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contents

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feature articles



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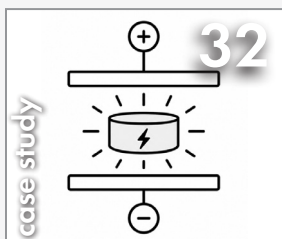
The Society will honor members and Corporate Partners at the Annual Honors and Awards Banquet during the 128th ACerS Annual Meeting in October 2026 to recognize significant contributions to the engineering ceramic and glass field.



Noncubic-structured transparent ceramics: Overcoming birefringence through improved structure–property understanding

This article demonstrates how a deeper understanding of the relationship between microstructure and optical properties in noncubic-structured ceramics could enable their design for widespread optical applications.

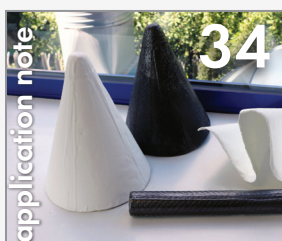
By Akio Ikesue



Leveraging electric fields for enhanced properties: A case study on TiO₂

While reaction kinetics can override the thermodynamic guidelines shown in phase diagrams, electric fields offer another lever to push materials past their solubility limits and create compositions with properties no standard equilibrium route allows.

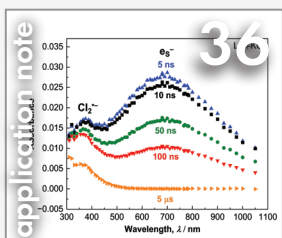
By Shikhar Krishn Jha



CMCs in application: Exploring the pros and cons of different ceramic matrix composites

Since ceramic matrix composites began development in the 1970s, many types have been developed to address various industry needs. This article overviews the advantages and disadvantages of each type.

By Chris Thompson



Radiation effects on rare earth chemistry in molten salts for nuclear applications

Recent findings by Idaho National Laboratory researchers highlight the importance of considering both radiation-driven and electrochemical pathways when evaluating multivalent rare earth element behavior in molten salts.

By Stephanie Castro Baldovino, Jacy K. Conrad, and Gregory P. Horne

departments

News & Trends	3
ACerS Spotlight	10
Research Briefs	16
Ceramics in the Environment	17

industry

Business and Market View	6
Lead-free piezoelectric ceramics: Technologies and global opportunities	
By BCC Publishing Staff	
Industry Perspectives	7
Why most AI manufacturing projects fail and how to fix it	
By Tim Beatty and John Liddy	
Industry Insights	8
Next-gen superconducting ceramics could change how we travel and much more	
By David Holthaus	

columns

Journal Highlights	38
Breaking the mold: Cutting-edge research involving contrary ceramics	
By Brittney Hauke	
Deciphering the Discipline	44
Polycrystalline transparent ceramics: Developing optical materials for extreme environments	
By Joseph Tallan	

meetings

Ceramics Expo 2026 highlights	39
Upcoming meetings	40

resources

Calendar	41
Classified advertising	42
Ad index	43

Cover image credit: Transparent noncubic-structured alumina disk observed by mid-infrared camera. Credit: Akio Ikesue

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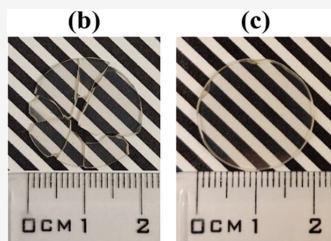


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As seen on Ceramic Tech Today...



Credit: Thof et al., *J. Am. Ceram. Soc.* (CC BY 4.0)

Fabricating transparent ceramics: Four studies provide a glimpse into several different systems

In the May 2026 issue of *Journal of the American Ceramic Society*, four studies provided a close look at the fabrication and application of several different transparent ceramic systems.

Read more at <https://ceramics.org/transparent-ceramic-fab>

Also see our ACerS journals...

Elaboration and characterizations of glasses/glass-ceramics in the $\text{Na}_2\text{O}-\text{V}_2\text{O}_5-\text{TeO}_2$ system for energy storage applications

By R. Piotrowski, J.-P. Laval, P.-M. Geffroy, et al.

International Journal of Applied Glass Science

In situ SrF_2 crystallization in transparent germanate glass-ceramics driven by erbium for NIR and MIR applications

By A. Deslandes, T. Guérineau, T. Meyneng, et al.

Journal of the American Ceramic Society

Materials and architectures for laminated-glass transparent armor systems: A review

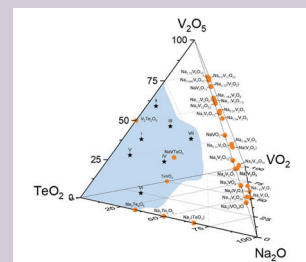
By S. Thimounier Ferreira and S. Marcio Toffoli

International Journal of Ceramic Engineering & Science

Aging effects on PTCR ceramics: SEM and C-AFM analysis of electrical conductivity and domain structures

By K. Koller, F. Ulč, P. Sokola, et al.

International Journal of Applied Ceramic Technology



Credit: Piotrowski et al., *IJAGS*



Read more at <https://ceramics.org/journals>

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ACSBA7, Vol. 105, No. 7, pp. 1–44. All feature articles are covered in Current Contents.

news & trends

Light-reflecting satellites could bring new challenges for astronomers

When governments first started launching satellites and probes in the 1950s, space seemed like an endless, empty void prime for development. But with private companies now also launching vehicles, low-Earth orbit has become one of the world's most heavily trafficked and cluttered environments.

Concerns about this congestion started catching public attention in 2019, when SpaceX launched the first 60 of its planned 42,000-satellite constellation. Since then, more companies have jumped on the private space train, and there are now about 16,000 active satellites currently orbiting Earth. However, the total number of trackable artificial

objects, including defunct satellites and larger debris fragments, exceeds 45,000—more than double the approximately 23,000 trackable objects prior to 2020.

We are now grappling with the realization that outer space does have a limit, one which may be shrinking due to changes in the Earth's atmosphere. As a result, more companies are adopting "design for demise" protocols to reduce the amount of debris left floating in space. However, astronomers may soon be dealing with another challenge to their nightly observations: satellites purposefully designed to reflect light.

Until now, satellites have mainly obstructed astronomical observations

through incidental reflections, or the unintentional bouncing of sunlight off their surfaces. Some companies have taken measures to reduce reflection, but others are creating satellites intentionally designed to reflect light.

Reflect Orbital is a California-based aerospace company that designs light-reflecting satellites to reportedly provide customers with light at any time. This light could be used to extend working hours on industrial sites, to aid with search-and-rescue missions, or to expand solar energy generation potential, according to the company's website.

In early July 2026, the Federal Communications Commission approved



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Reflect Orbital's satellite license, meaning the company has secured the necessary radio spectrum license to launch its test satellite. Notably, this license only clears communications and telemetry for the one test, not the company's long-term vision of a 50,000-satellite constellation.

Before the license was granted, the American Astronomical Society filed a petition to deny it on the grounds that the light-reflecting design could cause "catastrophic interference with federally funded astronomical research." However, the FCC stated in its approval that "concerns about Earendil-1's impacts on optical astronomy fall outside our review and authorization of the space station."

In a press release following the decision, AAS argues that this reasoning "implies that the Commission would also have no ability to consider the severe implications of a constellation of 50,000 solar reflectors like that envisioned by Reflect Orbital." But while the

FCC is taking a back seat in this situation, the Department of Commerce's Office of Space Commerce is working on a voluntary certification process to authorize novel space activities outside the regulatory authority of other agencies.

For its part, Reflect Orbital says in a press release that it is "committed to seeking out engagement and dialogue" with the astronomy community to conduct its operations "in a way that preserves the night sky." These measures will include establishing exclusion zones to protect astronomical research sites and sharing satellite positions in advance so researchers can plan around the satellites.

The FCC license also includes a nonformal commitment to coordinate with NASA and the National Science Foundation to protect optical astronomy. However, as the AAS pointed out in their press release, previous licenses for other satellite operators have required a formal coordination agreement. ■

Corporate Partner news

Beralmar Energies attends Hispalyt Congress 2026

This June, Barcelona-based Beralmar Energies attended the Hispalyt Congress 2026, held in Bilbao, Spain. Beralmar Energies is a specialist in energy solutions for heavy clay industrial processes. The team shared their views with manufacturers and experts and strengthened their relationship with other members of the brick industry.

Read more: <https://www.beralmar.com/en/news>

Fritsch China location now the largest Fritsch laboratory in Asia

Fritsch Milling and Sizing completed the relocation and upgrade of its office in Beijing, China. The new location now serves as Fritsch's largest laboratory base in Asia. The integrated hub will feature on-site customer visits and equipment demonstrations, customized sample pretreatment and testing solutions, and hands-on technical training for agents and customers.

Read more: <https://www.fritsch-international.com/news/current-news/general-news>

Niron Magnetics receives 2026 Innovation Excellence Award for Science Advancement from Innovation Research Interchange

Rare-earth-free permanent magnets producer Niron Magnetics was recognized with the 2026 Innovation Excellence Award for Science Advancement by Innovation Research Interchange. The award honors individuals and organizations driving innovation, advancing sustainability, strengthening innovative cultures, applying digital technologies, expanding scientific discovery, and building collaborative approaches to solving complex industry challenges.

Read more: <https://nironmagnetics.com/news-press> ■



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Lead-free piezoelectric ceramics: Technologies and global opportunities

The global market for lead-free piezoelectric ceramics was valued at \$279 million in 2024 and is expected to grow at a compound annual growth rate (CAGR) of 12.3% to reach \$549.8 million by the end of 2030.

The toxic impacts of lead on human health and the environment are driving the shift toward eco-friendly alternative material choices for piezoelectric ceramics. Several perovskite-structured ceramics are leading the list of alternatives (Table 1).

- **Potassium sodium niobate (KNN):** KNN was the first lead-free piezoelectric material to be widely researched, and it still has the largest share of the market. KNN has a higher Curie temperature (400°C to 470°C) than other materials, which makes it ideal for medium- and high-temperature applications, but its overall piezoelectric performance still falls short of its conventional lead-based counterparts.
- **Bismuth sodium titanate (BNT):** BNT is considered an ideal replacement in actuator applications due to its higher Curie temperature (320°C) and field-induced strain. However, BNT is susceptible to volatilization of the bismuth and sodium during sintering, which leads to off stoichiometry, together with complexity in poling due to its high coercive field and a large conductivity. To overcome these challenges, solid solutions based on BNT are being researched.
- **Barium titanate (BT):** BT-based lead-free piezoelectric ceramics include barium zirconate titanate,

barium calcium tin titanate, and barium calcium zirconate titanate. These ceramics exhibit low dissipation and high stiffness under a high electric field. However, they have a low Curie temperature (120°C) and suffer from low piezoelectric performance and poor stability near room temperature because of phase transitions.

- **Others (nonperovskites):** Other lead-free alternatives that do not feature a perovskite structure include sodium lithium niobate, tungsten bronze structure, and bismuth layer-structured ferroelectrics.

Lead-free piezoelectric ceramics can be categorized into three configurations: monolith, multilayer, and thin film. Currently, monolith configurations, which consist of a single structural unit in the form of a block, disc, cylinder, ring, or plate, account for 70% of the market due to their applications in consumer electronics and optoelectronics.

The large design space for lead-free piezoelectric ceramics, comprising various dopant choices and unfixed content, has been a challenge when modifying lead-free compositions to improve their piezoelectric performance. However, machine learning is emerging as a tool that can aid in the prediction, design, and development of new lead-free materials with tailored properties.

The emergence of artificial intelligence, virtual reality, and Internet of Things-enabled devices is also driving the demand for lead-free piezoelectric ceramics in consumer electronics.

Besides consumer electronics, the ongoing transition to electric vehicles and advanced driver assistance systems in the automotive industry are expected to boost demand for electronic components and devices.

The Asia-Pacific region (led by China and Japan) accounts for 52% of the global market for lead-free piezoelectric ceramics. In North America, a growing number of companies are shifting their operations back home from overseas.

About the author

BCC Publishing Staff provides comprehensive analyses of global market sizing, forecasting, and industry intelligence, covering markets where advances in science and technology are improving the quality, standard, and sustainability of businesses, economies, and lives. Contact the staff at ereister@bccresearch.com.

Resources

BCC Publishing Staff, "Lead-free piezoelectric ceramics: Technologies and global opportunities," BCC Research Report NAN063C, July 2025. <https://bit.ly/July-2025-lead-free-piezoceramics> ■

Material	2024	2025	2030	CAGR % (2025–2030)
KNN	107,618.9	121,008.2	237,568.1	14.4
BNT	94,674.8	103,470.4	178,355.6	11.5
BT	66,969.7	72,453.6	118,754.9	10.4
Others	9,766.6	10,335.6	15,144.2	7.9
Total	279,030.0	307,267.8	549,822.8	12.3

industry perspectives

Why most AI manufacturing projects fail and how to fix it

Artificial intelligence is reshaping advanced manufacturing, especially processes involving ceramics, glasses, and other hard or brittle materials. But adopting AI is far more difficult than simply buying software and connecting machines. Manufacturers must understand the advantages and limitations of different models, so they can determine where AI fits best within their operations.

Manufacturers who do not critically plan out AI adoption often end up with promising pilots that never scale. A better approach is to treat AI as a long-term capability built on four pillars: data and infrastructure, disciplined use cases, scaling awareness, and people.

Data and infrastructure: Building AI readiness

Manufacturers often treat AI as a software installation process rather than as a data problem. AI can identify patterns that are difficult to detect through traditional statistical process control or legacy analysis tools, but only when the underlying information is reliable and contextualized.

Many manufacturing environments still operate with fragmented data spread across legacy machines, disconnected systems, and inconsistent collection methods. Before meaningful AI work can begin, manufacturers may need hardware upgrades, machine data tagging, reliable extraction methods, and systems to organize information.

At Bullen Ultrasonics, data and infrastructure efforts began taking shape in 2019. Since then, Bullen has collected more than 2 billion data points by implementing all the improvements suggested above.

Disciplined use cases: Defining business problems before adoption

Manufacturers often ask “Where can we use AI?” A better question is “Which manufacturing problem is worth solving?”

Broad experimentation can produce demonstrations without improving operations. Instead, strong AI initiatives begin with measurable objectives, such as improving yield, reducing cycle times, optimizing tool utilization, or identifying process relationships that are difficult to uncover when variables are analyzed independently.

Current testing at Bullen focuses on applying data-driven AI models to machining operations. Structured production data is used to investigate complex process variables and determine whether models can improve performance and consistency.

Scaling awareness: Identifying levels of readiness across departments

Even with a clear use case, manufacturers cannot assume the entire operation is equally ready for AI adoption. One area may have years of historical data, while another may have only recently automated collection, while a third may still need machine upgrades. Forcing all three onto the same AI timetable creates unnecessary risk.

A more practical approach is phased adoption. Start with a narrowly defined use case in an area with sufficient data and then test the model against representative information. Once the model is confirmed to produce operational value, then it can expand when the environment is ready.

At Bullen, some departments are further along than others. But all are scaling according to evidence and not executive enthusiasm.

People: Ensuring employee buy-in

Technical readiness alone is not enough. Even sound AI projects can struggle when employees see new technology as something being done to them rather than with them.

Bullen learned this lesson before today’s AI boom. When the company

introduced its first robot, leadership held open sessions to show employees how the system would operate on the shop floor. They also explained why Bullen was investing in robotics: to expand capabilities, create more customer value, and respond to marketplace needs.

AI adoption requires the same level of transparency. Employees need to understand the business problem, how roles may evolve, and where their expertise remains essential. Shop-floor knowledge, process experience, and engineering judgment should inform implementation rather than be treated as obstacles to automation.

These factors are especially important in advanced materials manufacturing. AI may uncover correlations, model possibilities, or point engineers toward unconventional machining approaches. It cannot replace the creativity required to decide what is physically plausible, commercially meaningful, and worthy of testing.

AI adoption: Expanding, not replacing, engineering judgment

The future is not AI replacing engineering judgment. Instead, AI is giving engineers a broader range of possibilities to explore.

Manufacturers who gain the most from AI will not necessarily be those that move first. They will be the ones who build strong data foundations, define meaningful problems, scale deliberately, and bring their people along for the journey.

About the authors

Tim Beatty is president and John Liddy is vice president of operations at Bullen Ultrasonics (Eaton, Ohio), a company specializing in the precision machining of advanced materials using ultrasonic and laser-based technologies. Contact Beatty at tbeatty@bullentech.com. ■

Next-gen superconducting ceramics could change how we travel and much more

Forty years ago, two physicists from IBM's research laboratory in Zürich, Switzerland, reported a groundbreaking discovery: Superconductivity, or the quantum mechanical phenomenon in which certain materials exhibit zero electrical resistance when cooled, could be achieved at higher temperatures using ceramics.

Superconductivity had been discovered decades before, but its applications had been limited due to the extremely low temperatures needed to make it happen. The IBM physicists, Georg Bednorz and K. Alex Muller, added barium to crystals of lanthanum copper oxide to produce a ceramic material that became the first successful "high-temperature" superconductor in 1986 with a limit of 35 K (more than 10 degrees above the previous record of 23.3 K set in 1973).

