grades.

SPARKLER CERAMICS PVT LTD +91 20 3069 2878
J-508 MIDC Bhosari Fax: +91 20 2713 0955
Pune Maharashtra 411026 India

http://www.sparklerceramics.com
piezo@sparklerceramics.com

Manufactures lead zirconate titanate and lead-titanate-based piezoelectric elements for ultrasonic cleaners, welders, atomizers, and NDT probes; hydrophones, sonars, accelerometers, armament impact fusing, energy harvesting, and scores of other appliances.

Specialty GLASS
solving the science of glass™
since 1977

SPECIALTY GLASS INC 813-855-5779
305 Marlborough St Fax: 813-855-1584
Oldsmar FL 34677

http://sgiglass.com

Founded in 1977, Specialty Glass Inc (SGI) excels at utilizing innovative production techniques to become a leading manufacturer specializing in glass melting and processing for a wide array of industries within global markets. Examples include glass solutions for the following: abrasives, computer heads, vitrified-bonded grinding wheels, dental glass fillers, electronics, sealing, wood preservation, plus many other technical glass applications.

SPECTROCHEMICAL
Laboratories
Material Evaluation

SPECTROCHEMICAL LABORATORIES 724-334-4140
155 Prominence Dr Fax: 724-334-4143
New Kensington PA 15068

http://www.spectrochemicalme.com

Chemical testing services are used to evaluate glass, ceramics, raw materials, cements and concretes, slag, corrosion, refractory bricks and castings, anions, and aggregates.

SPECTRONICS CORP 800-274-8888
956 Brush Hollow Rd Fax: 516-491-6868
Westbury NY 11590

http://spectroline.com
info@spectroline.com

Manufactures UV lamps used to cure ceramics, adhesives, and coatings in applications ranging from windshield repair to spot curing on PC boards. Offer radiometers to check the intensity of UV lamps for curing. Lamps also custom-made for specific curing.

SPONTANEOUS MATERIALS 303-955-8537
8505 E Temple Dr Unit 474
Denver CO 80237

http://spontaneousmaterials.com
strout@ieee.org

A consultancy specializing in the rare earths, magnetic materials, technical training, and technical writing.

SPRAY DRYING SYSTEMS INC 410-549-8090
5320 Enterprise St Ste J Fax: 410-549-8091
Eldersburg MD 21784

http://www.spraydrysys.com
sales@spraydrysys.com

Designs and sells spray dryers. SDS spray dryers produce free-flowing ceramic powders with a controlled particle size. High yields and quality products, at competitive pricing.

SRI INTERNATIONAL 650-859-2000
333 Ravenswood Ave
Menlo Park CA 94025-3493

http://sri.com
customer-service@sri.com

An independent, nonprofit research institute conducting client-sponsored R&D for government agencies, commercial businesses, foundations, and other organizations.

STAHLI USA INC 847-719-0360
200 Sheridan Springs Rd Fax: 847-719-0361
Lake Geneva WI 53147

http://stahliusa.com
s.nelson@stahliusa.com

Stahli is one of the leading companies worldwide in the manufacture of flat honing, lapping, and polishing machines. To our customers, we are known just as much by our standard products as by our custom-made and need-oriented special products.

STARFIRE SYSTEMS INC 518-899-9336
8 Sarnowski Dr Fax: 518-289-2261
Glenville NY 12302

http://starfiresystems.com
info@starfiresystems.com

Offers the solution for high-temperature materials creating high-performance products. Our chemistry enables control of molecular structures combining ceramic materials with other materials to produce composites, laminates, and coatings.

STEDMAN MACHINE CO 812-718-4471
129 Franklin St Fax: 812-926-3482
Aurora IN 47001

http://stedman-machine.com
sales@stedman-machine.com

Since 1834, Stedman provides customers with material size reduction solutions for crushing, pulverizing, fine grinding, blending, or lump breaking a broad range of materials for applications from +40 inches to 10 microns.

STUDIOLX - HOME DECOR 888-423-5959
PO Box 563
Lincolnshire IL 60069

http://studiolx.com
info@studiolx.com

Traditional and contemporary ceramic vases, bowls, platters, and other decorative objects. Contemporary, decorative, and colored art glass vases, bowls, and platters.

