Celebrating 100 years

AMERICAN CERAMIC SOCIETY

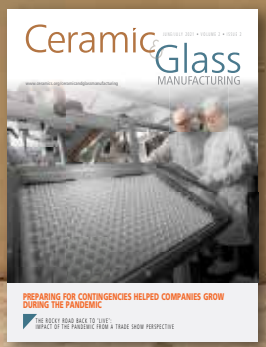
bulletin

emerging ceramics & glass technology

JUNE/JULY 2021

Student perspectives on facing uncertainty

New issue inside:



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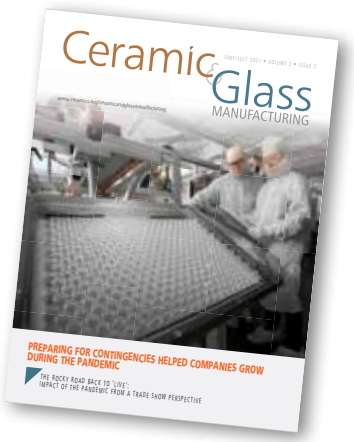
Preparing for contingencies helped companies grow during the pandemic



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As seen on *Ceramic Tech Today*...

Credit: NASA/JPL-Caltech

Video: NASA technology extracts oxygen from Martian atmosphere

To achieve future manned missions to Mars, we must be able to extract oxygen from the Martian atmosphere. An experimental instrument aboard the Perseverance rover called MOXIE succeeded in extracting oxygen for the first time during a test on April 20.

Read more at www.ceramics.org/MOXIE

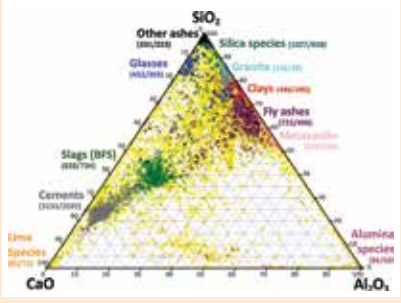
Also see our ACerS journals...

Artificial intelligence and machine learning in glass science and technology: 21 challenges for the 21st century
By Ravinder, V. Venugopal, S. Bishnoi, et al.
International Journal of Applied Glass Science

Relationship of structure and mechanical property of silica with enhanced sampling and machine learning
By Y. Deng, T. Du, and H. Li
Journal of the American Ceramic Society

Literature mining for alternative cementitious precursors and dissolution rate modeling of glassy phases
By H. Uvegi, Z. Jensen, T. N. Hoang
Journal of the American Ceramic Society

Ceramic materials for energy conversion and storage: A perspective
By O. Guillon
International Journal of Ceramic Engineering & Science



Read more at www.ceramics.org/journals

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ACSBA7, Vol. 100, No. 5, pp 1– 64. All feature articles are covered in Current Contents.

Obstacles and opportunities to commercializing carbon capture and storage

Carbon capture and storage, or CCS, is the process of trapping carbon dioxide and storing it in such a way that it cannot affect the atmosphere. Bipartisan members of Congress have for years looked favorably on and funded CCS technologies and policies, yet investment in CCS technology has to date yielded underwhelming results.

"The 2000s saw the largest U.S. push to commercialize the technology, with private industry and government investing tens of billions of dollars in dozens of industrial and power plant capture projects. Despite extensive support, the vast majority of these failed," researchers explain in a recent open-access article.

The researchers come from the University of California, San Diego, along with colleagues from Carleton University (Canada) and Imperial College London (U.K.). In a UC San Diego press release, they explain that with so much riding on CCS technol-

Credit: stanze, Flickr (CC BY-SA 2.0)

A coal-fired power station in Mannheim, Germany. Many governments expect carbon capture and storage technologies to play an important role in combatting carbon emissions, but to date investments in such technologies have yielded underwhelming results.