Ceramics are traditionally known for their electrical insulation characteristics, so the discovery that ceramics could set a new high-temperature superconductivity limit was groundbreaking. This breakthrough unlocked a new era of high-temperature superconductivity research around the world, and it resulted in the two scientists being awarded the Nobel Prize in physics the very next year.

Currently, many commercial products still use low-temperature metal alloy superconductors because their raw materials and manufacturing costs are cheaper, despite requiring costly liquid helium cooling. However, for nonstationary applications such as mobile intraoperative MRI systems, high-temperature superconductors are preferred because their cooling infrastructure is far less complex, making the device easier to transport.

High-speed magnetic levitation (maglev) trains are one of the most interesting developments in next-generation applications for high-temperature superconductors. These trains are suspended and propelled along the guideway by magnets, allowing them to travel at high speeds with minimal vibration and noise.

Two primary technologies are used to levitate maglev trains: electromagnetic suspension (EMS) and electrodynamic suspension (EDS). EMS systems use attractive forces between electromagnets on the train and ferromagnetic materials on the guideway to "pull" the train upward and maintain a stable gap. In contrast, EDS systems rely on repulsive forces from superconducting magnets (sometimes permanent magnets) that induce currents when the train moves, creating opposing magnetic fields that levitate the vehicle.

Currently, all commercial maglev trains use the EMS design due to the technical challenges with cooling traditional superconductors. But even though these systems have been in development since the 1930s, their design is far from simple. At high speeds, it becomes difficult to maintain the correct distance between an EMS maglev train and the guideway (about



Credit: Central Japan Railway Company

Figure 1. Photo of the Central Japan Railway Company's SCMaglev Series L0 train, which uses an electrodynamic suspension system.

10 mm or 0.4 inches). If the distance deviates more than 1 mm, the train will fail to levitate and come grinding to a halt. So, EMS systems require complex feedback-control systems to ensure the train is always stable.

In the 1960s, U.S. physician James R. Powell had the idea for an improved maglev system using superconducting magnets while he was stuck in car traffic on a bridge. He was already a proponent of magnetic force, having co-designed one of the world's most powerful particle accelerators using magnets, and he quickly set to work designing the first EDS system with his research partner, Gordon Danby.

EDS systems have the potential to go much faster than EMS-based maglev trains because they can levitate up to 4 inches off the track, allowing them to safely handle minor track bumps at extreme speeds. That safety margin means they are expected to reach speeds of more than 600 km/h (373 mph), in contrast to the current fastest commercial EMS maglev train, Shanghai Maglev (opened in 2004), which has clocked in at 431 km/h (268 mph).

In Japan, an EDS maglev train called SCMaglev is under development (Figure 1). Developed by the Central Japan Railway Company, the novel train set a speed record of 603 km/h (375 mph) in 2015 on a test track in Yamanashi. Japan now plans to use this technology for a passenger train line connecting Tokyo and Nagoya, with a planned opening in 2027.¹ The Central Japan Railway Company is also working with Maryland-based Northeast Maglev to promote the adoption of an SCMaglev system for a line from Washington D.C. to Baltimore. If completed, it would be the first commercial maglev system in the U.S.²

The SCMaglev system uses a traditional superconducting magnet made of a niobium-titanium alloy. As development of EDS technology continues, adopting high-temperature superconductors will reduce design complexity while still achieving

higher speeds, more stability, and better ride quality than current EMS systems.

Rare earth barium copper oxide (REBCO) ceramics will likely play an important role in next-generation EDS systems. REBCO ceramics have an impressive superconductivity limit of about 92 K, which means they can be cooled using cheaper liquid nitrogen cooling systems. They can also be made in a tape form that offers reduced cooling requirements, stronger magnetic fields, and increased propulsion, making them ideal to support future maglev systems.³

While a few studies explore the potential of REBCO ceramics for maglev applications specifically, most developments currently focus on other applications.

For example, SuperPower Inc. (Glenville, N.Y.), a subsidiary of Furukawa Electric Co. (Tokyo, Japan), manufactures second-generation REBCO wires that are being used in the development of a fusion prototype by U.K.-based Tokamak Energy.⁴ In 2022, a collaboration between SuperPower and the National High

Magnetic Field Laboratory, a joint project of Florida State University, the University of Florida, and Los Alamos National Laboratory, won a grant from the U.S. Department of Energy “to address critical scientific and technological challenges in the REBCO superconducting wire production for fusion.”⁵

Other companies developing commercial REBCO ceramics include

- **American Superconductor Corp.** (Ayer, Mass.), which manufactures REBCO wires for use in the electric power grid. The publicly traded company reported a revenue of \$299 million in fiscal 2026, up 34% from \$222.8 million in 2025.
- **Canyon Magnet Energy** (New York, N.Y.), which designs and produces REBCO magnets and cables for the energy, health care, and advanced computing sectors.

With the help of ceramics, the next generation of superconductors may revolutionize the future of transportation, health care, energy systems, and more.

About the author

David Holthaus is an award-winning journalist based in Cincinnati, Ohio, who covers business and technology. Contact Holthaus at dholthaus@ceramics.org.

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*All references verified as of July 23, 2026. ■

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Welcome new ACerS Corporate Partners

ACerS is pleased to welcome its newest Corporate Partner: Niron Magnetics.



To learn about the benefits of ACerS Corporate Partnership, contact Yolanda Natividad, associate director of membership and industry relations, at (614) 794-5827 or ynatividad@ceramics.org. ■

Northern California Section members support the CGIF's 'Magic of Materials Science' workshop at UC Berkeley

Members of the Northern California Section supported the Ceramic and Glass Industry Foundation's "Magic of Materials Science" Teacher Training Workshop on June 23, 2026, at the University of California, Berkeley. They joined the workshop attendees for lunch to give the teachers more information on the types of careers that exist. ■



Picture from the networking luncheon that took place during the "Magic of Materials Science" Teacher Training Workshop.

Dayton/Cincinnati/Northern Kentucky Section members enjoy a day at the ballpark

On June 28, 2026, the Dayton/Cincinnati/Northern Kentucky Section held a social event at a Dayton Dragons baseball game in collaboration with the local sections of the American Chemical Society and the Society for the Advancement of Materials Processing and Engineering. Each section provided food and drink for the attendees, who took full advantage of the cross-society networking opportunity. ■

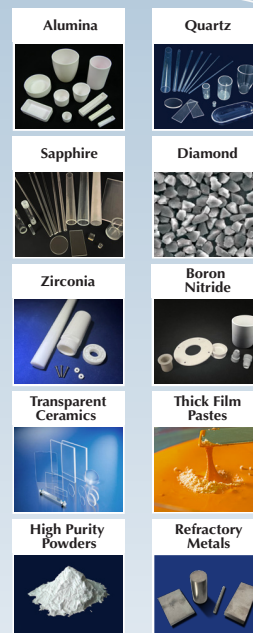


Members of ACerS, the American Chemical Society and the Society for the Advancement of Materials Processing and Engineering at the Dayton Dragons baseball game. The Dayton Dragons defeated the West Michigan Whitecaps 10-4.

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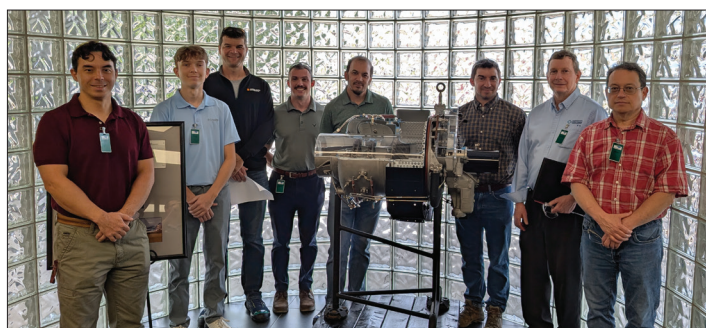


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Eastern Tennessee Section members tour StandardAero facility in Maryville, Tenn.

On June 26, 2026, the Eastern Tennessee Section visited StandardAero in Maryville, Tenn., for a tour of their jet engine repair and testing facilities. StandardAero primarily focuses on metal components, but the company also uses plasma spray technologies to deposit ceramic-based thermal barrier coatings on the components. After completing a rebuild, the engines are tested to full power to ensure no leaks. Each test takes approximately 500 gallons of fuel. ■



Eastern Tennessee Section members who attended the StandardAero tour, from left to right: Sam Smyth, Klement Maksymovych, Petro Maksymovych, Dan Delia, James Hemrick, Max Modugno, Bill Minehan, and Steve Bullock.

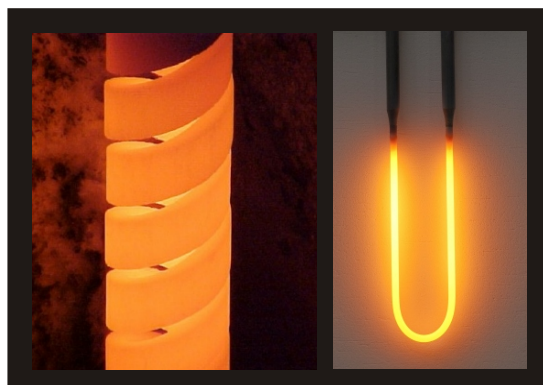
ACerS International Spain Chapter presents distinguished career award

The ACerS International Spain Chapter presented the SOCIEMAT-ACerS International Spain Chapter Award to Juan Bautista Carda Castelló, professor at the Universitat Jaume I of Castellón. This award recognizes a researcher's scientific and/or technological contributions to the development of ceramic and glass materials. The ceremony took place during the XVIII CNMAT Materials Congress 2026, held in Portugalete, Spain, from June 16–19. Carda Castelló delivered a keynote lecture titled “Beyond traditional ceramics: Contributions to development of sustainable and multifunctional materials.” ■



Juan Bautista Carda Castelló (second from right) receives the SOCIEMAT-ACerS International Spain Chapter Award from Chapter Chair Arnaldo Moreno Berto (right). They are joined by two SOCIEMAT Spanish Materials Society representatives, from left: Gloria Rodríguez (secretary) and Rodrigo Moreno (president).

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 Hosted by: ACerS Art, Archaeology & Conservation Science Division
 Featured speaker: Ellen Purdy

PROCESSING AND CHARACTERIZATION OF ULTRAHIGH-TEMPERATURE CERAMIC MATRIX COMPOSITES and AN OVERVIEW ON POWDER METALLURGY PROCESSING OF HIGH-ENTROPY BORIDES

Original air date: April 20, 2026
 Hosted by: ACerS International Italy Chapter and ACerS International Türkiye Chapter
 Featured speakers: Antonio Vinci and Dugyu Ağaoğulları

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Volunteer Spotlight: Prannoy Suraneni

ACerS Volunteer Spotlight profiles members who demonstrate outstanding service to the Society.



Prannoy Suraneni is associate professor of civil and architectural engineering and head of the Advanced Cement Chemistry, Engineering, Sustainability, and Science (ACCESS) Lab at the University of Miami in Florida. He received his bachelor's in civil engineering from the Indian Institute of Technology Madras,

M.S. from the University of Illinois Urbana-Champaign, and Ph.D. from ETH Zürich.

As head of the ACCESS Lab, Suraneni's research involves making concrete infrastructure sustainable, durable, and resilient through fundamental and applied research at multiple length and time scales. Current focuses include supplementary cementitious materials and coastal infrastructure. The lab also aims to make concrete knowledge accessible to K-12 students and the general public.

Suraneni has been an ACerS member since 2017 and a lifetime member since 2019. He has held numerous leadership roles in the Cements Division: secretary (2022–2023), chair-elect (2023–2024), chair (2024–2025), and outgoing chair (2025–2026). As outgoing chair, he and his team organized the 16th Advances in Cement-Based Materials meeting, which was the largest-ever Cements Division meeting with 198 attendees. Along with Shiho Kawashima and Alex Brand, he is serving this year as a guest editor for a special issue of *Journal of the American Ceramic Society* on emerging cement chemistry.

We extend our deep appreciation to Suraneni for his service to our Society! ■

Ceramic Tech Chat: Fumie Iizuka

Hosted by ACerS Bulletin editors, *Ceramic Tech Chat* talks with ACerS members to learn about their unique and personal stories of how they found their way to careers in ceramics.

Uncovering ceramic adoption in ancient cultures: Fumie Iizuka



In the August 2026 episode of *Ceramic Tech Chat*, Fumie Iizuka, assistant professor of anthropology at the University of Wisconsin–Madison, shares her journey to studying the relationship between pottery and ancient cultures, describes some of the techniques she uses in the field, and discusses how being a member of ACerS has benefited her research.

Listen to Iizuka's whole interview—and all our other *Ceramic Tech Chat* episodes—at <https://ceramicttechchat.ceramics.org/974767>. ■



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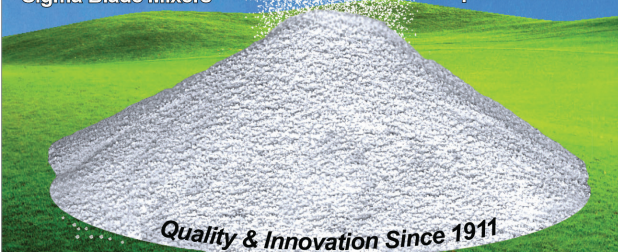
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The magic of materials science comes to Berkeley: The CGIF hosts hypersonics-themed teacher training workshop

The Ceramic and Glass Industry Foundation (CGIF) hosted a “Magic of Materials Science” Teacher Training Workshop at the University of California, Berkeley’s historic Hearst Memorial Mining Building on June 23, 2026. The workshop used hypersonic flight, one of the most demanding challenges in modern engineering, as a unifying theme for classroom lessons that teachers can bring directly to their students.

The 22 educators in attendance represented a diverse group, coming from 18 schools across 15 cities in the Bay Area. The teachers were primarily from high school science backgrounds, with a handful of middle and elementary teachers. Participants taught subjects ranging from chemistry, physics, and general science to engineering, math, and even ceramics, a testament to how materials science connects across the curriculum found in K–12 schools.

For some educators, the workshop was their first real introduction to the field. Lafayette Elementary School science teacher Hallie Bahr says, “I was very unfamiliar with materials science, and now I have a better understanding of what it involves, the careers associated with it, and its presence in every aspect of our lives.”

The workshop opened with an introductory presentation by Scott McCormack, assistant professor of materials science and engineering at the University of California, Davis, who guided teachers through the foundations of materials science and discussed the extreme thermal environments experienced by vehicles traveling at hypersonic speeds. Columbus City Schools teacher Darren Greschuk and CGIF Program Manager Nathan McIlwaine then led teachers through nine hands-on lessons and demonstrations connecting everyday materials to extreme environment applications.

Highlights from the hands-on activities included pulling glass-like fibers during the Candy Fiber Pull demonstration, exploring phase transformations through the Shape Memory Alloys lesson, and testing the strength of reinforced concrete during the outdoor Engineered Concrete experiment, which involved dropping concrete from more than 20 feet. Throughout the course of the day, the lessons wove in concepts from hypersonic thermal protection systems, structural materials, and the science of high-speed flight, threading real-world applications into the background of every activity.

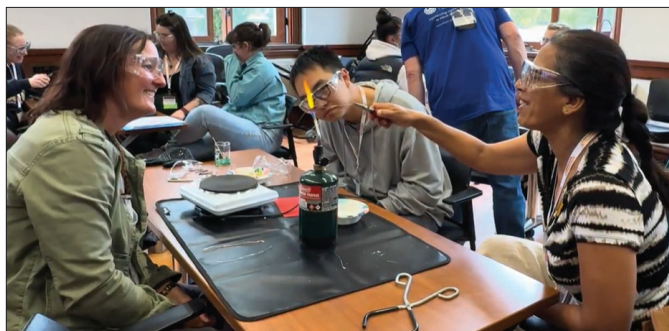
At midday, participants gathered for an industry networking luncheon in the building’s atrium. Guests from QuantumScape, Calctra, UC Berkeley, and UC Davis joined the teachers, staff, and volunteers for conversations about careers in the field of ceramics and glass. For Kurtis Bonano, a high school biology and life science teacher at Albany High School, the luncheon was the highlight of the workshop.

“I enjoyed talking with the industry people and professors during lunch the most. I learned a lot about what kinds of career prospects are out there in materials science, which I can tell my students about,” he says.

Every participant left with more than ideas. Each teacher received the Hypersonics Teacher Training Manual and a folder of class-



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During the Glass Bead on a Wire lesson, educators heated powdered borax and watched it transform into a glassy bead.



Group photo of all workshop attendees in front of the Hearst Memorial Mining Building.

room resources, including the Joint Hypersonics Transition Office Hypersonics STEM Curriculum, and each will receive the CGIF’s Materials Science Classroom Kit so the day’s activities can move straight into their classrooms this fall.

The CGIF extends a heartfelt thank you to UC Berkeley for hosting and to Scott McCormack, ACerS Northern California Section members, and the UC Davis and Berkeley graduate student volunteers who supported set-up and instruction throughout the day, and to our industry luncheon guests.

As these educators return to their classrooms with new lessons, kits, and confidence, thousands of Bay Area students will soon get their own hands-on introduction to the materials that make extreme engineering possible.