SUNROCK CERAMICS

SUNROCK CERAMICS CO 708-344-7600
2625 S 21st Ave Fax: 708-344-7636
Broadview IL 60155

http://www.sunrockceramics.com
info@sunrockceramics.com

U.S. manufacturer of high-alumina ceramics and specialty refractories, including kiln furniture for firing advanced ceramics. Many formulations available for demanding high-temperature applications with a wide assortment of pressed or cast shapes, plus flexibility to quickly and economically make new and custom shapes.

SUNTECH ADVANCED CERAMICS (SHENZHEN) CO LTD
1F&2F Building B No 21 +86 755 2658 4521
Nanling Rd New2 Community Fax: +86 755 2600 9083
ShaJing StBaoAn District ShenZhen China

http://www.suntechceramics.com
info@esuntech.com

Design, development, and manufacture of mechanical ceramic components, with batching, mixing, molding, sintering, and machining of ceramics fully in house.

SUPERIOR GRAPHITE
INNOVATING SINCE 1917

SUPERIOR GRAPHITE CO 800-325-0337
10 S Riverside Plaza Ste 1470 Fax: 312-559-9064
Chicago IL 60606

http://www.superiorgraphite.com
CustomerServiceUSA@SuperiorGraphite.com

Produces alpha- and beta-SiC powder for use in sintered wear parts, toners, MMCs, and abrasives. Produces PS SiC tile for armor. Produce advanced (graphite) materials for use in many industries.

Superior Technical Ceramics
Engineering. Partnership. Solutions.

SUPERIOR TECHNICAL CERAMICS CORP 802-527-7726
600 Industrial Park Rd Fax: 802-527-1181
St Albans VT 05478

http://www.ceramics.net
sales@ceramics.net

Established 1898. Manufactures custom technical ceramics components using extruding, dry-pressure, isopressing, injection molding, green-forming, and diamond-machining techniques. Also manufactures prototype-through-production quantities on contract.

SURMET CORP 781-272-3969
31 B St Fax: 781-272-9185
Burlington MA 01803

http://www.surmet.com
sales@surmet.com

A specialty materials manufacturing company known for its leadership in ALON, the superior lightweight transparent armor. Surmet's transparent spinel is stronger and tougher. Surmet produces and supplies aluminum nitride powder/products in tons.

TA INSTRUMENTS 302-427-4000
159 Lukens Dr Fax: 302-427-4001
New Castle DE 19720

http://thermophysical.tainstruments.com
info@tainstruments.com

TA Instruments, the world leader in thermal analysis, rheology, and calorimetry, provides innovative technology for advanced materials characterization by DSC/TGA, dilatometry, thermal conductivity and diffusivity, high temp viscometry, and more.

TABER INDUSTRIES 716-694-4000
455 Bryant St Fax: 716-694-1450
North Tonawanda NY 14120

http://www.taberindustries.com
sales@taberindustries.com

Manufacturer of test instruments that aid the understanding of material physical properties including abrasion and scratch resistance. Test results assist R&D, process control, and quality assurance for ceramics, coatings, and other materials.

TAKASAGO INDUSTRY CO LTD +81 572-59-8899
2321-2 Dachi-cho Gifu Fax: +81 572-59-3848
Toki-city 509-54 Japan

http://www.takasago-inc.co.jp
hitoshi_ando@takasago-inc.co.jp

Designs and manufactures electric-heated and gas-fired industrial kilns. Specializes in roller hearth kilns, rotary kilns, tunnel kilns, periodic kilns including shuttle kilns, microwave kilns, microwave+electric or +gas hybrid kilns, various dryers, and more.

TAM CERAMICS 716-978-9403
4511 Hyde Park Blvd Fax: 716-278-9571
Niagara Falls NY 14305

http://www.tamceramics.com
customer.service@tamceramics.com

Leading manufacturer of high purity engineered powders including zirconia, titanate, and zircon-based materials for a variety of industries and applications. Provides services such as custom toll processing and materials recycling.