Table I. The 12 CCS project attributes that can be evaluated quantitatively in a replicable manner. Hypothesis statements summarize how attributes could positively impact the likelihood of project success. Credit: Abdulla et al., *Environmental Research Letters* (CC BY 4.0)

Category	Project attribute	Hypothesis statement
Engineering economics	Plant siting	Locating on brownfield sites entails less site preparation, less extensive development of new infrastructure, and less regulatory burden.
	Capture technology readiness level	Deploying technologies already demonstrated at scale reduces technical, system integration, and project execution risks.
	Capital cost	Cheaper projects are easier to finance and overall carry less risk.
Financial credibility	Employment impact	Projects that improve local or regional economies through employment are more likely to form coalitions in their favor.
	Credibility of revenues	Projects that can demonstrate credible revenue streams or reduce their uncertainty are more likely to succeed.
	Credibility of incentives	Projects that secure a greater share of their cost are more likely to succeed. Incentives that are unconditional and upfront are more credible.
Local political features	Population proximity	Projects in sparsely populated locales are more likely to succeed because they encroach on fewer people and organized interests.
	Institutional setting	Projects benefit from jurisdictions with a legacy of supporting fossil infrastructure and attendant institutional memory in applying policy and regulatory frameworks.
	Burden of CO_2 disposal	Projects requiring less onerous arrangements for capture, storage, monitoring, and verification entail less risk.
Broader political features	Regulatory challenges	Projects that encounter neither legal difficulties nor regulatory delays are more likely to succeed.
	Public opposition	Projects that enjoy support from environmental or civil society groups are more likely to succeed.
	Industrial stakeholder opposition	Projects where concentrated industrial stakeholders align strategically with the developer are more likely to succeed.

ogy, "Policy design is essential to help commercialize the industry because CCS projects require a huge amount of capital up front." However, to design good policy, it is necessary to understand why investments in CCS projects to date have such a high failure rate.

Historically, studies on CCS failures and successes relied on analyzing CCS projects individually or in small studies. The researchers for this study, though, chose to robustly analyze 39 projects selected from the U.S. Department of Energy's National Energy Technology Laboratory database.

They used a linear regression model and a random forest model to identify functional relationships between 12 project attributes (see Table I) to project outcome. They also conducted an invitational workshop with CCS experts to learn their thoughts on each attribute's relative importance.

Three attributes emerged as significant variables across both the statistical models and expert-derived model.

1. **Capital cost:** Projects with larger capital costs are more likely to fail.
2. **Technological readiness:** High levels of readiness improve the chances of project success.
3. **Credibility of project revenues:** More credible sources strongly increase odds of project success.

Corporate Partner News

Allied Refractory Products India celebrates 10th anniversary

Allied Refractory Products India celebrated its 10th anniversary in April. The facility in Sanand, Ahmedabad district manufactures high-quality refractory products to the same standards used at its headquarters in Columbus, Ohio.

Since establishing itself in India in 2011, Allied saw significant growth in the refractory industry practices. During the early years, most foundries used sand in their holding and transfer ladles. Allied provided a more efficient way of transferring metals using monolithics to extend lining life and reduce cost. Allied also was a pioneer in introducing a range of premixed, boron oxide-silica-based linings for coreless induction furnaces, melting cast iron and ductile-base iron. One of Allied's most innovative technologies for the region is its large grain silica technology. Additionally, Allied introduced high alumina, spinel linings to replace the traditional method of using local magnesia.

Learn more at www.alliedmineral.com. 100

CM Furnaces celebrates 75th anniversary

CM Furnaces is currently celebrating its 75th anniversary. The company was started in 1946, primarily serving the lighting, molybdenum, and tungsten industry. It has grown since that time, providing furnaces for 12 different industries worldwide. CM is a major producer of laboratory and production furnaces for numerous applications.

Learn more at www.cmfurnaces.com. 100

On the other hand, three different attributes witnessed disagreement among models.

1. **Regulatory challenges:** While both statistical models found this attribute to be the fourth most important in explaining project outcome, experts ranked it seventh in importance. Analysis of the historical record suggests that projects that face permit denials, extended regulatory proceedings, or lawsuits are more likely to fail.