Help us continue to empower the next generation of ceramic and glass professionals by giving now at <https://ceramics.org/donate>. ■

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Concrete understanding of restraint-induced cracks thanks to reinforced collaborations

Cracking is the most common form of damage in concrete structures, and it serves as a gateway for water infiltration, corrosion of steel reinforcement, and premature collapse. So, methods to effectively monitor and control crack width in concrete structures are vital to safely enable long-term service of concrete structures.

Current standards for monitoring crack width make heavy use of formulations originally developed for load-induced cracking. In other words, the standards predict crack initiation and growth based on external forces. However, cracks in concrete structures are mainly a result of volume changes in the concrete itself.

Moisture loss, hydration, and temperature fluctuations can cause concrete to shrink or contract. But external structures or internal reinforcement can restrict the concrete's movement, generating tensile stresses that exceed the concrete's tensile strength, resulting in cracks.

Because current standards do not capture the mechanics of this restraint-induced cracking, researchers such as ACerS member Agnieszka Jędrzejewska have spent years working to develop better models. Jędrzejewska is associate professor and deputy head of the Department of Structural Engineering at Silesian University of Technology in Poland. She has contributed significantly to the literature on restraint-induced cracking in reinforced concrete

structures, notably through work with RILEM Technical Committees 254-CMS and 287-CCS.

In February 2025, Jędrzejewska gave a lecture as part of the ACerS Cements Division Rising Star Webinar Series on hydration-induced cracking of reinforced concrete structures (learn more about this series in the June/July 2026 *Bulletin* on page 39). During the event, she met Kamran Aghaee, assistant professor of mathematics, engineering, and computer science at West Virginia State University. Aghaee specializes in using machine learning methods to study cementitious materials, and "We quickly realized that his perspective could open new ways of looking at familiar problems," Jędrzejewska says in a LinkedIn post.

Jędrzejewska then invited Mariusz Zych, associate professor of civil engineering at Cracow University of Technology in Poland, to work with her and Aghaee. She has collaborated with Zych on numerous projects over the past decade involving in-situ measurements of restraint-induced cracking, and so she knew he could provide valuable support to this new collaboration.

The three researchers scoured the literature and compiled a dataset containing nearly 200 studies on restraint-induced cracking in externally restrained reinforced concrete structures. They then employed several machine learning algorithms, including linear regression, decision trees, random forest, and

XGBoost, to see which method could most accurately forecast the restraint-induced crack width.

Among the algorithms, random forest and XGBoost exhibited the most robust performance; their predictive capacity on the test set reached an R^2 up to 0.74. Inherent database inhomogeneity arising from the scarcity, variability, and complexity of in-situ measurements constrained the prediction accuracy, but the machine learning-based predictions still "outperform[ed] standardized models of Eurocode 2, CIRIA C766, and ACI 207 and ACI 224," the researchers write.

While the paper itself is a meaningful outcome of the collaboration, also notable is the database of the nearly 200 laboratory and field cases, which the researchers uploaded to the open repository Zenodo so it can be accessed by anyone in the cements and concrete community.

In her LinkedIn post, Jędrzejewska says that while working with machine learning was never her original plan, this collaboration "gave me a very concrete understanding of its strengths and limitations and made me even more convinced that we need structured knowledge and semantic technologies for meaningful reasoning in structural engineering."

The paper, published in *Journal of Building Engineering*, is "Machine learning-based prediction of restraint-induced crack width in reinforced concrete structures" (DOI: 10.1016/j.job.2025.115137). ■

Materials in the news

Graphene and lasers for space propulsion

An international research team boarded the European Space Agency's 86th parabolic flight campaign in May 2025 with ultralight graphene aerogels and then hit them with light during zero gravity phases to observe their reaction under space-like conditions. The effect was startling: The graphene samples shot forward instantly. Under Earth's gravity conditions, the aerogels barely moved at all, demonstrating that microgravity unlocks the potential of light propulsion for graphene aerogels in terms of velocity, thrust, and distance. For more information, visit https://www.esa.int/Science_Exploration.

The hidden structure behind relaxor ferroelectrics

Researchers led by Massachusetts Institute of Technology directly characterized the three-dimensional atomic structure of a relaxor ferroelectric for the first time. They used a technique called multislice electron ptychography, which involves moving a nanoscale-sized probe of electrons over a material and measuring the resulting electron diffraction patterns. Overlapping regions can be used to create a 3D scan of the material's atomic structure. The technique revealed that many regions of differing polarization in the material were much smaller than predicted by the leading simulations. For more information, visit <https://news.mit.edu>. ■

Toward a circular space economy: Opportunities for resource and material efficiency

Ensuring long-term stability of the growing space economy requires us to move away from the traditional linear production-consumption paradigm. Instead, “the integration of circular economy principles—centered on reducing inputs, reusing functional components, and enabling recycling—offers a viable pathway for alleviating both orbital and environmental burdens,” University of Surrey researchers write in a recent open-access paper.

The authors framed their analysis around five key stages in the space sector: materials, design and manufacturing, launch, service, and end of life.

- **Materials:** Reduction-oriented approaches include the development of novel materials and alternative extraction techniques.
- **Design and manufacturing:** Strategies such as 3D printing, min-

iaturization, and the use of digital twins contribute to reduction.

- **Launch:** Reduction is enabled by multipayload launches, whereas reusability is advanced through recoverable rockets and satellites.
- **Service:** Reduction measures include on-orbit servicing (such as refueling and repair), multimission satellites, and cooperative satellite constellations that fulfill complex tasks collectively. Reuse is supported by mission reconfiguration and collision-avoidance systems that enable safe reentry and repeated deployment. The recycle strategy is represented by in-orbit recycling technologies and closed-loop material reuse within space stations.
- **End of life:** Reduction is pursued through active minimization of space debris, whereas recycling

involves recovery and reintegration of in-orbit materials into Earth-based manufacturing via novel reprocessing methods.

To successfully adopt circular economy principles in the space sector, the authors note that advanced digital technologies, such as artificial intelligence, can help space companies improve resource efficiency, minimize waste, and maximize the reuse and life cycle of materials and spacecraft. The biggest factor in successful implementation of these principles, though, is adopting a whole-system approach to the challenge rather than focusing on individual components or processes, the authors state.

The open-access paper, published in *Chem Circularity*, is “Resource and material efficiency in the circular space economy” (DOI: 10.1016/j.checir.2025.100001). ■

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Honoring the ACerS

Over its long history, The American Ceramic Society has established a tradition of awards to recognize its members' outstanding contributions and accomplishments and to create career benchmarks for aspiring young scientists, engineers, and business leaders. The most prestigious of ACerS awards is Distinguished Life Member designation, a recognition bestowed upon only two or three members each year.

In 2026, two individuals will receive DLM honors: Makio Naito and George Quinn. The Society will elevate 13 members to Fellow and recognize many more outstanding members with various Society and Class awards during the ACerS Annual Honor and Awards Banquet Reception on Oct. 5, 2026.

2026 DISTINGUISHED LIFE MEMBERS

Makio Naito



The development of advanced ceramics can feel almost clinical, requiring high-end cleanrooms and demanding processing conditions. But spending time in nature can give you an appreciation for how much ceramics have evolved from traditional clay until now. For Makio Naito, it also motivated him to use those advanced technologies for environmental protection.

"During high school in the 1970s, the global environmental movement prompted my interest in how we could balance industrial development and climate awareness," Naito says. But even before then, he had developed an appreciation for the environment by conducting soil sample and analysis near Mt. Fuji through his junior high science club.

Naito pursued a bachelor's in chemical engineering, but it was during his graduate studies at Nagoya University that his early experience with soil analysis came full circle. He met Genji Jimbo, a professor known for his work on powder technology, which "is a bit related to soil handling," Naito says. Jimbo had also published articles on the relationship between industrial development and sustainable societies, which prompted Naito to join his group.

Naito first studied dust collection to improve air quality and then transitioned into researching particle surface modification to control powder mechanical properties. It was then that Jimbo introduced him to the book *Ceramic Processing Before Firing*, edited by Larry Hench and George Onoda, and "It was the first time I became interested in ceramic science," Naito says.

After graduation, Naito worked at Hosokawa Micron Corporation on developing an ultrafine grinding machine, which brought him into contact with numerous ceramic manufacturers. He then joined the Japan Fine Ceramics Center in 1993, where he developed advanced characterization tools for ceramics defects, before becoming a professor in the Joining and Welding Research Institute at

Osaka University in 2002. He is now Emeritus Professor at Osaka, as well as managing director of Hosokawa Powder Technology Foundation and director of Toyo Tanso Co., Ltd.

Among Naito's many accomplishments, he has developed heat- and binder-free mechanical methods to achieve direct bonding between particles in the dry state. He has also helped edit all three editions of the *Nanoparticle Technology Handbook*, and he is grateful to Hosokawa Powder Technology Foundation President Masuo Hosokawa for supporting the publication and continued success of this book.

Naito has been involved in many national and international projects, including a New Energy and Industrial Technology Development Organization grant, an International Energy Agency project, and a Versailles Project on Advanced Materials and Standards, all of which aimed to develop powder characterization methods for international testing standards. It was through such collaborative projects that Naito first met ACerS members George Onoda (FACerS) and Stephen Freiman (FACerS, DLM), both from the National Institute of Standards and Technology.

"I was especially surprised to meet George because he was one of the editors of the book that I knew in my graduate student days!" Naito says.

Naito eventually joined ACerS after presenting a talk on powder characterization techniques in a NIST-organized symposium at the 100th ACerS Annual Meeting in 1998. He became a Fellow in 2010.

Naito says that the Society's ability to develop good relationships between industry and academia helped him organize and launch the International Conference on the Characterization and Control of Interfaces for High Quality Advanced Materials (ICCCI) in 2003. The next edition of this conference will be held near Mt. Fuji in July 2028—back to where it all began for Naito in junior high.

Naito would like to thank Mrityunjay Singh (FACerS, DLM) for being "my best adviser to support international network and collaborations between powder technology and advanced ceramics." He would also like to thank Kevin Ewsuk (FACerS), who has been "my best partner to organize ICCCI from the very first one."

Awards Class of 2026

George Quinn



Not everyone can say they stuck with one niche throughout their entire profession. George Quinn, however, can.

Quinn's first experience with ceramics was during his mechanical engineering undergraduate studies at Northeastern University (Boston, Mass.). As part of their cooperative education program, he was sent to the Army Materials and Mechanics Research Center in 1969, which

required him to travel to the nearby town of Watertown, Mass., to work in the ceramics division.

Quinn says the division chief's first attempt at explaining ceramics to him "did not make very much of an impression."

"He fumbled in his desk drawer and pulled up a little tungsten carbide cutting tool insert, and he said, 'Well, this is a ceramic,'" Quinn recalls.

Quinn says the co-op eventually became a "synergistic relationship" as he learned more about ceramic materials, and he ultimately adapted to the research quite well. He also had the serendipity of meeting his late wife, Janet (Gorcenski) Quinn, during the co-op. She was another Northeastern student participating in the program who also later became a ceramic engineer.

After graduating from Northeastern with his bachelor's in 1973, Quinn joined the Army Research Center as a ceramic engineer and became a member of The American Ceramic Society. He then worked at the German Aerospace Research Laboratory in Cologne before joining the National Institute of Standards and Technology in 1990.

"I must tell you that at that formative period in my life, particularly in the 1960s and 1970s, I met a lot of interesting scientists," Quinn says.

ACerS Fellow James Varner is one of those "interesting" scientists. Quinn taught a fractography summer course alongside Varner at Alfred University for 25 years, and they organized various conferences together on fractography and mechanical properties. Quinn also taught graduate courses at Northeastern following encouragement from his former instructor, ACerS Fellow Thomas Vasilos.

Quinn's passion for materials and teaching has manifested in numerous achievements, including his book, *Fractography of Ceramics and Glasses*, now in its fourth edition. Quinn says this book is one of his top five career accomplishments.

Another one of Quinn's greatest accomplishments is helping develop standard procedures and methods for various organizations, including ASTM, ISO, and the military, to determine the mechanical properties of advanced ceramics. In particular, he developed the only reference material in the world for fracture toughness (NIST's Standard Reference Material 2100).

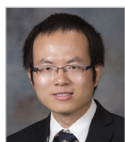
While working at NIST, Quinn's wife joined him nearby at the American Dental Association (ADA). After Janet died from lung cancer in 2008, Quinn retired as a civil government worker and collaborated with the ADA for five years to continue her work on edge chip testing and the fractography of dental crowns and bridges. This decision gave him "a chance to grieve for my wife's passing while also doing something about it," Quinn says. Now, he serves as a guest researcher and consultant for NIST.

Throughout his lengthy career in ceramics and glass, Quinn has remained active in the Society and was recognized as a Fellow in 2001. Based on his personal and professional involvement within the ceramics community, Quinn likes to joke that rather than materials science, his Ph.D. is from the "school of experience."

"I've met a lot of wonderful people, scientists, and colleagues from a variety of disciplines that I would not normally have been exposed to, and I have learned a lot from them," Quinn says. "The American Ceramic Society has been the ground where these interactions have been done."

Quinn would like to extend his gratitude to former Lieutenant Thomas Rankin, Lieutenant Jack Stiglich, R. Nathan Katz, James McCauley, Thomas Vasilos, Van Fréchette, James Varner, Susanne Scherrer, Edwin Fuller, Wolfgang Braue, and Janet Quinn. ■

The 2026 Class of Fellows



Bai Cui is professor of mechanical and materials engineering at the University of Nebraska-Lincoln. He received his Ph.D. in materials science and engineering from Imperial College London. He joined ACerS in 2014 and belongs to the Manufacturing Division, as well as Basic Science and Engineering Ceramics Divisions. He has served the Manufacturing Division in various roles, including secretary (2022–2023), vice-chair (2023–2024), chair-elect (2024–2025), and chair (2025–2026). He currently serves on the ACerS Meetings Committee (2025–2029) and has served as an associate editor for *Journal of the American Ceramic Society*. He is a recipient of numerous ACerS awards, including the Global Ambassador Award (2023), Global Star Award (2022), and the Outstanding Associate Editor Award for *Journal of the American Ceramic Society*.



Matthew D'Ambrosia is adjunct professor of civil and environmental engineering at Northwestern University and principal at MJ2 Consulting. D'Ambrosia received his Ph.D. from the University of Illinois at Urbana-Champaign. He joined ACerS in 2000 and belongs to the Cements Division, where he co-chaired four of the Division's annual meetings and progressed through the Executive Committee. He is also a Fellow of the American Concrete Institute and 2025 ASCE Construction Engineering Person of the Year.



Qiang Fu is principal scientist at Corning Incorporated. Fu received his B.S. and M.S. degrees in materials science from Tongji University, China, and a Ph.D. in ceramic engineering from Missouri University of Science and Technology. He joined ACerS in 2012 and belongs to the Glass & Optical Materials Division, as well as Basic Science and Bioceramics Divisions. Fu was program chair of GOMD 2023, and he has organized eight bioactive glass-related symposia at major conferences, including ICG, GOMD, and MS&T. From 2017–2021, he was a committee member of ACerS Diversity & Inclusion Subcommittee, and he currently serves on the ACerS Rishi Raj Medal Subcommittee (2025–2030). Fu has served as an editor for *Journal of the American Ceramic Society* since 2023. He has received numerous awards, including the ACerS Tadashi Kokubo Award (2024) and the Darshana and Arun Varshneya Frontiers of Glass Technology Lecture Award (2022).



Ashutosh Goel is professor of materials science and engineering at Rutgers University. He earned his B.S. and M.S. in physics from Guru Nanak Dev University, India, and his Ph.D. in materials science and engineering from the University of Aveiro, Portugal. He joined ACerS in 2012 and belongs to the Glass & Optical Materials Division, as well as Bioceramics Division. Goel served as chair of the Bioceramics Division from 2021–2022, and he currently serves as associate editor for both *Journal of the American Ceramic Society* and *International Journal of Applied Glass Science*. He received the ACerS Tadashi Kokubo Award in 2023.



Timothy Gross is research and development director for inorganic materials at Corning Incorporated. He received his B.S. in ceramic engineering from Alfred University, M.S. in materials science and engineering from Rochester Institute of Technology, and Ph.D. in materials engineering from Rensselaer Polytechnic Institute. Gross joined ACerS in 2012 and belongs to the Glass & Optical Materials Division. He has given 15 talks at GOMD meetings and has also co-authored 18 GOMD talks given by junior scientists. From 2020–24, he was a session organizer and chair for the Mechanical Properties of Glass session at GOMD. Gross currently serves on the ACerS Finance Committee. He is a recipient of the ACerS Stookey Discovery Award (2025) and the Darshana and Arun Varshneya Frontiers of Glass Technology Award (2026).



Shiho Kawashima is associate professor of civil engineering and engineering mechanics at Columbia University. Kawashima received her B.S. in civil engineering from Columbia University and her M.S. and Ph.D. in civil engineering from Northwestern University. She joined ACerS in 2013 and belongs to the Cements Division. She served as chair of the Cements Division from 2020–2022 and currently serves as a guest editor for upcoming special issues in *Materials and Structures* and *Journal of the American Ceramic Society*. Kawashima is a recipient of the ACerS Cements Division Early Career Award (2022) and the ACerS Global Ambassador Award (2024).