TECHNICAL PRODUCTS INC 800-869-2008
PO Box 189 Fax: 262-335-3606
Hubertus WI 53033

http://technicalproductsinc.com
tpi@technicalproductsinc.com

One of the largest Macor distributors in the world with expertise in machining, engineering, specifying, developing, and manufacturing simple or complex designs to precise tolerances in high-tech ceramics and plastics.

TECHNISONIC RESEARCH INC 203-368-3600
328 Commerce Dr Fax: 203-368-1922
Fairfield CT 06825

http://technisonicinc.com
tonyr@technisonic.net

Manufactures ultrasonic transducers for nondestructive testing applications, including flaw detection, thickness gauging, and weld inspection. Medical and industrial types are offered.

TECHNOLOGY ASSESSMENT AND TRANSFER INC (TA&T)
133 Defense Hwy Ste 212 410-224-3710
Annapolis MD 21401 Fax: 410-224-4678

http://techassess.com
info@techassess.com

Technology Assessment and Transfer Inc (TA&T) is a Small Business Administration certified Woman Owned Small Business (WOSB) that specializes in high technology, developing, and commercializing advanced materials for defense, biomedical, and industrial applications. TA&T strives to commercialize its innovations through cooperative development programs with end users and technology licensing to interested third parties.

TECHNOLOGY OF MATERIALS 800-682-2922
4020 N Palm St Ste 202 Fax: 714-446-9229
Fullerton CA 92835

http://xraydiffrac.com
sam@xraydiffrac.com

Analytical lab specializing in analysis of materials using XRD (Rietveld quantification and size/strain), thermal analysis (DTA/TG), microscopy (SEM/EDS), and FTIR. Also specializes in clay and soil mineralogy.

TEETER MARKETING SERVICES LLC 716-510-1408
115 Sand Dollar Ln
Sarasota FL 34242-1335

cereng19@aol.com

Provides industrial market research, business planning, product development and introduction, marketing communications, and education and training services for companies in the high-performance materials field. Serves as managing director for SECA.

TEMPO PLASTIC 559-651-7711
1227 N Miller Park Ct 559-651-0123
Visalia CA 93291

http://tempogloss.com
tempo@tempo-foam.com

Stock and custom protective packaging for wafers and substrates. Automated foam molding process.

TETHON 3D 402-889-6191
719 South 75th St
Omaha NE 68114

http://www.tethon3d.com
info@tethon3d.com

Tethon 3D is revolutionizing ceramic additive manufacturing with innovative materials and hardware.

TevTech
MATERIALS PROCESSING SOLUTIONS

TEVTECH LLC 978-667-4557
100 Billerica Ave Fax: 978-667-4554
North Billerica MA 01862

http://www.tevtechllc.com
sales@tevtechllc.com

TevTech delivers state-of-the-art materials processing high-temperature vacuum furnace systems and components that enable your company to maintain its competitive edge.

TEXERS TECHNICAL CERAMICS INC 647-866-1047
7171 Yonge St Fax: 855-383-5483
Thornhill ON Canada

http://texers.com/index.html
info@texers.com

Texers Inc is a growing international technical ceramics company. It designs, produces, and supplies ceramic products and components engineered to customer needs. Texers supplies a wide spectrum of industries, including automotive and aerospace; medical and healthcare; oil, gas, and petrochemical; energy and environment; and food and agriculture.

THE AMERICAN CERAMIC SOCIETY 866-721-3322
550 Polaris Pkwy Ste 510 Fax: 240-396-5637
Westerville OH 43082

http://ceramics.org
customerservice@ceramics.org

The American Ceramic Society (ACerS) is a nonprofit professional society for individuals involved in materials science and engineering. The Society's mission is to advance the study, understanding, and use of ceramics and related materials, for the benefit of our members and society.

THE FURNACE SOURCE LLC 860-582-4201
99 Agney Ave Fax: 860-584-8854
Terryville CT 06786

http://thefurnacesource.com
info@thefurancesource.com

The Furnace Source is a manufacturer and reseller of vacuum furnaces, sintering furnaces, vertical bell furnaces, and much more.