2. **Employment impact:** This attribute is important in the random forest model but not statistically significant in the linear regression; the experts judged it to be largely irrelevant. Analysis of the historical record reveals projects that propose more extravagant plans to improve economies through employment are those that are expensive, high-profile, and high-risk—all factors that increase odds of failure.

3. **Burden of CO_2 disposal:** Experts ranked this attribute fourth of 12 in importance, whereas it is insignificant in the statistical models. The experts stated that the visibility of documentary evidence (which the statistical models focus on) inherently ignores the groundwork that disposal requires on the part of project developers.

A fourth attribute—**credibility of incentives**—was significant for both the linear regression and expert-derived models, but not in the random forest. However, the linear regression and expert-derived models felt incentives were significant for different reasons.

The linear regression model found an inverse relationship between incentives and project outcome—successful projects rely less on incentives than those that fail. "Projects with high price tags have generally received government incentives; they are flagship, high-profile, sometimes high-risk, demonstration projects. It is precisely these types of projects that often fail, ... By contrast, projects that succeed are smaller, less costly, and rely less on incentives," the researchers write.

Nonetheless, CCS experts argue incentives are essential to successfully commercializing CCS technology—though not necessarily in the form of funding for specific projects. "In other words, experts believe that it is not direct support for the CCS industry that will lead to the largest volumes of CO_2 capture; rather, what matters most are incentives that encourage systematic decarbonization, such as government procurement of decarbonized industrial products or a broad low-carbon fuel standard," the researchers write.

The open-access paper, published in *Environmental Research Letters*, is "Explaining successful and failed investments in U.S. carbon capture and storage using empirical and expert assessments" (DOI: 10.1088/1748-9326/abd19e).

By Lisa McDonald

Into the Bulletin Archives—A look back at our 100 years in print

Since May 1922, the *ACerS Bulletin* has served the ACerS community, providing them updates on member news, Division meetings, and the latest research in ceramics and glass.

In celebration of Volume 100 this year, the *Bulletin* editorial team is running a special column in each issue of the 2021 *Bulletin* that looks at the history of the *Bulletin* by decade. This issue highlights the 1960s.

We hope you enjoy following the journey of the *Bulletin* from its early years to today. As an ACerS member, you have access to all 100 years of the *Bulletin* on the *Bulletin Archive Online* at https://bulletin-archive.ceramics.org. 100

Into the *Bulletin* Archives—1960s

The *Bulletin* regularly featured a buyer's guide section since the 1930s, but the first instance of an annual ceramic company directory appeared in the January 1964 issue. About 1,000 companies were listed in the first edition; by the end of the decade, the sixth edition contained about 1,300.

While the use of big data for materials design is a hot topic in current times (see page 24 for our interview on the Materials Genome Initiative), the use of computers to accelerate research was just beginning to take hold in the 1960s. This budding trend can be tracked throughout the *Bulletins* of this decade. For example,

- July 1966: Announcement for a joint seminar on the application of computers and computer technology in the ceramic industry, to be held by the National Institute of Ceramic Engineers and the Ceramic Educational Council. (p. 675)
- March 1968: A summary of the Northern Ohio Section's technical session on the use of computers by ceramic producers (p. 321) and an article on using computers to perform whiteware control tests (pp. 287–291).
- June 1968: Several articles exploring the use of computers for materials design, including one on using computerized process control for ferrite core manufacturing (pp. 569–571) and one on using computers to process data in production of glass containers (pp. 576–577).

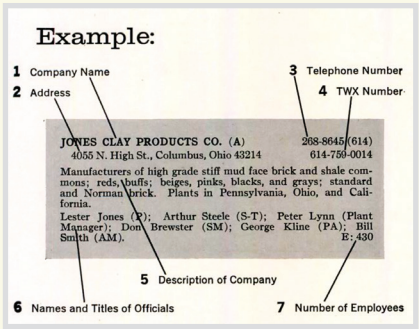
The role of computers in emerging space applications also made an appearance in the August 1962 issue, in an article discussing ceramic-metal science and technology in the Space Age.