Dietmar Koch is managing director of the Institute of Materials Resource Management at the University of Augsburg, Germany. He received his Ph.D. in mechanical engineering from the University of Karlsruhe (now Karlsruhe Institute of Technology). He joined ACerS in 1999 and belongs to the Engineering Ceramics Division, as well as Basic Science Division. Koch currently serves on the ACerS Strategic Planning & Emerging Opportunities Committee (2024–2027) and as associate editor for *International Journal of Applied Ceramic Technology*. In 2025, Koch helped organize the CMC-Europe event with the ACerS International Italy Chapter.

The 2026 Class of Fellows (continued)



Peter Kroll is professor of chemistry and biochemistry at The University of Texas at Arlington. He received his undergraduate diploma in physics from Ruprecht-Karls University Heidelberg and Ph.D. in materials science from the Technical University of Darmstadt. Kroll joined ACerS in 2010 and belongs to the Basic Science Division, as well as Engineering Ceramics Division. He has organized and co-organized more than 30 symposia focusing on polymer-derived ceramics, ultrahigh-temperature ceramics, and computational modeling. He is a co-founder of the ACerS Technical Interest Group on polymer-derived ceramics and a recipient of the ECD Global Star Award (2026).



Nathan Orloff is the microwave materials project leader at the National Institute of Standards and Technology. He received both his B.S. in physics and Ph.D. in physics from the University of Maryland. He joined ACerS in 2016 and belongs to the Electronics Division. Orloff has made a variety of contributions to ACerS at the local and conference-wide levels. In 2018, he helped found the ACerS Colorado Section and then served as treasurer and secretary. He also organized five special sessions on telecommunications at the Basic Science and Electronic Divisions' Electronic Materials and Applications conference. Additionally, he has served as chair of the Corporate Relations Committee of the Electronics Division.



Laetitia Petit is professor of photonic glasses at Tampere University, Finland. She received her Ph.D. in solid-state chemistry and materials science engineering from the Université of Bordeaux. She joined ACerS in 2014 and belongs to the Glass & Optical Materials Division. She currently serves on the John Jeppson Award Subcommittee (2023–2028). She is vice-chair of the Technical Committee 20 in the International Commission on Glass and an associate editor for *Optical Materials*.



Marissa Reigel is director of research at Saint-Gobain NorPro. She received her Ph.D. in metallurgical engineering from the Colorado School of Mines. She joined ACerS in 2006 and belongs to the Manufacturing Division, as well as Energy Materials and Systems and Refractory Ceramics Divisions. She is an active ACerS volunteer, having recently completed a three-year term on the ACerS Board of Directors. She continues to serve on multiple ACerS committees and task forces, such as the Material Advantage Committee, the Society Awards Committee (2025–2027), and the Nominating Committee (2025–2028).



Lisa Rueschhoff is senior materials research engineer at the Air Force Research Laboratory. She received her B.S. in materials engineering from Iowa State University and Ph.D. in materials engineering from Purdue University. She joined ACerS in 2010 and belongs to the Engineering Ceramics Division, as well as Basic Science Division. She has served in ACerS leadership roles since her student years, first as chair of the Material Advantage Chapter at Iowa State and then as chair of ACerS President's Council of Student Advisors during her graduate studies at Purdue. Rueschhoff has also served as chair of the ACerS Membership Services Committee (2020–2024) and associate editor for *International Journal of Applied Ceramic Technology*. She has co-organized more than six technical symposia and acted as program co-chair for the 10th ICC. A 2017 ACerS Global Ambassador and recipient of the ACerS Du-Co Ceramics Young Professional award (2023), Rueschhoff will continue her dedicated service as an incoming member of the ACerS Board of Directors starting in 2026.



Shunpei Yamazaki is chairman and CEO of Semiconductor Energy Laboratory, Japan. He earned his B.E., M.E., and Ph.D. from Doshisha University, Japan. He joined ACerS in 2015 and belongs to the Engineering Ceramics Division, as well as the Basic Science and Electronics Divisions. Yamazaki holds the Guinness World Records title for the most patents credited to an individual, with 20,120 patents recognized as of July 2025. His achievements have been recognized with numerous prestigious honors, including five major ACerS awards: the Richard M. Fulrath Award (1984), the Medal for Leadership in the Advancement of Ceramic Technology (2016), the W.D. Kingery Award (2018), the Rustum Roy Lecture Award (2024), and the Mrityunjay Singh Bridge Building Award (2025). ■

Visit <https://ceramics.org/awards/society-fellows>
to learn more about the **2026 Fellows**

Society Awards

W. DAVID KINGERY AWARD recognizes distinguished lifelong achievements involving multidisciplinary and global contributions to ceramic technology, science, education, and art.



John C. Mauro, FACerS, is the Dorothy Pate Enright Professor and associate head for graduate education in the Department of Materials Science and Engineering at The Pennsylvania State University.

He is a pioneer in the use of physics-based and machine learning models to design new glassy materials. He has invented or co-invented new glass compositions for Corning Incorporated, including Gorilla Glass products, and invented new models for supercooled liquid and glass viscosity, glass structure and topology, relaxation behavior, and thermal and mechanical properties.

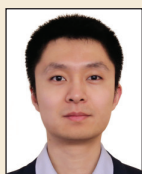
JOHN JEPPSON AWARD recognizes distinguished scientific, technical, or engineering achievements.



Ungyu Paik is Distinguished Professor in the Department of Energy Engineering at Hanyang University, Korea.

His research centers on the exploration and development of materials for advanced lithium-ion batteries and next-generation electronic devices, particularly those designed for environmentally benign and carbon-neutral energy systems.

ROBERT L. COBLE AWARD FOR YOUNG SCHOLARS recognizes an outstanding scientist conducting research in academia, industry, or at a government-funded laboratory.



Yanhao Dong is associate professor in the School of Materials Science and Engineering at Tsinghua University, China.

During the five years he spent as a postdoctoral researcher at Massachusetts Institute of Technology, Dong proposed and developed new concepts, theories, and techniques for robust ceramic materials and devices, including ultrauniform nanocrystalline materials beyond Hillert's theoretical limit, stress corrosion cracking and self-healing phenomena in high-voltage battery cathodes, planetary centrifugal deagglomeration for single-crystalline cathode synthesis, and rejuvenated cathode-electrolyte interface in protonic ceramic fuel and electrolysis cells. His current research involves advanced ceramics for structural and energy applications.



Scott McCormack is assistant professor of materials science and engineering at the University of California, Berkeley.

His research focuses on ultrahigh-temperature thermochemistry for materials in extreme environments for applications in hypersonic platforms, nuclear energy, and space exploration. He is also passionate about STEM outreach, and much of his activity in ACerS has been in that direction, including partnering with the regional Math Engineering Science Achievement program.

RICHARD AND PATRICIA SPRIGGS PHASE EQUILIBRIA AWARD honors authors who made the most valuable contribution to phase stability relationships in ceramic-based systems literature during the calendar year prior to selection.

"Key phase diagram experiments and thermodynamic modeling of the $\text{ZnO-B}_2\text{O}_3$, ZnO-SiO_2 , and $\text{ZnO-B}_2\text{O}_3\text{-SiO}_2$ systems," *Journal of the American Ceramic Society* 2025, 108(3): e20252.

Min-Kyung Kim, Seoul National University, Korea
Jaesung Lee, Seoul National University, Korea
In-Ho Jung, Seoul National University, Korea

ROSS COFFIN PURDY AWARD recognizes authors who made the most valuable contribution to ceramic technical literature during the calendar year two years prior to selection.

"Mechanical tailoring of dislocations in ceramics at room temperature: A perspective," *Journal of the American Ceramic Society* 2024, 107(3): 1425–1447.

Xufei Fang, Karlsruhe Institute of Technology, Germany

MORGAN MEDAL AND GLOBAL DISTINGUISHED DOCTORAL DISSERTATION AWARD recognizes a distinguished doctoral dissertation in the ceramics and glass discipline.



Petra Špringer Šimonová is postdoctoral researcher and Humboldt Fellow at the University of Bayreuth, Germany.

Her dissertation focused on understanding the relationships between microstructure, composition, and properties in oxide and silicate ceramics, and her work has now expanded to exploring how microstructural design influences the mechanical and functional properties of ceramic matrix composites.

Society Awards (continued)

MEDAL FOR LEADERSHIP IN THE ADVANCEMENT OF CERAMIC TECHNOLOGY recognizes individuals who have made substantial contributions to the success of their organization and expanded the frontiers of the ceramics industry through leadership.



Seon-kyu Jeon is founding chairman of MiCo Group, Korea.

Over nearly three decades, Jeon positioned MiCo as the parent of a cluster of specialized affiliates, including KoMiCo for semiconductor equipment part cleaning and coating, MiCo Ceramics for high performance heaters and electrostatic chucks, and MiCo Hightech for vacuum and high temperature ceramic equipment. He also championed MiCo Power and related initiatives in solid oxide fuel cells, waste to energy systems, and carbon capture, reflecting a strategic shift toward eco-friendly and net-zero solutions.

DU-CO CERAMICS YOUNG PROFESSIONAL AWARD recognizes a young professional member of ACerS who demonstrates exceptional leadership and service to ACerS.



Xuan Song is associate professor of industrial and systems engineering at the University of Iowa.

Song currently serves as co-chair (2024–2026) of the ACerS Young Professionals Network, and he previously served on the ACerS Committee on Strategic Planning for Emerging Opportunities. He has also collaborated with the ACerS Education and Professional Development Council, contributing to the alignment of ACerS leadership strategies with early-career engagement. Song has continuously served as a symposium organizer for ceramic additive manufacturing at major ACerS conferences, and he has served on the International Advisory Board for the International Ceramics Congress. Two of his articles on ceramic additive manufacturing have been chosen as Editor's Choice in *Journal of the American Ceramic Society*.

RISHI RAJ MEDAL FOR INNOVATION AND COMMERCIALIZATION recognizes an individual whose innovation lies at the cusp of commercialization in a field related, at least in part, to ceramics and glass.



Vincent Harris is University Distinguished Professor and William Lincoln Smith Chair Professor at Northeastern University and CEO of Metamagnetics Inc.

Harris's research interests encompass a wide range of advanced materials and topics, including magnetoceramics, critical materials and global supply chain dynamics, and the impact of technology upon global climate change. As founder and CEO of Metamagnetics Inc., a company that produces innovative solutions for the defense and aerospace communities, he has led efforts

in the productization of self-biased circulators, Autotune Filters, high-efficiency power conversion and conditioning components, among others. He has received the distinction of Fellow in numerous science organizations and is a recipient of the ACerS Edward C. Henry (2020) and W. David Kingery (2023) and Awards. ■

ECerS-ACerS JOINT AWARD recognizes individuals who foster international cooperation between The American Ceramic Society and the European Ceramic Society, in demonstration of both organizations' commitment to work together to better serve the international ceramics community.



Mrityunjay Singh, FACerS, DLM, is chief scientist at Ohio Aerospace Institute. Singh is an ACerS past president and currently president of World Academy of Ceramics. He is a Fellow of ACerS, ASM International, American Association for the Advancement of Science, Indian Institute of Metals, and National Academy of Inventors. He is an Honorary Fellow of the European Ceramic Society, Indian Institute of Ceramics, and honorary member of Materials Research Society of India, Indian Ceramic Society, and Distinguished Life Member of Alpha Sigma Mu. He is the recipient of nearly 100 national and international awards and has received honorary doctorates from Nagaoka University of Technology, Japan; Slovak Academy of Sciences, Slovakia; and AGH University of Krakow, Poland.

ECerS-ACerS JOINT YOUNG PROFESSIONAL AWARD recognizes individuals who foster international cooperation between The American Ceramic Society and the European Ceramic Society, in demonstration of both organizations' commitment to work together to better serve the international ceramics community.



Scott McCormack is assistant professor of materials science and engineering at the University of California, Berkeley. During his student years, McCormack was an active member in ACerS President's Council of Student Advisors (PCSA), serving as a member (2016–2017) then chair (2017–2018) of the Outreach Committee and then as chair of the PCSA (2018–2019). Since 2024, he has served as a Mentor-at-Large for the PCSA. The PCSA is an international student-based group, and McCormack's involvement with the PCSA has allowed him to help connect European and U.S. ceramic students, along with students from Asia, Africa, and South America." ■

Society Awards (continued)

DAVID W. RICHESON EDUCATIONAL

OUTREACH AWARD is given annually to honor up to two undergraduate or graduate student members of the ceramic and glass materials community who have made a significant impact in outreach to primary and secondary school students.



Katelyn Kirchner is a 2024 graduate of The Pennsylvania State University and currently glass process scientist at CelSian Inc. During her academic studies, Katelyn earned the Graduate

Student Online Teaching Certificate (June 2021) and Graduate Student Teaching Certificate (May 2022), skill sets which she now uses as an industrial trainer at CelSian Academy. Kirchner co-organized student events for the 2021, 2022, 2023, and 2024 Glass & Optical Materials Division annual meetings, and she currently serves as the GOMD Young Professional Network liaison and U.S. representative for the ECerS Young Ceramics Network.



Fox Thorpe is a 2024 graduate of the University of California, Davis, and now founding engineer and materials scientist at Calectra. Thorpe was a delegate of the ACerS

President's Council of Student Advisors during his student years, and in his current role, he continues materials science outreach work with teachers in California and Kentucky. ■

Corporate Environmental Achievement Award

The Corporate Environmental Achievement award recognizes a single outstanding environmental achievement made by an ACerS Corporate Partner in the field of ceramics.



Elkem, headquartered in Oslo, Norway, is a global leader in silicon-based advanced materials. In 2020, the company was rated among the world's top 5% on climate. Elkem already uses 83% renewable electricity in its operations, and the company aims to reduce its total carbon dioxide emissions by 28% from 2020–2031 while growing its supplies to the green transition, thereby delivering a 39% improvement of its product carbon footprint in the same period. Elkem's long-term goal is net-zero emissions by 2050. ■

Corporate Technical Achievement Award

The Corporate Technical Achievement award recognizes a single outstanding technical achievement made by an ACerS Corporate Partner in the field of ceramics.

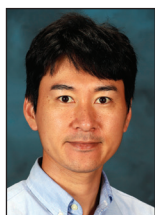


Niron Magnetics' proprietary iron nitride permanent magnet technology provides a rare-earth-free permanent magnet composition for motors, consumer electronics, and industrial applications. This innovation helps improve supply chain security and reduces environmental impact while still providing high-performance magnetic properties.

Niron Magnetics spun out of the University of Minnesota in 2013 and is currently supplying magnets to select customers from its Minneapolis pilot plant. The company broke ground on its full-scale manufacturing facility in September 2025 and expects to be operational in 2027. ■

Richard M. Fulrath Symposium and Awards

Promote technical and personal friendships between Japanese and U.S. ceramic engineers and scientists.



U.S. industrial:
Takaaki Koyanagi,
Oak Ridge National
Laboratory



Japanese academic:
Shintaro Yasui,
Institute of Science
Tokyo



Japanese industrial:
Takayuki Nakao,
Osaka Gas Co., Ltd.



Japanese industrial:
Kenji Shinozaki,
National Institute of
Advanced Industrial Science
and Technology

Society Award Lectures

ACERS/EPDC ARTHUR L. FRIEDBERG CERAMIC

ENGINEERING TUTORIAL AND LECTURE provides a tutorial that reviews and instructs in some area of ceramics or glass with a distinct engineering flavor.

Extending the Weibull framework: High-throughput and in-situ approaches to understanding fracture



Frank DelRio is a principal member of technical staff in the Department of Materials Mechanics and Tribology at Sandia National Laboratories.

DelRio's research focuses on the development and use of materials and assemblies for small-scale mechanical applications via advancements in stand-alone and integrative mechanical measurement and microscopy techniques.

EDWARD ORTON JR. MEMORIAL LECTURE provides a learned lecture in a field related to the interests of the Society's membership.

Advanced ceramics for energy transition and decarbonization



Alexander Michaelis, FACerS, is director of the Fraunhofer Institute for Ceramic Technologies and Systems, Germany, and chair of inorganic nonmetallic materials in the Institute of Materials Science at Dresden University of Technology, Germany.

Michaelis' research focuses on advancing electroceramics and energy systems using hybrid manufacturing approaches that couple additive processes with 2D thick film functionalization. These efforts have seeded spin outs and first-of-their-kind demonstrations, such as integrated co-electrolysis/Fischer-Tropsch pilot concepts and ceramic membrane oxygen generation for medical ventilation.

ACERS FRONTIERS OF SCIENCE AND SOCIETY RUSTUM ROY

LECTURE provides a learned lecture about the relationship between science, technology, and society.

Powder processing technology for high-quality advanced materials



Makio Naito, FACerS, DLM, is Emeritus Professor at Osaka University, Japan, as well as managing director of Hosokawa Powder Technology Foundation and director of Toyo Tanso Co., Ltd.