THERMAL PRODUCTS CO INC 770-662-0456
4520 S Berkeley Lake Rd Fax: 770-242-6210
Berkeley Lake GA 30071-1639

http://www.thermalproductsco.com
info@thermalproductsco.com

Fabricates and distributes ceramic fiber and biosoluble insulation, ceramic fiber modules, and SiC heating elements. Die-cutting & slitting capabilities of insulation. Ceramic fiber braids for kiln car seals and door gaskets. Large modules for kilns.

THERMAL WAVE IMAGING INC 248-414-3730
845 Livernois St Fax: 248-414-3764
Ferndale MI 48220

http://thermalwave.com
sales@thermalwave.com

Thermal Wave Imaging is the leading innovator and provider of state-of-the-art thermographic nondestructive testing (NDT) solutions ranging from low-cost portable systems for field applications to highly sophisticated automated inspection equipment for manufacturing QA. Our products are designed to meet critical needs of aerospace, power generation, and automotive OEMs and suppliers.

Thermcraft
incorporated

THERMCRAFT INC 336-784-4800
3950 Overdale Rd 336-784-0634
Winston Salem NC 27107

http://www.thermcraftinc.com
info@thermcraftinc.com

Provides furnaces for industrial, R&D, OEM, and end users for all industries. Manufactures lab- and industrial-heating elements, furnaces, and control systems. Systems are available for temperatures up to 1,700°C.

THERMOCARBON INC 407-834-7800
391 Melody Ln
Casselberry FL 32707

http://www.dicing.com
frankc@thermocarbon.com

Manufactures diamond resin wheels.

THROUGHPUT BLUESTREAK 888-785-0509
1805 Sunset View Dr
Delafield WI 53018

http://www.go-bluestreak.com
jeff.somenske@go-bluestreak.com

Bluestreak Software is enterprise-level manufacturing software designed specifically for process-based manufacturers that work with ceramics powder/paint, metal finishing, heat treat, and more. Bluestreak manages real-time information across manufacturing departments.

TOTO LTD +81 467-54-3310
Honson Kanagawa-Pref
Chigasakai-City 253-8577 Japan

http://www.toto.com

New technology demands ceramic materials with higher performance and improved functions in terms of design, durability, thermal resistance, and electrical characteristics. Toto has a reputation for making quality ceramics for the semiconductor manufacturing equipment industry. It is known for manufacturing high precision ceramic products, including air bearings, electrostatic chucks, and bonding capillaries.

TOYAL AMERICA INC 630-505-2170
1717 N Naper Blvd Fax: 630-505-2176
Naperville IL 60563

http://toyala.com
nicolas.justeau@toyala.com

Producer and distributor of various grades of aluminum nitride for sintering. Also produces silica coated aluminum nitride with excellent thermal conductivity properties. Atomized spherical and conventional aluminum powders are offered.

TOYOTA CENTRAL R&D LABS INC +81 561-63-6569
41-1 Yokomichi
Nagakute Aichi 480-1192 Japan

http://www.tytlabs.com

Producer and distributor of various grades of aluminum nitride for sintering. Also produces silica coated aluminum nitride with excellent thermal conductivity properties. Atomized spherical and conventional aluminum powders are offered.

TRANS-TECH INC 301-695-9400
5520 Adamstown Rd
Adamstown MD 21710

http://www.skyworksinc.com/Products_TechnicalCeramics.aspx
RFCeramics@skyworksinc.com

Skyworks Solutions, through its wholly-owned subsidiary Trans-Tech, is an industry leader in technical ceramic materials. With over 60 years of experience, the company offers a complete line of high-quality, low-cost, ceramic-based materials for many RF and microwave markets, including wireless communications, infrastructure, military, cable television, and broadband access. Tightly controlled processes—from raw materials to forming, firing, finishing, assembling, and testing—produce the best and most consistently reproducible components available today for both low and high volume requirements. Product portfolio includes advanced materials (in both technical powder and ingot form) as well as dielectrics, ferrites, and magnetics.

TREIBACHER INDUSTRIE AG +43 4262 505310
Auer-von-Welsbach-Straße 1 Fax: +43 4262 5058310
Althofen 9330 Austria

http://www.treibacher.com
treibacher@treibacher.com

Treibacher Industrie AG is an international company with over 100 years experience in chemistry and metallurgy. At its headquarters in Althofen, Austria, Treibacher Industrie AG develops and manufactures ferro alloys for the steel and foundry industries, powders for the carbide industry, high performance ceramics, fine chemicals, and special alloys. Our customers value our high product quality, flexibility, and customized solutions.