> "It appears then that *Materials Science* looms large as we face the challenge of the 'space age.' It is indeed already in action. Computers take data on properties of materials and conditions to be met and solve (let us hope) the problems of what to use. Speaking of computers, Richard Hamming of the Bell Telephone Laboratories recently suggested (as quoted from *Space Age News*) that processes required to program a problem for a computer can illuminate methods of solving the problem by pointing out

1960s

Credit: *ACerS Bulletin* (June 1969) Vol. 48 Iss. 6, p. 638

▲ While ACerS held exhibitions at its meetings before (see May 1922, p. 10), the first Annual Exposition took place at the 71st Annual Meeting in Washington, D.C. The exposition contained displays by 116 participating companies.



Credit: *ACerS Bulletin* (January 1964) Vol. 43 Iss. 1, p. 38.

▲ An example listing that shows companies how their information will be presented in the new ceramic company directory.

details and techniques previously overlooked without actually utilizing the computer."

–ACerS Bulletin, Vol. 41., Iss. 8., August 1962 (p. 524)

The Society added one Division and changed the name of another during the 1960s. The Enamel Division was renamed Ceramic-Metal Systems to better represent the Division's expanding interests, as detailed in the November 1961 issue. Four years later, the Nuclear Division was established in December 1965. The February 1966 issue explains that the Board received a petition to create a Nuclear Division in September 1959, but it wasn't until July 1965 that the proposal was considered and approved.

The biggest shakeup to the Society took place in 1969, when the Board thoroughly revised and updated the Constitution and Bylaws. The March 1969 issue provides a detailed guide listing the changes approved for adoption, contingent upon acceptance by the members. Some of the notable changes include

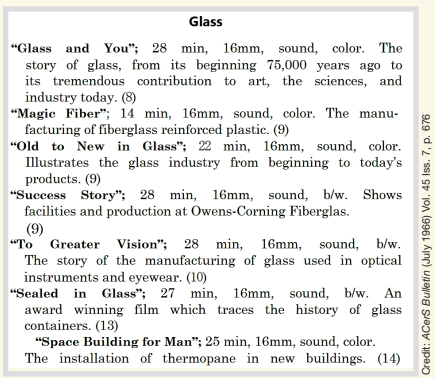
• Article III, Membership: Qualifications for the grades of membership are moved from the Constitution to the Bylaws, leaving only the grades of membership listed in the Constitution.

• Article VI, Nominations and elections: Constitutional provision barring the president-elect from serving on the Nominating Committee, thus making it impossible for them to take part in the choice of their successor.

• Article X, Divisions: Prohibition against voting or holding office simultaneously in more than one Division.

DIVISIONS OF THE SOCIETY During the 1960s, the Society had 10 Divisions.

- Basic Science
- Ceramic-Metal Systems (previously Enamel)
- Design
- Electronics
- Glass
- Materials and Equipment
- **Nuclear (new)**
- Refractories
- Structural Clay Products
- White Wares



Glass

"Glass and You"; 28 min, 16mm, sound, color. The story of glass, from its beginning 75,000 years ago to its tremendous contribution to art, the sciences, and industry today. (8)

"Magic Fiber"; 14 min, 16mm, sound, color. The manufacturing of fiberglass reinforced plastic. (9)

"Old to New in Glass"; 22 min, 16mm, sound, color. Illustrates the glass industry from beginning to today's products. (9)

"Success Story"; 28 min, 16mm, sound, b/w. Shows facilities and production at Owens-Corning Fiberglas. (9)

"To Greater Vision"; 28 min, 16mm, sound, b/w. The story of the manufacturing of glass used in optical instruments and eyewear. (10)

"Sealed in Glass"; 27 min, 16mm, sound, b/w. An award winning film which traces the history of glass containers. (13)

"Space Building for Man"; 25 min, 16mm, sound, color. The installation of thermopane in new buildings. (14)

Credit: *ACerS Bulletin* (July 1966) Vol. 45 Iss. 7, p. 676

Several times throughout the 1960s, the *Bulletin* published a list of films pertaining to ceramics and related fields. The list was a continuing project of the Missouri Chapter of Keramos. The number following each film indicates the distributor who offered it.