Naito is globally recognized for his pioneering contributions to powder technology, nanoparticle processing, and advanced ceramic materials. His work focuses on interfacial engineering of particulate systems and "smart" powder processing for high-performance materials. ■

Class Awards

EPDC OUTSTANDING EDUCATOR AWARD recognizes outstanding work and creativity in teaching, directing student research, or the general educational process.



Ghatu Subhash, FACerS, is the Newton C. Ebaugh Professor and UF Research Foundation Professor of Mechanical and Aerospace Engineering at the University of Florida. He received his M.S. and Ph.D. from the University of California, San Diego, and conducted post-doctoral research at the California Institute of Technology.

Subhash seeks to foster students' interests in ceramic and glass sciences by empowering undergraduates to lead independent research in his laboratory and attend international conferences to present their research. He also encourages his senior graduate students to mentor the junior students under his close supervision. Furthermore, Subhash has pioneered efforts to incorporate relevant topics on ceramics not only in classroom lectures but also in specialized technical courses offered at professional society conferences, industries, and academic institutions. ■

The American Ceramic Society

2026

Annual Honors and Awards Banquet

128 Years of Advancing the Ceramics and Glass Community

Monday, Oct. 5 at MS&T26

Location: Omni William Penn Hotel (Pittsburgh, Pa.)

6–6:30 p.m. Reception (Urban Room)

6:30–9 p.m. Dinner and awards (Grand Ballroom)

Purchase banquet tickets with your conference registration or contact Erica Zimmerman at ezimmerman@ceramics.org.

Tickets must be purchased by **Sept. 21, 2026**

Division Award Lectures

GLASS & OPTICAL MATERIALS DIVISION

COOPER DISTINGUISHED LECTURE PRESENTATION



Vincenzo Sglavo, professor of materials science and technology, University of Trento, Italy

"From vision to practice: Advancing the chemical strengthening of silicate glass"

GEORGE W. MOREY AWARD



Sabyasachi Sen, Blacutt-Underwood Distinguished Professor of Materials Science and Engineering, University of California, Davis

"An oxygen-centric view of the network former vs. modifier role of high field strength cations in oxide glasses"

NORBERT J. KREIDL LECTURE

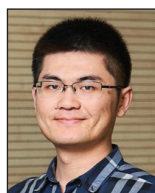


Cosmin-Constantin Popescu, senior staff engineer, 2Pi Inc., Mass.

"Phase-change metasurfaces with 2D pixel-level addressability"

ENERGY MATERIALS AND SYSTEMS DIVISION

D.T. RANKIN AWARD



Yang Bai, associate professor of energy harvesting materials and sensing, University of Oulu, Finland

"Advances and bottlenecks in energy harvesting technologies—How far are we from sustainable IoT?"

Attend your Division business meeting at MS&T26

Monday, Oct. 5

Electronics: 11 a.m.–12 p.m.

Engineering Ceramics: 12–1 p.m.

Energy Materials and Systems: 5:30–6:30 p.m.

Tuesday, Oct. 6

Basic Science: 12–1 p.m.

Glass & Optical Materials: 1 p.m.–2 p.m.

Wednesday, Oct. 7

Art, Archaeology & Conservation Science: 2–2:20 pm

2026 ALFRED R. COOPER YOUNG SCHOLAR AWARD



Rafael Baságlio Rosante, Federal University of São Carlos, Brazil

"Leakage-free, interpretable machine learning for glass-forming ability"

2026 ALFRED R. COOPER YOUNG SCHOLAR AWARD RUNNERS-UP

Azriel Carr, University of Tennessee-Knoxville, Tenn.

"Versatile additively manufactured stained glasses via transition metal acetylacetonate dopants"

Kai Penner, University of Manitoba, Canada

"The structure and durability of phosphorus-doped borosilicate glass for nuclear waste immobilization"

Isaac Schrooten, Iowa State University, Iowa

"Influence of oxide precursors on the structure and properties of the $\text{Li}_{2.35}\text{SiS}_{2.8}\text{O}_{0.38}$ glass system"

BIOCERAMICS DIVISION

LARRY L. HENCH LIFETIME ACHIEVEMENT AWARD



Robert Hill, Emeritus Professor of dental physical sciences, Queen Mary University of London, U.K.

"Designing bioactive glasses based on an understanding of chemical structure"

BIOCERAMICS YOUNG SCHOLAR AWARD



Ngoc Huu Nguyen, research associate, Flinders University, Australia

"Multifunctional bioceramic interfaces for infection-resilient and regeneration bone implant"

TADASHI KOKUBO AWARD



Maziar Montazerian, professor of materials science and engineering, The Pennsylvania State University, Pa.

"Past, present, and future of bioactive glasses and glass-ceramics"

AC_{ERS} SPRING MEETING

MAY 23–28, 2027

SAN FRANCISCO, CALIF.
Hilton Union Square



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Noncubic-structured transparent ceramics: Overcoming birefringence through improved structure-property understanding

By Akio Ikesue

Example of a transparent noncubic-structured alumina disk observed by mid-infrared camera.

Transparent ceramics with cubic crystal structures can exhibit optical performance comparable to—or even surpassing—that of single crystals, and their application in high-technology devices such as lasers and optical isolators is already underway.

In contrast, transparent ceramics with noncubic crystal structures have found only limited use in optical applications, for example, as arc tubes for high-pressure sodium lamps.¹ This limitation is due to the birefringence arising from their crystallographic symmetry.

Some noncubic-structured ceramics demonstrate superior mechanical properties compared to cubic-structured ceramics, so they would offer more options as optical materials in physically demanding environments (e.g., ballistic armor and missile domes). But does their intrinsic birefringence limitation mean that they have no future as optical materials?

Not necessarily. This article demonstrates how a deeper understanding of the relationship between microstructure and optical properties in noncubic-structured ceramics could enable their design for widespread optical applications.

Cubic-structured ceramics in optical applications

In 1995, my colleagues and I developed high-quality neodymium-doped yttrium aluminum garnet (Nd:YAG) ceramics that achieved highly efficient laser oscillation.² While transparent ceramics existed prior to this paper, this study was the first time that optical properties rivaling those of single crystals were achieved in a polycrystalline ceramic.

This breakthrough not only marked the starting point for the development of a wide range of laser ceramics specifically, but it also attracted significant attention worldwide to the topic of transparent ceramics in general. As a result, functionalities and power scaling that surpassed single crystal optical materials were realized.³ For example, my colleagues and I developed polycrystalline terbium aluminum garnet and terbium yttrium oxide Faraday rotators,^{4,5} which now have been industrially applied in isolator devices for high-power fiber lasers. Meanwhile, some advanced spinel ceramics have exceeded the ultraviolet-visible performance of single crystals.⁶

Notably, all the transparent ceramics described above possess cubic crystal structures, which means their crystal lattices consist of three equal axes intersecting at right angles. This symmetry allows cubic-structured ceramics to behave isotropically, i.e., demonstrate uniform properties in all directions, which inherently frees them from birefringence.

The following section provides a deeper look at the phenomenon of birefringence and how it hinders the development of noncubic-structured transparent ceramics.

Birefringence in noncubic-structured ceramics

In the 1950s, R.L. Coble succeeded in preparing translucent alumina ceramics through precise microstructural control, overturning the prevailing concept that alumina was inherently opaque.¹ This material was subsequently employed in arc tubes for high-pressure sodium lamps, but in recent years, such discharge-based light sources have been largely replaced by quantum-based light generation technologies, namely high-efficiency white light emitting diodes.

The reason Coble's alumina ceramics were translucent rather than fully transparent is because of alumina's noncubic structure. In contrast to cubic structures, which have three equal axes, noncubic structures consist of unequal axes or angles. As a result, their physical and mechanical properties are anisotropic, meaning the material's behavior depends on the direction in which it is measured.

In the case of alumina, it crystallizes with a hexagonal structure. As light passes through the individual alumina grains, the unequal axes cause extraordinary rays to be generated in directions different from that of the incident beam (i.e., birefringence). Consequently, coherent light is progressively transformed into diffuse light, thereby deteriorating the alumina's optical performance and making even passive optical uses, such as windows, extremely challenging.

Enabling isotropic optical properties in noncubic-structured ceramics

In principle, the primary method for improving the in-line transmittance of noncubic-structured ceramics is the extreme refinement of grain size, as smaller grains reduce scattering efficiency. However, from the standpoint of optical physics, the fundamental requirement is the elimination (or effective suppression) of birefringence.

Previous studies on improving the optical properties of noncubic-structured ceramics have focused primarily on the processing methods and measured transmittance values

while presenting little or no discussion of the birefringence property itself.^{7,8} In two recent papers,^{9,10} my colleagues and I centered the discussion on birefringence by integrating optical characterization techniques with microstructural observation and property evaluation.

In the first paper,⁹ we focused on the optical properties of birefringence and transparency and their relationship to microstructure by comparing three alumina morphologies: conventional alumina (processed using a magnesium oxide sintering aid), advanced alumina (processed using a zirconia sintering aid), and *c*-axis single crystal sapphire.

While both magnesium oxide and zirconia contribute to suppressing grain growth and reducing the volume of internal pores, zirconia is a significantly more effective inhibitor for a couple reasons. First, there is generally less grain growth when

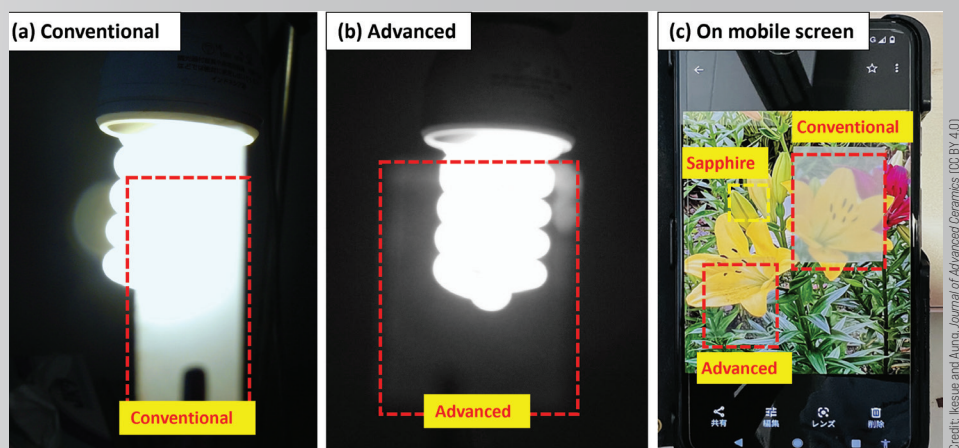


Figure 1. Fluorescent lamp observed through a) conventional and b) advanced alumina ceramics. c) Appearance of conventional and advanced transparent alumina ceramics and *c*-axis sapphire crystal placed on a mobile phone screen. Images republished from Reference 9.

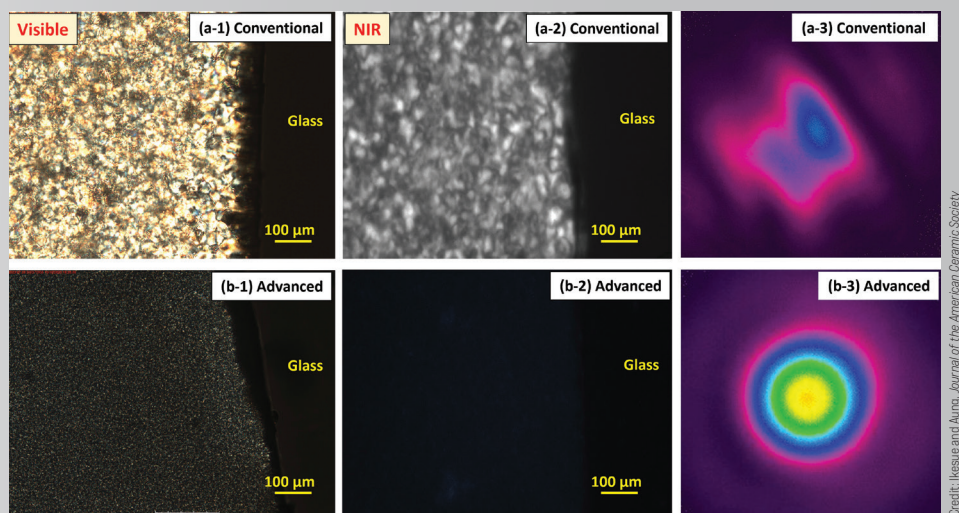


Figure 2. Polarizing transmission microphotographs of conventional and advanced translucent alumina ceramics at visible (a-1, b-1) and near-infrared (a-2, b-2) wavelength area, and laser beam pattern after passing through each ceramic specimen (a-3, b-3). Images republished from Reference 10.

Noncubic-structured transparent ceramics: Overcoming birefringence through . . .

sintering at lower temperatures. While magnesium oxide additives require sintering temperatures of about 1,400–1,500°C, zirconia additives sinter at about 1,200–1,300°C. Second, magnesium oxide and zirconia suppress grain growth through slightly different mechanisms. Magnesium oxide will react with the alumina to form a spinel phase that remains near the grain boundaries, slowing but not fully stopping grain growth. On the other hand, zirconia additives do not react with the alumina and will ultimately dissolve evenly into the alumina grains, leaving none detected at the grain boundaries and effectively restricting grain growth.

Figure 1 demonstrates the optical tradeoffs between the three alumina morphologies for a mobile phone screen application.⁹ Figures 1a and 1b show a fluorescent lamp observed through conventional alumina and the advanced alumina, respectively (both 0.3 mm thick). The conventional alumina appears frosted and lacks image clarity, whereas the advanced alumina allows clear visualization. When these materials, together with the reference *c*-axis sapphire single crystal, are placed directly on a mobile phone screen (Figure 1c), we observe distinct differences between them. The advanced alumina exhibits screen performance comparable to that of the *c*-axis sapphire, while the conventional alumina not only distorts the image but also significantly reduces sharpness.

For thin optical components such as display cover plates, the advanced type may appear satisfactory at first glance; however, fundamental underlying issues remain, as discussed in our second paper.¹⁰

Figures 2a-1 and 2b-1 present polarized-light observations in the visible wavelength region for conventional alumina (average grain size ~10 μm) and advanced alumina (average grain size ~0.4 μm), respectively, with optical glass (an isotropic optical material) used as a reference.¹⁰ With conventional alumina, a large amount of birefringence is clearly detected. In contrast, the advanced alumina exhibits only trace levels of residual birefringence (although even a minute amount can be fatal for certain demanding optical applications). As expected, no birefringence is observed in the optical glass.

Figures 2a-2 and 2b-2 show analogous observations performed using a near-infrared camera operating in the 1.2–1.7 μm wavelength range. The conventional alumina still exhibits pronounced birefringence in the infrared region, whereas birefringence becomes undetectable in the advanced alumina, similar to the glass reference.

Figures 2a-3 and 2b-3 display the beam patterns of laser light ($\lambda = 1 \mu\text{m}$) transmitted through the same specimens. In the conventional alumina, the beam profile is severely degraded: The central intensity is weakened and distorted, and scattered light spreads into the periphery. By contrast, the beam transmitted through the advanced alumina maintains a strong central intensity and preserves a near-original Gaussian mode, indicating a high beam quality state.

Figures 3a and 3b quantitatively present the wavelength dependence of total transmittance and the intrinsic birefringence of noncubic-structured ceramics measured under crossed polarizers for 1-mm-thick specimens.¹⁰ The *c*-axis sap-

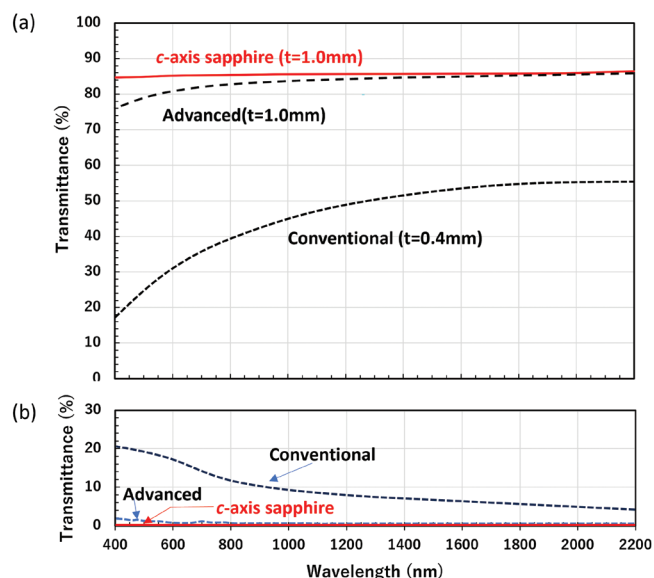


Figure 3. a) Total transmittance spectra of conventional and advanced alumina ceramics and *c*-axis sapphire crystal. b) Wavelength dependence of leaked light (transmittance) measured with crossed polarizers. Graphs adapted from Reference 10.

phire single crystal exhibits a high transmittance of 85–86% across the entire measured wavelength range. The advanced alumina shows some reduction in transmittance in the short-wavelength region due to intrinsic birefringence; however, at measuring wavelengths in the near-infrared (780–2,500 nm) and longer, its transmittance becomes comparable to that of the single crystal. In contrast, the conventional alumina exhibits extremely low transmittance even when the thickness is reduced by 60%.