TRENT INC 215-482-5000
201 Leverington Ave Fax: 215-482-9389
Philadelphia PA 19127

http://trentheat.com
trentheat@aol.com

Manufactures electrically heated process equipment for industrial applications. Manufactures furnaces and ovens for the glass and ceramics industries as well as replacement heating elements.

TRI-MER CORP 801-294-5422
1400 Monroe St Fax: 989-723-7844
Owosso MI 48867

http://www.tri-mer.com
kevin.moss@tri-mer.com

Glass furnace emissions: UltraCat Catalyst Filters are the technology of choice for container and flat glass. Also kilns, ceramic production, and cement. Remove any combination of PM, SO_x, and NO_x, HCl, HF, and metals to below EPA standards.

TRINITY CERAMIC SUPPLY INC 214-631-0540
9016 Diplomacy Row Fax: 214-637-6463
Dallas TX 75247

https://trinityceramic.com
trinityceramic@sbcglobal.net

Established 1950. Distributes raw materials and chemicals to the tile, sanitaryware, brick, porcelain enamel, artware, and hobby industries. Inventories include opacifiers, kaolins (foreign and domestic), feldspars, nepheline syenite, ball clays, and more.

U.S. SILICA CO 800-345-6170
8490 Progress Dr Ste 300 Fax: 304-258-8295
Frederick MD 21740

http://www.ussilica.com
sales@ussilica.com

Produces aplite, round angular and subangular whole-grain sand, ground silica, fine-ground silica, and assorted clay materials. Materials available in bulk and bagged quantities.

UNIFRAX I LLC 716-768-6400
600 Riverwalk Pkwy Ste 120 Fax: 716-768-6500
Tonawanda NY 14150

http://unifrax.com
info@unifrax.com

Global leader in the development and manufacture of high-temperature insulation products including Fiberfrax ceramic fiber, and revolutionary Insulfrax and Isofrax soluble fiber products.

UNIMIN CORPORATION 203-966-8880
258 Elm St Fax: 203-966-3453
New Canaan CT 06840

http://www.unimin.com
ContactUs@QualityCeramics.com

Unimin offers a complete portfolio of fillers, fluxes, clays, custom blends, and prepared bodies. Engineered to the highest quality standards, we supply the global ceramic industry with proven, performance-oriented industrial minerals.

UNION PROCESS INC 330-929-3333
1925 Akron-Peninsula Rd Fax: 330-929-3034
Akron OH 44313

http://unionprocess.com
unionprocess@unionprocess.com

Union Process manufactures a broad line of particle size reduction equipment such as wet and dry grinding attritors and small media mills, in laboratory and production sizes. We also offer a wide assortment of grinding media and provide toll milling, laboratory testing, and refurbishing services.

UNIVERSIDAD AUTONOMA DE NUEVO LEON +52 81 8352 1984
Fax: +52 81 8376 0477
Instituto de Ingenieria Civil Av Universidad s/n Cd
Universitaria San Nicolas de los Garza
Nuevo Leon 66450 Mexico

http://www.uanl.mx
infoecomateriales@gmail.com

Universidad Autonoma de Nuevo Leon is a public university with seven campuses across Nuevo Leon, Mexico. It is the oldest and largest university in the state in terms of student population.

UTTAM INDUSTRIES +91 240 773 48
708 Gidc Sector 28
Gandhinagr India

http://www.uttamzincoxide.com
uttamrajiv@hotmail.com

Manufacturing zinc oxide since 1990.

VALLEY DESIGN CORP 978-425-3030
Two Shaker Rd Bldg E-001 Fax: 978-425-3031
Shirley MA 01464

http://valleydesign.com
info@valleydesign.com

Manufactures substrates, windows, wafers, shims, and spacers from ceramics, glass, and metals. Precision lapping, polishing, 4-axis CNC machining, dicing, edge-polishing, thinning, grinding services. Specializes in ultrathin, ultraflat, superpolishing.

VANDERBILT MINERALS, LLC 203-295-2140
33 Winfield St Fax: 203-855-1220
Norwalk CT 06856-5150

http://www.vanderbiltminerals.com
mineralsales@vanderbiltminerals.com

Vanderbilt Minerals LLC specializes in industrial minerals and chemicals, including kaolin clays, pyrophyllite, wollastonite, smectite and hectorite clays, dispersing agents, and xanthan gum.

VELCO GMBH
Haberstr 40 Velbert
North Rhine-Westphalia 42551 Germany

https://www.velco.de
info@velco.de

Produces gunning machines for dry and humid/plastic mixes, gunning robots for hot repair of EAF, ladle, RH, and more. Pneumatic injection machines for the steel industries. Using the patented GUNMIX system, it is possible to apply LC qualities in dry gunning with low dust and rebound.

VERDER SCIENTIFIC INC 866-473-8724
11 Penns Trail Ste 300 Fax: 267-757-0358
Newtown PA US 18940

https://www.verder-scientific.com
info-us@verder-scientific.com

Verder Scientific Inc, comprised of the Retsch, Retsch Technology, Carbolite Gero, and ELTRA brands, sets the standard in high-tech scientific equipment, serving research institutions and analytical laboratories, as well as manufacturing companies, for decades. The company manufactures and supplies instruments for sample preparation and elemental analysis as well as heat treatment of solid materials.

VERITY TECHNICAL CONSULTANTS LLC 614-440-1306
1266 Dobbins Dr
New Albany OH 43054-9409

http://www.verityconsultants.com
djeter@verityconsultants.com

Verity provides manufacturing consulting, technical investigations, analysis, reports, and testimony for the resolution of litigation and claims involving failures of glass and ceramic materials, product liability, and industrial workplace accidents.

VESUVIUS 843-774-6026
753 Enterprise Rd Fax: 843-774-3735
Dillon SC 29536

http://www.vesuvius.com
Marcus.Bancroft@vesuvius.com

Vesuvius is a worldwide leader in advanced ceramics for the solar, glass-tempering, and glass-forming industry.

VIRIDIS3D LLC 978-455-0131
92 Bolt St
Lowell MA 01852

http://www.viridis3d.com
sales@viridis3d.com

Develops and commercializes materials for advanced applications in additive manufacturing, including technical and art ceramics and metal casting. Provides complete solutions with hardware, software, installation, training, and materials.

VITCAS LTD +44 117 911 7895
8 Bonville Rd Fax: +44 117 971 1152
Brislington Bristol BS4 5NZ UK

http://www.vitcas.com
info@vitcas.com

British manufacturer of refractory cement, fire cement, refractory castables, fire bricks, ceramic fiber products, acid resistant cements, zircon refractory products, coatings, tap hole clays, refractory mouldables, taming mix, and high alumina mortars.

WASHINGTON MILLS ELECTRO MINERALS CO
1801 Buffalo Ave 716-278-6600
Niagara Falls NY 14302 Fax: 716-278-6650

http://www.washingtonmills.com
info@washingtonmills.com

Manufactures fused synthetic minerals for use in refractory raw materials, abrasives, ceramic raw materials, and industrial applications. Products include silicon carbide, brown fused alumina, white fused alumina, boron carbide, bubble alumina, and more.

WERNER G SMITH INC 216-861-3676
1730 Train Ave Fax: 216-861-3680
Cleveland OH 44113-4201

http://wernergsmithinc.com

Werner G Smith Inc produces biodegradable, biosustainable, and biorenewable additives most commonly used in machining and metal working, cleaners, personal care products, and coatings and paint. Ingredients are from earth-friendly sources and have been since 1950.

WESBOND CORP 302-655-7917
1135 E 7th St Fax: 302-656-7885
Wilmington DE 19801

http://wesbond.com
sales@wesbond.com

Established 1976. Develops and manufactures new binding and bonding systems for refractory-fiber shapes and ceramic composites as well as ceramic shell molds for investment castings. Products include colloidal alumina, and silica and mullite binders.