With respect to the leaked light under crossed polarizers (the quantitative measure of birefringence), the advanced alumina exhibits values comparable to those of *c*-axis sapphire and optical glass. In particular, in the near-infrared and longer wavelength regions, birefringence becomes nearly undetectable. X-ray diffraction analysis confirms that the advanced alumina retains the hexagonal crystal structure of conventional alumina, suggesting that it has evolved into a noncubic-structured ceramic possessing pseudo-optical isotropy. Furthermore, Fourier transform infrared spectroscopy measurements of a 4-mm-thick advanced specimen reveal an in-line transmittance of 86% in the mid-infrared region (2.5–5 μm), equivalent to that of *c*-axis sapphire crystal.¹¹

Figures 4a–d show near-infrared camera images of the author's hand observed through different window materials: no window (blank), conventional alumina, advanced alumina, and *c*-axis sapphire single crystal.¹⁰ Compared with the blank image, photographs taken through the advanced alumina (6 mm thick) and the *c*-axis sapphire single crystal (4 mm thick) appear equally bright and sharp. In contrast, images obtained through a thinner conventional alumina window (2 mm thick) are dark and severely distorted. The conventional

alumina retains intrinsic birefringence within individual grains even in the infrared region, a characteristic feature of noncubic-structured ceramics. As a result, both low transmittance and poor image quality become evident limitations.

Figures 4e and 4f present images of dome- and disk-shaped advanced alumina specimens (each 4 mm thick), which were taken using a mid-infrared camera operating in the 3–5 μm wavelength range. In these images, the ceramic appears transparent, comparable to optical glass. This behavior arises because birefringence in the advanced alumina is effectively eliminated, as demonstrated in Figure 2, resulting in pseudo-optical isotropy and enabling the transmission of highly coherent light. Because no residual pores remain in the ceramic, Mie scattering, which is caused by structural defects larger than the wavelength of light, is absent. Moreover, by suppressing birefringence, the refractive index dependence on the crystallographic orientation among the constituent grains is effectively removed.

Notably, we achieved these impressive optical results even though the average grain size of the advanced alumina is relatively large ($\sim 0.4\ \mu\text{m}$). This fact is significant because it demonstrates that the critical issue to engineering optical-grade noncubic-structured ceramics is how to eliminate birefringence rather than simply decreasing the grain size. However, grain size remains an important factor. We estimate that further refinement of the advanced alumina ceramics to about $0.1\ \mu\text{m}$ could yield high transparency even in the visible region, enabling true optical-grade components.

A clearer future for noncubic-structured transparent ceramics

In the 1990s, it was widely believed that the synthesis of polycrystalline ceramics with optical properties comparable to single crystals was theoretically impossible, even for materials with cubic crystal structures. When our pioneering 1995 paper proved otherwise, it opened the door to new research and development pathways that have since led to the commercialization of optical-grade cubic-structured ceramics.

Now in the 2020s, we stand at the cusp of a novel optical paradigm based on noncubic-structured ceramics, if we can successfully overcome the problem of birefringence. It is my hope that the insights provided in this article can inspire future research that ultimately opens the door to new technological frontiers.

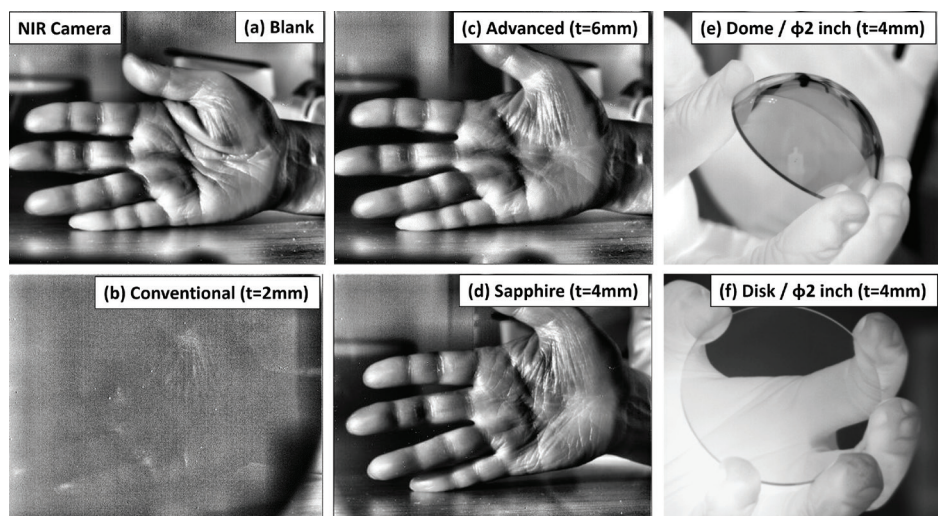


Figure 4. Hand image observed by near-infrared camera for a) blank, b) conventional alumina (2 mm thick), c) advanced alumina (6 mm thick), and d) c-axis sapphire single crystal (4 mm thick).¹⁰ Appearance of e) dome and f) disk-shaped advanced alumina observed by mid-infrared camera.

About the author

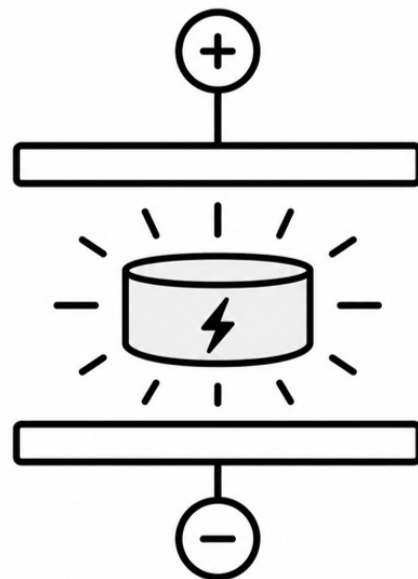
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Leveraging electric fields for enhanced properties: A case study on TiO_2

By Shikhar Krishn Jha



Schematic representation of flash sintering.

Credit: Jha

How do we control the properties of a material? It is one of the oldest questions in materials engineering, and titanium dioxide (TiO_2) is one of the best systems in which to watch the answer unfold.

This simple compound serves in a multitude of applications, including as a white pigment, a sunscreen, a photocatalyst that breaks down pollutants, and as an electrode in various types of metal-ion batteries. The key factor that changes from one role to the next is not necessarily the TiO_2 's composition but rather its electronic structure, which depends on how the material is synthesized and processed. Learning to tune the structure on demand, rather than accepting what the equilibrium process provides, enables this cheap and abundant oxide to exhibit a wide range of properties, which are well suited for each of its many applications.

Classic levers for changing electronic structure

Crystal structure is the first and least complicated lever for changing TiO_2 's electronic structure. TiO_2 has three primary (meta)stable crystal structures, or polymorphs: anatase, rutile, and brookite. The first two polymorphs feature tetragonal lattices, while the rather rare brookite form features an orthorhombic lattice.

All three polymorphs are wide band gap semiconductors, but their slightly different band gap sizes and crystal structures make them better suited for different applications. For example, anatase has a band gap of 3.2 eV and a more open crystal lattice. These features give anatase a high chemical reactivity, allowing it to be used primarily for light-activated applications such as photocatalytic water purification and solar cells. On the other hand, rutile has a band gap of 3.0 eV and a dense crystal lattice. These features give rutile superior stability and light-scattering properties, making it preferable for industrial pigments, sunscreens, and optics.

Besides the electronic structures inherently associated with the three polymorphs, scientists can use stoichiometry to tune TiO_2 's electronic structure. The titanium and oxygen phase diagram allows a wide range of oxygen-deficient compositions such as TiO , Ti_2O , Ti_2O_3 , Ti_3O_5 , Ti_4O_7 , and Ti_5O_9 , collectively written $\text{TiO}_{2-\delta}$. The oxygen vacancies in these compositions introduce localized electronic states inside the band gap, which can push TiO_2 's traditional light absorption spectrum from the ultraviolet range toward the visible.

Doping, or the substitution of a foreign element into the structure, is another way to introduce new electronic states into TiO_2 . Common dopants used to reduce TiO_2 's bandgap include both nonmetals (nitrogen, carbon, or sulfur) and metals (chromium, vanadium, iron, copper, silver, or cerium).

Each of these classic levers for changing TiO_2 's electronic structure has a limit, however. The metastable polymorphs will convert to rutile (the most thermodynamically stable phase) upon heating, the oxygen vacancies will disappear upon heating in air, and a dopant will dissolve only up to its equilibrium solubility before it segregates as a second phase. These limits are determined by the thermodynamic and kinetic parameters specific to TiO_2 . To achieve properties beyond these limits, the process by which TiO_2 is synthesized—rather than just the starting components—must change.

Harnessing electric fields and currents as a new lever

In a seminal 2010 study by Cologna et al.,¹ heating zirconia under an electric field (150 V/cm) brought the sintering temperature down from 1,500°C to 850°C, and the densification happened in merely 5 seconds instead of hours. The novel sintering process was named flash sintering because of the rapid densification and electroluminescence associated with the process.

The kinetics of diffusion and reaction during the flash sintering process were abnormally high, and Cologna et al. could not explain these values through simple Joule heating calculated from the blackbody radiation model. Later, several groups found that in addition to Joule heating, several mechanisms

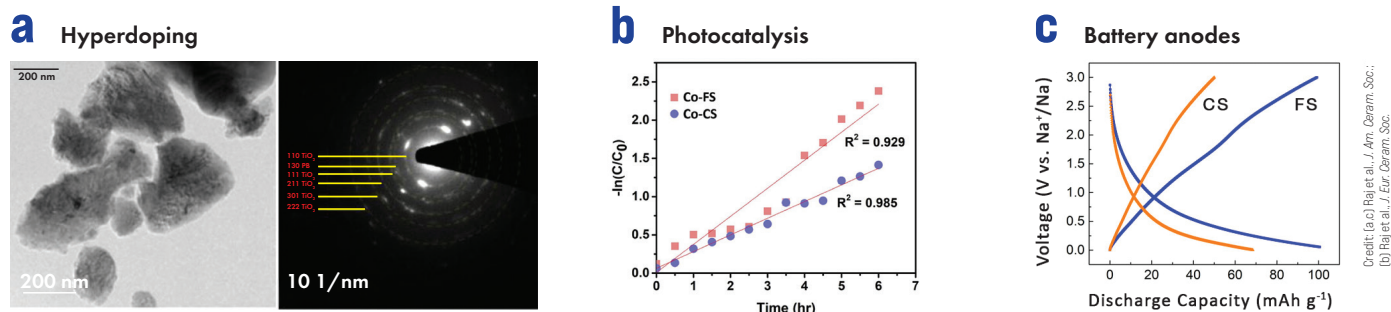


Figure 1. Examples of materials and applications enabled by processing TiO_2 under an electric field: (a) iron hyperdoping,⁵ (b) improved photocatalytic degradation kinetics,⁴ and (c) higher sodium-ion battery charge and discharge capacity.⁵ FS = flash sintering; CS = conventional sintering. Part (b) reprinted with permission from Reference 4. Copyright 2025 Elsevier.

were at work: ultrahigh heating rates, defect generation, and field-driven electrochemical activity.²

If there are indeed nonthermal defect formations that are speeding up the densification, these defects are likely altering the Gibbs free energy of the phases. If so, the phase equilibrium lines of the material could potentially be shifted, allowing the material's traditional solubility limit to be exceeded.

My colleagues and I investigated this possibility of using an electric field to exceed the solubility limit by flash sintering a TiO_2 sample doped with 10 at.% iron.³ TiO_2 's natural equilibrium solubility limit is only 5 at.% iron, but the electric field drives the material into a metastable state rich in Ti^{3+} and oxygen vacancies that ordinary sintering processes cannot reach. The result is a pronounced redshift in optical absorption, which allows for "hyperdoping" of the material.

Because the electric field alters the defect chemistry in the lattice, one hyperdoped TiO_2 platform can serve very different applications. For example, codoping with iron and copper narrows the band gap enough to degrade methylene blue under visible light, and our flash sintered catalyst outperformed its conventionally sintered twin thanks to a higher density of Ti^{3+} and oxygen vacancies.⁴ The same defect-rich oxide can also serve as a better sodium-ion battery anode, where the extra vacancies raise the electronic conductivity and sodium storage capacity that could not be achieved in conventional setups.⁵ A few results from these experiments are shown in Figure 1.

Beyond the equilibrium phase diagram

For more than a century, phase diagrams have been the maps that materials engineers use to predict thermodynamically stable materials. However, we have long known that phase diagrams may not provide the full picture. For example, the supersaturated, metastable solid martensite, which gives quenched steel its strength, does not appear on the traditional iron-carbon equilibrium phase diagram.

While reaction kinetics can override the thermodynamic guidelines shown in phase diagrams, electric fields offer another lever to push materials past their solubility limits and create compositions with properties no standard equilibrium route allows. In addition, other external fields such as atmosphere, (electro)magnetic, and pressure offer more levers that scientists

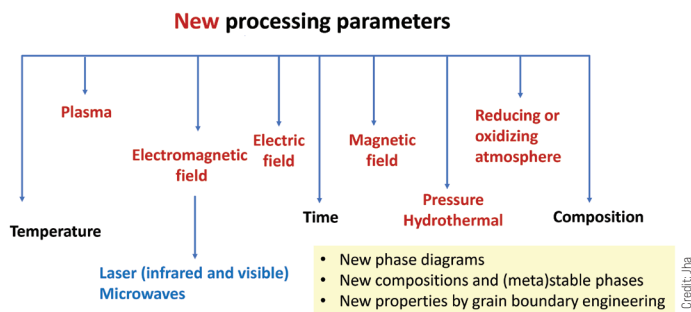


Figure 2. External processing parameters beyond temperature, composition, and time can open the door to new phase diagrams, (meta)stable compositions, and properties tailored by grain boundary engineering. New "levers" written in red.

can use to push past the limits of natural formation (Figure 2). Treated as genuine process parameters rather than as fixed background conditions, these fields turn the familiar map of temperature, composition, and time into a far larger design space. TiO_2 is only one example, and it already shows how much of that space is still open.

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CMCs in application: Exploring the pros and cons of different ceramic matrix composites

By Chris Thompson

Credit: Lucidson

Example parts made from Ox/Ox (white) and C/SiC (black) ceramic matrix composites.

Monolithic ceramics have helped shape the modern world, forging major technologies from cell phones to turbo chargers. But there is a key downside to these materials: their brittleness.

Most monolithic ceramics exhibit failure mechanisms that tend to be both sudden and catastrophic. In contrast, ceramic matrix composites (CMCs), which consist of a network of fibers or aggregates infiltrated with a ceramic matrix, can offer many of the same benefits as monolithic ceramics but with the addition of some ductility (Figure 1).

When a ceramic monolith cracks, the strong and directional atomic bonds in the material mean that atoms cannot easily slide past each other to blunt a crack. So, the crack usually travels rapidly through the part, causing total failure.

In CMCs, the ceramic typically begins to crack at a lower yield stress than in monolithic ceramics. However, when a crack hits the fibers in a CMC, it is deflected. This deflection continues to happen at other sites in the matrix, stunting the propagation of cracks and leading to pseudo-ductile behavior.

As the strain is further increased in CMCs, the matrix's ultimate strength is reached. Fibers then begin to bridge and pull out from the matrix until complete failure occurs. The result is a gradual, rather than catastrophic, failure mechanism.

It cannot be overstated how useful an engineering solution CMCs are, as they allow manufacturers to exceed the ceramic matrix's base properties. But aside from their failure mechanism,

other attributes of CMCs make them attractive to industry. Large parts can be made directly by infiltrating woven fibers with the ceramic matrix, which would not be possible with ceramic monoliths. Most fiber-based CMCs also offer weight savings compared to alloy alternatives, a characteristic of great interest for aerospace applications.

Since CMCs began development in the 1970s, many types of CMCs have been developed to address various industry needs. Each type comes with different advantages and disadvantages, as summarized below.

Types of CMCs

Ox/Ox

Ox/Ox are a family of CMCs consisting of oxide ceramic matrices (usually alumina) and fibers (typically woven pure alumina or mullite fibers). Because both the matrix and fibers are already fully oxidized, in contrast to nonoxide-based CMCs, Ox/Ox CMCs are a popular choice for applications that require high-temperature oxide resistance.

The flexural strength of Ox/Ox CMCs is typically much lower than monolithic alumina, with values around 150 MPa compared to about 400 MPa. The low flexural strength is due partly to the fact the alumina matrix cannot be fully sintered because of the low sintering temperature required to protect the fibers.

The requirement for a low sintering temperature can be mitigated by using alumina with a superfine particle size or sintering aids. However, liquid-phase sintering aids can reduce fiber strength due to chemical attack at high temperatures.

SiC/SiC

SiC/SiC CMCs, or those consisting of a silicon carbide (SiC) matrix and SiC fibers, are an exciting proposition due to SiC's inherent properties. It is an ultrahigh-temperature material with low thermal expansion and high hardness, and some grades possess a degree of electrical conductivity. These properties make SiC/SiC CMCs a big area of interest for nuclear fusion, in applications such as large neutron-absorbing structures for tokamak linings.