WILLIAMS PATENT CRUSHER & PULVERIZER CO INC
2701 N Broadway 314-436-2639
St Louis MO 63102 Fax: 314-621-3348

http://williamscrusher.com
info@williamscrusher.com

Offers a complete line of processing equipment for the ceramics industry, including primary and secondary impact crushers, nonclog hammer mills, single- and double-roll crushers, impact dryer mills, roller mills, and direct-fired coal pulverizers.

WINNER TECHNOLOGY +82 31-683-1867
14-12 Geumgok 3-gil Anjung-eup Fax: +82 31-683-1870
Pyeongtaek-si Gyeonggi-do Korea

http://www.winnertechnology.co.kr
info@winnertechnology.co.kr

Winner Technology specializes in research, development, and production of $MoSi_2$ heating elements for 1,700°C, 1,800°C, and 1,900°C. It exports more than 1,000 pieces worldwide. Winner offers distinguished products at reasonable prices and is trusted by domestic and international customers, including those in Germany, Italy, Spain, Taiwan, Japan, Poland, and Austria.

WISTRA GMBH +49 221 2820890
Wilhelm-Mauser-Strasse 41-43 Fax: +49 221 28208925
Koln 50827 Germany

http://www.wistra.com
info@wistra.com

Wistra GmbH, part of the Cerinnov group, manufactures thermal equipment, sintering units, and turnkey plants and supplies the technical ceramics market with global performance solutions. It also revamps existing equipment.

WYSSMONT CO 201-947-4600
1470 Bergen Blvd Fax: 201-947-0324
Fort Lee NJ 07024

http://wyssmont.com
sales@wyssmont.com

Provides continuous equipment systems for drying, calcining, cooling, activating, regenerating, and solids handling (lump breakers, rotary air locks, multiple screw feeders). Observation ports available. Test facilities and in-plant rental units.

XIAMEN INNOVACERA ADVANCED MATERIALS CO LTD +86 592 558 9730
A506-507 No 7 Yu'nan Fourth Road Fax: +86 592 558 9733
Huli District Xiamen Fujian China 361006

http://www.innovacera.com
sales@innovacera.com

With more than 20 years experiences in technical ceramic solutions, Innovacera manufactures products made of technical ceramics for customer-specific applications. Products include metallized ceramic components, alumina ceramic heater, ceramic pump components, and other ceramic components. All of our products are underpinned by the most rigorous quality accreditation.

XIAMEN UNIPRETEC CERAMIC TECHNOLOGY CO LTD
No 151 Yuehua Rd Huli District +86 592 551 0319
Xiamen Fujian 361006 China

http://www.unipretec.com
info@unipretec.com

Unipretec is a professional manufacturer for advanced ceramics. Our materials include alumina ceramic, zirconia ceramic, boron nitride, and machinable glass ceramic. We aim to provide high quality products and solutions for our customers.

YOUNG INDUSTRIES INC 570-546-3165
16 Painter St Fax: 570-546-1888
Muncy PA 17756

http://younginds.com
mktinfo@younginds.com

Designs and manufactures process equipment, including size reduction and classification, mixing and blending, air pollution control, and pneumatic conveying systems. Operations include national sales network and engineering services.

ZENITH 573-889-6795
No 416 Jianye Rd S Jinqiao Area
Pudong Shanghai 201206 China

http://www.miningplant.org
info@miningplant.org

We hold "Pursuing the Zenith Technology and Quality" as our management concept all the time. In addition to our full efforts, we rely on world-leading absorbing, crushing, and powder processing technology; advanced management; and a quality control system.

ZHENGZHOU MISSION CERAMIC PRODUCTS CO LTD
No 11 Zhengshang Rd +86 371 5668 9683
Zhengzhou Henan 450000 China
Fax: +86 371 6710 3091

http://www.mscera.com
frank@mscera.com

We are a professional manufacturer of high purity alumina (99.7%) and zirconia tubes, rods, plates, balls, crucibles, boats, nozzles, and other custom-made special parts. Large quantity in stock, with very competitive prices.