There are several methods of making SiC/SiC CMCs, and all involve high temperatures and liquid- or solid-state reactions. To get any benefit from a SiC/SiC system, the fibers must be prevented from assimilating into the matrix structure. To protect the fibers, an interface coating such as boron nitride is applied to the fibers to act as a barrier. This coating keeps the fibers intact during manufacture and provides a mechanism for the fibers to bridge, deflect cracks, and pull out in operation.

To protect SiC/SiC CMCs from oxidation, environmental barrier coatings can be applied. These coatings are particularly important for applications such as jet engine combustor liners or exhaust mixers, where material loss could be severe and consequential. These coatings often consist of multiple layers such as a silicon bond coat, a mullite intermediate layer, and a rare earth oxide top layer.

C/SiC

CMCs consisting of a SiC matrix and carbon fibers is a common configuration, due in no small part to the cost and limited availability of SiC fibers. The fibers have a pyrolytic carbon coating to protect them as the SiC matrix forms. Generally, C/SiC CMCs perform well at low temperatures, but they are less effective than SiC/SiC at higher temperatures in an oxidizing atmosphere due to fiber degradation. This issue can be mitigated to a certain extent by environmental barrier coatings.

UHTCMCs

Ultrahigh-temperature ceramics are materials that are designed for applications exceeding 2,000°C. Materials such as zirconium diboride, hafnium diboride, or mixes thereof are usually used as the matrix in CMCs alongside SiC or carbon fibers; SiC is often added to the matrix to aid sintering. Applications for these CMCs are extremely demanding, such as the leading edges for hypersonic vehicles or rocket thrusters.

Geopolymer CMCs

Geopolymers are aluminosilicate materials that are activated by strong alkali materials to form an inorganic polymer, which is cured at low temperatures (typically below 100°C) to achieve a ceramic-like solid. The source of aluminosilicate in geopolymers is typically an inexpensive material such as fly ash, metakaolin, or slag. When combined with fibers such as carbon, glass, basalt, or alumina, a CMC is produced that bridges the gap between organic polymer composites and a true CMC.

Some geopolymers can be heat treated to form ceramic phases, which allow operation at around 1,000°C. However, such treatment tends to result in significant shrinkage, which can compromise the CMC structure and expose the fibers.

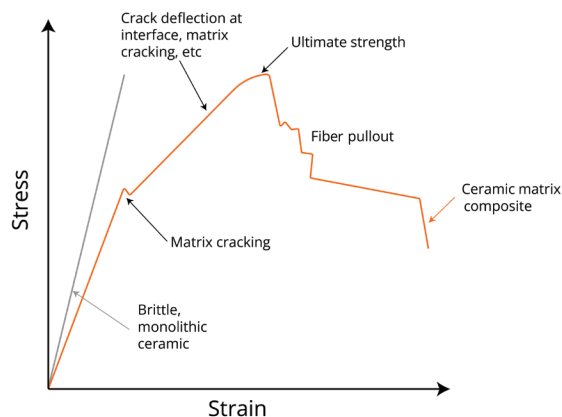


Figure 1. Typical stress versus strain curve for a ceramic matrix composite compared to a monolithic ceramic.

A cured geopolymer CMC can operate at around 250–450°C, but by careful formulation, products such as those produced using Lucideon's MIDAR™ technology can operate at around 1,000°C without heat treatment and with minimal cracking.

Geopolymer CMCs display a high flexural strength (200–300 MPa), which makes them a good choice for structural applications that require some heat resistance, such as aircraft heat shielding, fireproof building materials, and high-temperature oven linings. However, the choice of fibers for geopolymer CMCs is critical for the intended application. Carbon fibers are generally a poor choice for high-temperature applications in air, with alumina or basalt serving as the choice for up to 1,000°C operation in air. The largest material cost for geopolymer CMCs is usually the fibers.

The next 50 years of CMCs

As manufacturers prepare for the next five decades of CMC development, attention will focus on the continued maturation of the technology in supply chains, manufacturing capabilities, and end-use applications.

The tremendous performance capabilities of the materials are beyond doubt. The challenge now is determining how best to scale supply and production capacity, and to integrate the necessary processes and components into next-generation applications such as spacecraft heat shields, jet engine turbine blades, hypersonic propulsion systems, and leading-edge structures.

At U.K.-based international materials science consultancy and testing organization Lucideon, we work to accomplish these objectives through internal research and industry collaborations on CMCs, augmented by access to the sintering and densification equipment available at the open-access AMRICC Centre. Learn more about this work at <https://www.lucideon.com>.

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Radiation effects on rare earth chemistry in molten salts for nuclear applications

By Stephanie Castro Baldivieso, Jacy K. Conrad, and Gregory P. Horne

Across the nuclear energy sector, molten salts are shaping the next generation of nuclear technologies, from advanced power reactors to used nuclear fuel recycling.

In molten salt reactors (MSRs), molten salts uniquely serve as both the primary coolant and fuel medium, a dual role that sets MSRs apart from conventional reactor designs. In parallel, molten salts enable pyrochemical reprocessing of used nuclear fuel, allowing the recovery of valuable fissile material that can be fabricated into new fuel, supporting both energy security and nuclear waste management.

In both applications, nuclear radiation continuously modifies the salt's chemistry; understanding exactly how it does so is critical to making these technologies work safely and efficiently. Recent work from our group is beginning to map radiation-induced changes in detail, contributing to a mechanistic understanding of how fission products (FPs) behave and how radiation drives nonequilibrium chemistry in high-temperature molten chloride salt systems.

Fission product behavior in molten salts

In pyrochemical reprocessing, used nuclear fuel is dissolved in a molten chloride salt matrix, enabling chemical reduction of uranium dioxide and other FPs to the metallic state. This process is followed by electrochemical reduction to selectively isolate desired materials, such as uranium, onto a solid cathode.¹

However, some FPs are thermodynamically stable in the salt matrix, resulting in their accumulation over time. Accumulation of FPs gradually degrades the salt's usefulness and limits its recyclability, leading to additional nuclear waste.

In this regard, multivalent rare earth elements pose significant challenges because they are notoriously difficult to separate and tend to undergo comproportionation and disproportionation reactions, complicating recovery efforts. Neodymium, for instance, is typically recovered at efficiencies below 55%.²

The same rare earth element FPs pose challenges for MSRs because some are strong neutron poisons, absorbing neutrons needed to sustain a nuclear chain reaction. Their accumulation

must be carefully controlled, making effective management of these FPs essential for long-term reactor performance.

Accurately predicting the long-term behavior of these hard-to-separate rare earth elements requires a fundamental understanding of how ionizing nuclear radiation influences their chemistry in molten salts, an area that remains largely underexplored despite its importance to both reactor operation and salt waste management.

Radiation-induced speciation of neodymium ions

In our recent work,² we explored what happens to neodymium ions when they are exposed to nuclear radiation in molten lithium chloride–potassium chloride (LiCl–KCl) eutectic salt.

When the salt absorbs radiation energy, it generates two key reactive species: 1) strongly reducing solvated electrons (e_s^-) and 2) oxidizing chlorine atoms ($Cl^\bullet$), which rapidly react with surrounding chloride anions (Cl^-) to form dichlorine radical anions ($Cl_2^{\bullet-}$). In a pure salt with no other solutes, e_s^- either reduce trace metal ion impurities or recombine with $Cl^\bullet$, while $Cl_2^{\bullet-}$ predominantly undergo disproportionation, ultimately generating chlorine gas (Cl_2). In the presence of neodymium ions (Nd^{2+} and Nd^{3+}), predicting the radiolytic redox landscape becomes more complex. Mapping out these interactions required us to combine electrochemistry, spectroscopy, and a time-resolved technique called electron pulse radiolysis.

Electron pulse radiolysis works by firing intense, ultrashort pulses of high energy electrons into a sample, generating a burst of reactive species (e_s^- and $Cl^\bullet$ among them) in concentrations large enough to monitor in real time. Using transient absorption spectroscopy, researchers can watch these species form and decay on timescales ranging from nanoseconds to milliseconds, directly observing radiation-induced reaction pathways and deriving their chemical kinetics.

Our experiments were performed at the Brookhaven National Laboratory Laser Electron Accelerator Facility,³ a specialized facility designed for exactly this kind of ultrafast, time-resolved work. We measured how the molten salt absorbed light at different time intervals after each electron pulse, both with and without neodymium ions present, building up a picture of how the chemistry evolved in real time (Figure 1).

These measurements revealed that irradiating molten LiCl–KCl eutectic produces two dominant radiolytic species: short-

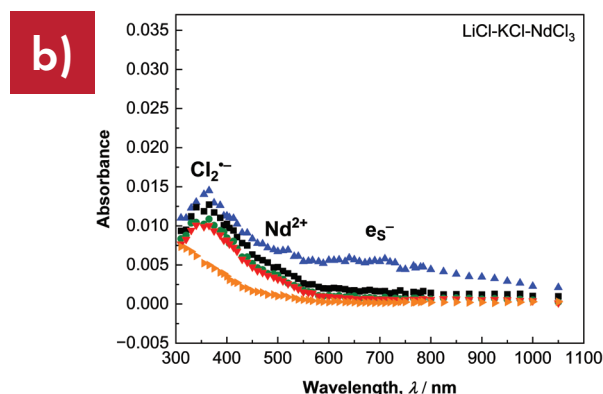
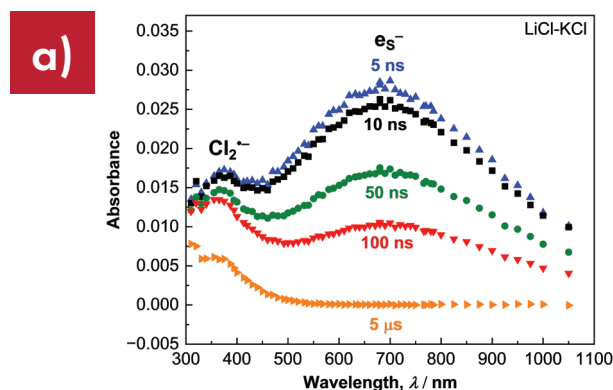


Figure 1. Transient absorption spectra for molten LiCl-KCl eutectic in the a) absence and b) presence of 10 mM NdCl_3 at select times following an electron pulse at 673 K. Reprinted with permission from Reference 2. Copyright 2026 American Chemical Society.

lived e_s^- ($< 5 \mu\text{s}$) and longer lived Cl_2^- ($> 5 \mu\text{s}$) (Figure 1a). Adding Nd^{3+} to the salt drastically changed the absorption landscape (Figure 1b). The e_s^- signal essentially vanished, indicating that Nd^{3+} rapidly reacts with them to become reduced to Nd^{2+} .

Using these spectra, we analyzed the decay kinetics of the e_s^- signal at 700 nm and found that the data are consistent with the reduction of Nd^{3+} at 673 K. Meanwhile, Cl_2^- (350 nm absorption maximum) remained detectable as a transient species. We also observed a small but consistent increase in absorbance in the region between 450 and 500 nm, suggesting the formation of Nd^{2+} , which was confirmed by complementary electrochemical measurements as well.

In molten LiCl-KCl eutectic salt, neodymium ions are predominantly stable in the +3 oxidation state,⁴ but under the right conditions, they can be reduced to the +2 oxidation state. Using spectroelectrochemistry, we demonstrated that the 450–500 nm feature corresponds to the characteristic absorption of Nd^{2+} , confirming that ionizing radiation can drive this reduction directly in molten chloride salts.

Additional insights into the behavior of Nd^{2+} were gained with a simpler experiment: immersing a neodymium metal rod into a molten NdCl_3 -LiCl-KCl salt mixture. Under these conditions, the metal rod reacted with the salt through comproportionation, steadily forming Nd^{2+} (Figure 2). Leaving the rod submerged for more than 30 minutes noticeably shifted the overall neodymium speciation in the salt, reinforcing the idea that both radiolytic and electrochemical pathways can generate Nd^{2+} under these conditions.

Toward a safer and more reliable nuclear future

As pyrochemical reprocessing and MSRs continue to mature, understanding how radiation shapes the chemistry of FPs in molten salts will be essential for improving process efficiency, predicting long-term materials behavior, and designing more robust nuclear fuel cycles. Our findings highlight the importance of considering both radiation driven and electrochemical pathways when evaluating multivalent rare earth element behavior in molten salts. They contribute to the ever-growing institutional knowledge of molten salt radiation chemistry, thereby helping pave the way for safer and more reliable nuclear technologies.

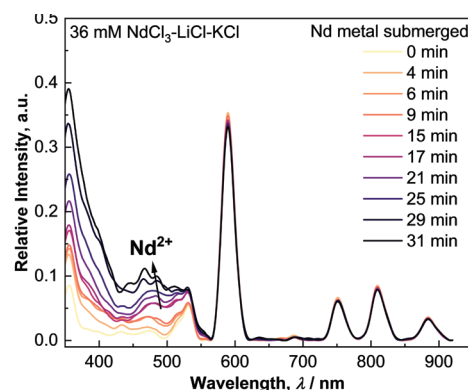


Figure 2. Absorption spectra for molten 36 mM NdCl_3 -LiCl-KCl at select times after submerging a neodymium metal rod at 773 K. Reprinted with permission from Reference 2. Copyright 2026 American Chemical Society.

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Breaking the mold: Cutting-edge research involving contrary ceramics

In general, ceramics and glasses are both considered hard, brittle materials that are resistant to corrosion and heat. However, researchers are constantly pushing the boundaries of what properties these materials can possess. This column will briefly highlight a variety of research that is expanding what our definition of a ceramic or glass can be.

For most use cases, glasses are designed to be chemically inert. But the area of bioactive glass requires the opposite, where the glass degrades over time to release drugs or other therapeutic agents. A subset of these glasses, called mesoporous bioactive glass (MBG), provide high surface areas and well-ordered pore structures that allow for even greater control of degradation, thereby promoting rapid tissue regeneration.

In the paper “Manganese-doped mesoporous bioactive glasses,”¹ Luna et al. investigated the doping of a specific bioactive glass composition (85S) with small mol% of manganese. They found that the compositions containing 0–2 mol% of manganese preserved the mesoporous structure, with the 1 and 2 mol% samples specifically showing enhanced antibacterial activity while also maintaining favorable bioactive behavior.

When one thinks of a glass fiber, optical cables are often the first application that comes to mind. But glass fibers are used as bioactive glasses as well. With diameters of tens to hundreds of micrometers, these alkali borosilicate fibers can offer mechanical flexibility while remaining chemically tunable.

The paper “From rigid membranes to flexible textiles: Porous glass fibers as carriers for sustained drug release” by Paul et al.² demonstrated that porous sodium borosilicate glass fibers could be processed into flexible woven textiles capable of sustained drug release. The authors investigated the effect of geometry, thermal history, and leaching conditions on the structural and mechanical properties of two different compositions and found that weaving the fibers offered superior bending flexibility and faster fabrication than rigid membranes.

While glasses and glass-ceramics are often considered mediums through which you can carry light, certain glass and glass-ceramic compositions can emit light themselves. This phenomenon is known as photoluminescence, which is triggered when a material absorbs a photon.

In the paper “Tunable white emission of $\text{Tm}^{3+}/\text{Dy}^{3+}$ co-doped phosphate glass and NaYF_2O_7 glass-ceramics for solid-state lighting,”³ Liang et al. presented a novel $\text{Na}_2\text{O}-\text{ZnO}-\text{Y}_2\text{O}_3-\text{B}_2\text{O}_3-\text{P}_2\text{O}_5$ phosphate glass and NaYF_2O_7 glass-ceramic co-doped with Tm^{3+} and Dy^{3+} . The authors investigated the influence of the Tm^{3+} and Dy^{3+} ion concentrations and heat treatments on the photoluminescence properties. Both the glass and glass-ceramic demonstrated tunability in the white-light emission, which was

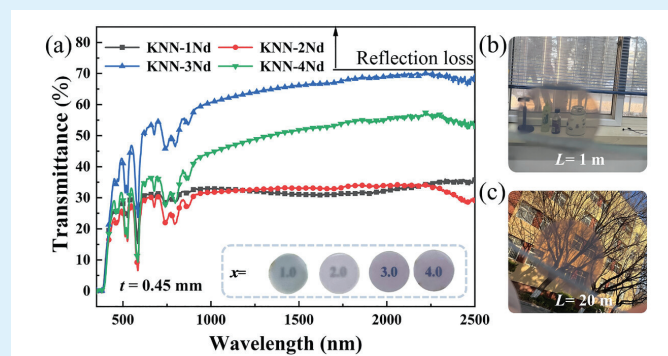


Figure 1. a) Transmittance spectra of the different KNN-xNd ceramics along with pictures of each sample. b) Near-view and c) far-view photos taken through one of the samples from 1 meter and 20 meters away.

also tested by assembling $\text{Tm}^{3+}/\text{Dy}^{3+}$ co-doped phosphate glass and glass-ceramic-based white-light-emitting diodes devices.

Finally, transparent ceramics can be synthesized that combine both photoluminescence and photochromism (when a material undergoes a reversible color change after light exposure). This combination of properties allows for multimodal modulation of optical properties, which is especially useful for applications such as smart windows, tunable optical switches, and optical storage devices.