ZIBO GUANGTONG CHEMICAL CO LTD +86 136 9765 7735
No 27 London Rd Fax: +86 532 8676 6180
Qingdao Free Trade Zone
Shandong 266555 China

http://www.gtchems.com
sales@gtchems.com

Zibo Guangtong Chemical is one of the leading manufacturers in China for diacids, diols, and zirconia products. Main products are zirconium compounds, including zirconium oxychloride (CAS No.: 7699-43-6), zirconium dioxide (CAS No.: 1314-23-4), and zirconium carbonate.

ZILI USA LLC
149 Nichol Ave No 2
McKees Rocks PA 15136

http://www.zilialutech.com
jsum@ziliref.com

Zili USA is a subsidiary of Zhejiang Zili Alumina Materials Co Ltd, specializing in high-purity alumina materials development and manufacturing. Its products include tabular alumina, low sodium alumina, reactive alumina, and calcined alumina. With warehouses situated in the states, Zili has fully stocked inventories ready for shipment.

Products are widely used in refractories, including sliding gate, purging plug brick, nozzles, well blocks, as well as kiln furniture, electronic industries, petrochemical industries, and ceramic industries.

ZIRCAR CERAMICS INC 845-651-6600
100 N Main St Fax: 845-651-0441
PO Box 519
Florida NY 10921-0458

http://zircarceramics.com
sales@zircarceramics.com

ZIRCAR Ceramics Inc manufactures ceramic fiber based high temperature thermal and electrical insulation products for use at temperatures up to 1,825°C. Offering boards, cylinders, blankets, papers, textiles, coatings, and adhesives. Furnace insulation assemblies, resistance heated modules, and a special emphasis on precision custom CNC machined components. Legendary heritage in high performance!

ZIRCAR REFRACTORY COMPOSITES INC 845-651-2200
PO Box 489 Fax: 845-651-1515
Florida NY 10921

http://zrci.com
sales@zrci.com

Manufactures and markets a wide range of high-temperature (up to 1,825°C) thermal insulation and heating (up to 1,900°C) element products and castertip (aluminum strip) products. Standard products consist of boards, blankets, papers, cements, and particulates.

ZIRCAR ZIRCONIA INC 845-651-3040
PO Box 287 Fax: 845-651-0074
Florida NY 10921

http://www.zircarzirconia.com
sales@zircarzirconia.com

For more than 40 years, Zircar has produced yttria stabilized zirconia, pure zirconia, alumina, ceria and yttria felts, cloths and rigid vacuum formed shapes for insulation in crystal growing, powder metal sintering, fuel cells, furnace construction, quartz working and filtration membranes. Our insulation products stand up to the hottest, most corrosive environments providing lasting solutions to your biggest challenges.

ZIRCOA INC 440-248-0500
31501 Solon Rd Fax: 440-248-8864
Solon OH 44139

http://zircoa.com
sales@zircoa.com

Zircoa tailors and manufactures zirconia products to meet extreme conditions in temperature, mechanical stress, and corrosion required to improve industrial processes. Examples of our products include a unique granular zirconia; crucibles for investment casting; refractories for steel, powder metallurgy, glass, quartz, crystal growth, and carbon black; beads and grinding media for dispersion and milling; dies for extrusion of nonferrous metals and other forming methods; and components for oil and gas.

ZSCHIMMER & SCHWARZ 478-454-1942
70 Georgia Hwy 22 W Fax: 478-453-8854
Milledgeville GA 31061

http://zschimmer-schwarz.com
pcuthbertzsus@windstream.net

Manufactures special chemical products for the ceramics industry. Plants in United States, Germany, Italy, Spain, and Brazil.

Z-SYSTEMS USA INC 781-754-6566
284 Monponsett St Ste 209 Fax: 781-754-6565
Halifax MA 02338

http://www.zsystemsusa.com
support@zystems.com

Expert for metal-free dental implants; ceramic implant systems Z-Look3 and Z-Look3 EVO are made of a special zirconia, ZrO2-TZP-A-Bio HIP; special production process fulfills requirements of implantology as well as metal-free and cosmetic dentistry.

ZYP COATINGS INC 865-482-5717
120 Valley Court Fax: 865-482-1281
Oak Ridge TN 37830

http://zypcoatings.com

Produces specialized coating formulations, primarily refractory coating for reactive-metal melting and transport, high-temperature lubricants and release agents, and high-temperature marking inks. Worldwide sales.