In the paper “Optical modulation of near-infrared-emitting KNN-xNd transparent photochromic ceramics,”⁴ Wang et al. fabricated neodymium-doped $\text{K}_{0.5}\text{Na}_{0.5}\text{NbO}_3$ (KNN) transparent photoluminescent ceramics that display high optical transparency, strong near-infrared emission, and controllable photochromic behavior (Figure 1). This tunable behavior is due to the presence of color centers that influence the visible light absorption and the relaxation processes of the excited electronic states.

These articles are just a few examples of the research being reported in ACerS journals that change the way we think about ceramic and glass materials. To read more, visit the ACerS journals homepage at <https://ceramics.onlinelibrary.wiley.com>.

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CERAMICS EXPO 2026: UNLOCKING THE POTENTIAL OF ENGINEERED CERAMICS FOR THERMAL MANAGEMENT

All photos credit: ACerS

Things are heating up in the world of engineered materials as next-generation aerospace, energy, and electronic applications push manufacturers toward better thermal management solutions. Ceramics in particular have an important role to play in this regard, as demonstrated at the annual Ceramics Expo.

Ceramics Expo is the leading annual supply chain exhibition and conference for the advanced ceramics and glass industry. After three years in Novi, Mich., this year's event returned to its original home of Cleveland, Ohio, from May 5–6, 2026.

Ceramics Expo kicked off Monday night with a VIP networking event, where the mayor of Cleveland gave a talk welcoming the conference back to the city. The following two days were filled with exhibiting and conference talks at the Huntington Convention Center of Cleveland, which ran alongside the co-located Thermal Management Expo.

The welcome address on Tuesday morning by Andrea Ross, director of meetings, membership, and marketing at The American Ceramic Society, wasted no time outlining the benefits of ceramics for thermal management. She noted that ceramics have been used in traditional thermal management applications for centuries, such as metallurgical processing, and then highlighted recent *ACerS Bulletin* articles that demonstrate the use of ceramics in more advanced sectors, such as nuclear energy and silicon carbide semiconductors.

To support the development of engineered ceramics for thermal management and other advanced applications, organizations across the United States are funding projects and collaborations that will lead to accelerated discovery. The American Ceramic Society is doing its part through the U.S. Department of Defense-funded Hypersonic Training Program, held in partnership with the United States Advanced Ceramics Association.

ACerS is not the only Ohio-based organization supporting advanced ceramics research and development—the state in general has become known as a national leader in this area. The opening panel



Jennifer Scheel (far left), executive attraction officer for the City of Cleveland, led a panel discussion on what universities, government laboratories, and companies across Ohio are doing to advance ceramic research and development in the state. Panelists from left: Marissa Reigel, director of R&D at Saint-Gobain NorPro; Daniel Gisser, president of Tillerline Associates LLC; Nick Barendt, assistant vice president of research for technology and ecosystem growth at Case Western Reserve University; and Matt Dolan, CEO of Team NEO.

session, moderated by City of Cleveland Executive Attraction Officer Jennifer Scheel, talked with four experts from across Ohio about how universities, government laboratories, and companies are collaborating to advance ceramic research and development in the state.

In addition to the focus on engineered materials for thermal management applications, featured talks also covered some of the practical challenges of advanced ceramics processing. Additive manufacturing was touched on several times, as usual, but discussion of nanomanufacturing, quality control systems, and how to transition laboratory innovations to commercial deployment took place as well.

A special roundtable discussion on artificial intelligence also took place on Tuesday morning. Delivered in alliance with the Greater Cleveland Partnership, the discussion titled “Enterprise capacity through AI/ML: Scaling what you already do well” brought together chief information officers from across the advanced manufacturing sector for a candid conversation about AI integration. They noted that even



In addition to giving the welcome address, Andrea Ross (right) also moderated the morning keynote by Jon Goldsby (left) of NASA Glenn Research Center, who presented on ultrahigh-temperature ceramics for space and aeropropulsion applications.

though industry has been making use of AI for years now, it remains an expensive practice with no clear return on investment in sight.

Again this year, Ceramics Expo 2026 included a Solutions Innovation Stage alongside the main conference presentations. This stage provides an opportunity for ceramic suppliers and manufacturers to present real-world examples of the solutions discussed during the main talks.

The number of presentations on the Solutions Innovation Stage grew noticeably this year. Representatives from Alloy Enterprises, Fabric8Labs, Lucideon, Eurofins EAG Laboratories, Laird Technologies, American Elements, Almatris, Switzer, Fabrisonic, ThermStar System, Alpha HPA, Case Western Reserve University, Resonac Corporation, and West Ohio Tool Co. all gave talks.

Overall, this year's conference demonstrated the bright future ahead for engineered ceramics. Next year, Ceramics Expo will take place in Cleveland, Ohio, April 20–21, 2027. ■

UPCOMING MEETINGS



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Submit your abstract!



MAY 23-28, 2027

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SAN FRANCISCO, CALIF.**

Six ACerS Divisions are collaborating to host the second-annual ACerS Spring Meeting in San Francisco, Calif. Each of the six Divisions will create its own programming, though collaborative sessions will take place as well. One registration fee will allow you access to all programming and events.

Submit your abstract!

LEGEND: A red circle ● denotes a new event in this issue. A star ★ denotes an ACerS short course.

September 2026

ENDORSED EVENT

6–11 11th International Congress on Ceramics – Sapporo Convention Center, Sapporo, Japan; <https://www.ceramic.or.jp/icc11>

★ ACERS COURSE

14–15 Tools for Visualizing and Understanding the Structure of Crystalline Ceramics – Virtual <https://ceramics.org/course/sparks-crystalline-ceramics>

★ ACERS COURSE

15–Dec. 10 Refractory Fundamentals – Virtual; <https://ceramics.org/course/homeny-refractory-fundamentals>

★ ACERS COURSE

22–Oct. 1 Sintering of Ceramics – Virtual; <https://ceramics.org/course/castro-sintering-course>

★ ACERS COURSE

29 Thermal Measurement Workshop – Columbus, Ohio; <https://ceramics.org/course/thermal-measurement-workshop-2026>

ENDORSED EVENT

29–Oct. 1 International Thermal Conductivity Conference and International Thermal Expansion Symposium 2026 – Renaissance Columbus Westerville-Polaris Hotel, Westerville, Ohio; <https://ceramics.org/itcc2026>

October 2026

ACERS EVENT

4–7 ACerS 128th Annual Meeting with Materials Science and Technology 2026 – David L. Lawrence Convention Center, Pittsburgh, Pa.; <https://ceramics.org/annual-meeting2026>

★ ACERS COURSE

13–22 Practical AI and Machine Learning for Materials Science – Virtual; <https://ceramics.org/course/sparks-practical-ai-machine-learning>

November 2026

★ ACERS COURSE

3–4 Ceramic Matrix Composites and Joining of Dissimilar Materials – Virtual; <https://ceramics.org/course/cmc-joining-materials>

January 2027

ACERS EVENT

24–29 51st International Conference and Expo on Advanced Ceramics and Composites – Hilton Daytona Beach Oceanfront Resort, Daytona Beach, Fla; <https://ceramics.org/icacc2027>

May 2027

ACERS EVENT

23–28 ACerS Spring Meeting 2027 – Hilton San Francisco Union Square, San Francisco, Calif.; <https://ceramics.org/acersspring2027>

June 2027

ENDORSED EVENT

20–24 16th International Conference on the Structure of Non-Crystalline Materials – Embassy Suites Boulder and Hilton Garden Inn Boulder, Boulder, Colo.; <https://ceramics.org/ncm16>

October 2027

ACERS EVENT

24–27 ACerS 129th Annual Meeting with Materials Science and Technology 2027 – David L. Lawrence Convention Center, Pittsburgh, Pa.; <https://ceramics.org/annualmeeting2027>

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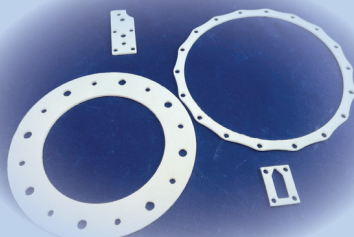
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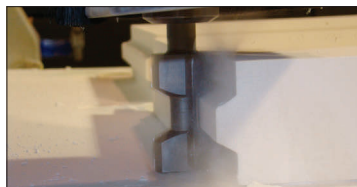
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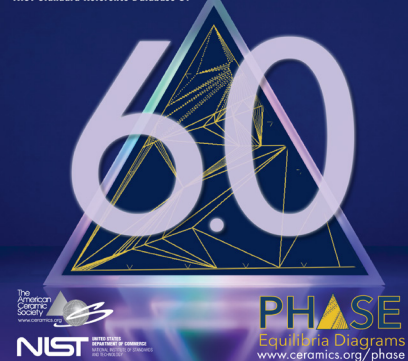
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Polycrystalline transparent ceramics: Developing optical materials for extreme environments

When people think of transparent materials, they often think first of glass or plastic. Indeed, for everyday applications, these materials are hard to beat: They offer excellent optical properties, adequate mechanical properties, and can be fabricated easily and affordably on an industrial scale.

In extreme environments, however, these materials fall short of the mark. Glasses and plastics simply cannot withstand the extreme thermal and mechanical loads encountered during hypersonic flight or when monitoring experimental fusion reactors, for example.

Enter transparent ceramics. These advanced materials combine the extraordinary thermal resistance and mechanical strength of ceramics with the transparency of glasses and plastics.

Transparent ceramics are traditionally single crystals, with sapphire (single crystal aluminum oxide) being the prime example. Sapphire exhibits both extreme thermal resistance (melting point above 2,000°C) and mechanical resistance (second hardest material after diamond on the Mohs scale).¹

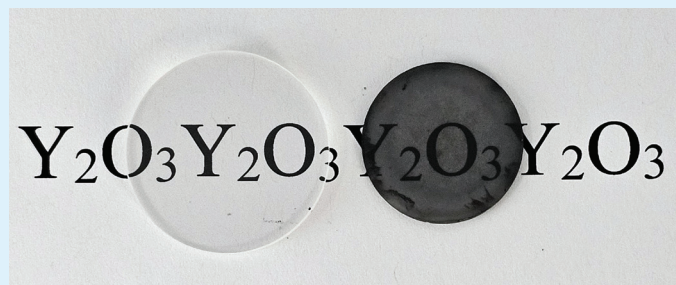
Although the mechanical and thermal properties of sapphire and other single crystal transparent ceramics outperform those of glasses and plastics, polycrystalline ceramics can potentially achieve even greater performance. In contrast to single crystals, which feature a continuous, uninterrupted atomic lattice, polycrystalline ceramics consist of many smaller, randomly oriented crystals called grains. These differing atomic structures mean that single crystals and polycrystalline ceramics demonstrate different failure mechanisms.

In general, ceramic materials are extremely resistant to compression, but due to their rigid nature, they are prone to failure when exposed to tensile and shearing forces. These forces can generate small cracks that propagate rapidly through the material, causing catastrophic failure.

In single crystals, there is little barrier to this crack propagation. So, once a crack reaches a certain critical size, complete failure is only a matter of time. In contrast, the grain boundaries in polycrystalline ceramics can help deflect and slow the growth of cracks in the material.

It is important to note that polycrystalline ceramics with large grain sizes may have lower strength than single crystals. This seemingly contrary behavior is because the larger grains can accommodate larger internal flaws and cracks. However, decreasing the grain size both limits the flaw size and increases the number of grain boundaries, which limits crack propagation. Shrinking the grain size can also improve the optical performance of polycrystalline ceramics, as described in the feature article “Noncubic-structured transparent ceramics” on page 28.

Achieving these ultrafine grain structures poses significant technical challenges, however. Polycrystalline ceramics are



Credit: Tallan

Figure 1. Two samples of polycrystalline yttria. The left-side sample is of exceptional quality, while the right-side sample has numerous defects, such as chemical impurities and oxygen vacancies.

almost always manufactured by densifying raw powders. The manufacturing process typically starts by treating ultrahigh-purity powders to increase their processability. Next, the powders are pressed into a moderately dense mass and then sintered at high temperatures to near theoretical density. If porosity remains at this point, hot isostatic pressing may be used followed by an annealing step to relieve internal stresses.²

My research group at Washington State University works on manufacturing fine-grained transparent ceramics for infrared imaging applications (Figure 1). We are particularly interested in noncubic-structured optical materials, such as tetragonal zirconia, and dual-phase materials, such as gadolinia. These materials have promising qualities but require highly refined microstructures before they can be realized.

We use high-purity nanopowders to create our samples, which also undergo careful machining, grinding, and polishing to achieve a mirror finish. Extreme caution must be used during these final forming steps, as any flaws introduced during this part of the process can become weak points in the material.

If these steps are correctly and carefully followed, we can obtain high-quality transparent ceramics with both excellent optical and mechanical properties, ready to be used in the most demanding applications not suitable for any other materials.

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Joseph Tallan is a Ph.D. student at Washington State University. His research involves ultrahigh-temperature ceramics, optical materials, and infrared windows and domes. Outside of school, he enjoys weightlifting, Strongman, cooking, autocross, and working on cars. ■



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37 Rb 85.4678 Rubidium										38 Sr 87.62 Strontium										39 Y 88.90585 Yttrium										40 Zr 91.224 Zirconium										41 Nb 92.90638 Niobium										42 Mo 95.94 Molybdenum										43 Tc (98.0) Technetium										44 Ru 101.07 Ruthenium										45 Rh 102.9055 Rhodium										46 Pd 106.42 Palladium										47 Ag 107.8682 Silver										48 Cd 112.411 Cadmium										49 In 114.818 Indium										50 Sn 118.71 Tin										51 Sb 121.76 Antimony										52 Te 127.6 Tellurium										53 I 126.90447 Iodine										54 Xe 131.29 Xenon									
55 Cs 132.9054 Cesium										56 Ba 137.327 Barium										57 La 138.90547 Lanthanum										58 Ce 140.12 Cerium										59 Pr 140.90768 Praseodymium										60 Nd 144.242 Neodymium										61 Pm (145) Promethium										62 Sm 150.36 Samarium										63 Eu 151.964 Europium										64 Gd 157.25 Gadolinium										65 Tb 158.92535 Terbium										66 Dy 162.5 Dysprosium										67 Ho 164.93032 Holmium										68 Er 167.259 Erbium										69 Tm 168.93421 Thulium										70 Yb 173.054 Ytterbium										71 Lu 174.967 Lutetium																			
72 Hf 178.48 Hafnium										73 Ta 180.948 Tantalum										74 W 183.84 Tungsten										75 Re 186.207 Rhenium										76 Os 190.23 Osmium										77 Ir 192.222 Iridium										78 Pt 195.084 Platinum										79 Au 196.96657 Gold										80 Hg 200.59 Mercury										81 Tl 204.3833 Thallium										82 Pb 207.2 Lead										83 Bi 208.9804 Bismuth										84 Po (209) Polonium										85 At (210) Astatine										86 Rn (222) Radon																																							
87 Fr (223) Francium										88 Ra (226) Radium										89 Ac (227) Actinium										90 Th 232.03756 Thorium										91 Pa 231.03688 Protactinium										92 U 238.02891 Uranium										93 Np (237) Neptunium										94 Pu (244) Plutonium										95 Am (243) Americium										96 Cm (247) Curium										97 Bk (247) Berkelium										98 Cf (251) Californium										99 Es (252) Einsteinium										100 Fm (257) Fermium										101 Md (258) Mendelevium										102 No (259) Nobelium										103 Lr (262) Lawrencium																			
104 Rf 261.10881 Rutherfordium										105 Db 262.10881 Dubnium										106 Sg 263.10881 Seaborgium										107 Bh 264.10881 Bohrium										108 Hs 265.10881 Hassium										109 Mt 266.10881 Meitnerium										110 Ds 267.10881 Darmstadtium										111 Rg 268.10881 Roentgenium										112 Cn 269.10881 Copernicium										113 Nh 270.10881 Nihonium										114 Fl 271.10881 Flerovium										115 Mc 272.10881 Moscovium										116 Lv 273.10881 Livermorium										117 Ts 274.10881 Tennessine										118 Og 275.10881 Oganesson																																							

72 Hf 178.49 Hafnium	73 Ta 180.948 Tantalum	74 W 183.84 Tungsten	75 Re 186.207 Rhenium	76 Os 190.23 Osmium	77 Ir 192.222 Iridium	78 Pt 195.084 Platinum	79 Au 196.966569 Gold	80 Hg 200.59 Mercury	81 Tl 204.3833 Thallium	82 Pb 207.2 Lead	83 Bi 208.9804 Bismuth	84 Po (209) Polonium	85 At (210) Astatine	86 Rn (222) Radon
90 Th 232.03756 Thorium	91 Pa 231.03688 Protactinium	92 U 238.02891 Uranium	93 Np (237) Neptunium	94 Pu (244) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (247) Berkelium	98 Cf (251) Californium	99 Es (252) Einsteinium	100 Fm (257) Fermium	101 Md (258) Mendelevium	102 No (259) Nobelium	103 Lr (262) Lawrencium	

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