Text analytics: Global markets

By BCC Publishing Staff

Text analytics is the practice of using technology to gather, store, and mine textual information to translate large volumes of unstructured text into quantitative data to uncover insights, trends, and patterns that can be used to inform smarter business decisions.

BCC offers two ways for you to learn about this important topic, through their full-length report and a shorter innovation spotlight.

Highlights from the report

The text analytics market is expected to grow from $5.9 billion in 2020 at a compound annual growth rate (CAGR) of 23.0% to reach $16.6 billion in 2025.

Drivers for this market include

- The rise in adoption of predictive analytics and sentiment analytics by various industries,
- Continuous improvements in language processing algorithms, and
- Increasing attractiveness of social media analytics.

Restraints for this market include

- Dearth of technical expertise and technological awareness, and
- Data security and privacy issues.

Globally, retail and travel businesses are the two lead runners, followed by healthcare, in the implementation of text analytics. In the past year, however, the COVID-19 pandemic further propelled the market for text analytics in the life sciences and healthcare industries, which needed to analyze research documents from all over the world across different languages to come up with new drugs or courses of treatment.

Table 1. Text analytics processing technologies

Technology	Details	Capabilities	Adoption challenges
Statistical technique	Computers that use statistical pattern learning to classify and reveal patterns such as entities, intents, and relationship in text.	• More efficient/cost-effective than manually coding rules. • Proactively surfaces new patterns in data. • Self-learning. • Language independent.	• Requires efforts to make insights actionable, as patterns can be unintuitive or be statistical artifacts. • No grammar check available for text.
Linguistic technique	Linguistic pattern recognition using rules hand-coded for each use case, domain, or language.	• Good user control. • Results are easy to interpret. • Can check and correct spelling /grammar.	• Costly to update with new rules. • Low accuracy as patterns miss alternate phrasings or capture unrelated text. • Not self-learning/improving.
Machine learning	Subject matter experts, or crowdsourcing platforms, create labelled training data that an algorithm uses to identify patterns in the data.	• Highest accuracy. • Lower efforts than creating linguistic rules. • Results are easy to interpret. • Training data is a high-effort, high-cost process.	• Models are often opaque. • No grammar checks are available for text.
Hybrid approach	A mix of all of the above technologies.	• Applies each technology to different parts of the text analytics process and therefore shares a similar strength.	• Applies each technology to different parts of the text analytics process and therefore shares the same cautions.

Highlights from the innovation spotlight

The innovation spotlight for text analytics includes an interview with Megaputer Intelligence Inc. (Bloomington, Indiana), a developer of data and text mining software. An excerpt of the interview is below.

BCC: ***Where do you see text analytics taking the industry in 15 years?***

Megaputer: *In 10–15 years, we will see the advent of new hardware tools that use different physical principles of operation and different logic of their organization that will be much more similar to the operation of the human brain. Simultaneously, additional research will reveal new ways to train text analysis systems to make the depth, accuracy, and speed of their analysis similar to those of a human. Text analytics and voice analytics will be combined in a single field: when processing voice data the new tools will be preforming simultaneous analysis of the tone and content of the data.*

New techniques for analyzing images and streaming video data will help with building multi-media data analysis solutions that will be integrating data received through different channels. We will see an increasing number of operations automated through the use of AI-based text analytics solutions. And before long, we might be forced to rethink our own position and even purpose in the new world where machines become capable of performing yet more intelligent operations that previously could be handled only by humans.

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 info@bccresearch.com.

Resources

BCC Publishing Staff, "Text Analytics: Global Markets" BCC Research Report IFT221A, April 2021.

BCC Publishing Staff, "Innovation Spotlight: Megaputer: Text Analytics" BCC Research Report IFT225A, April 2021. www.bccresearch.com.

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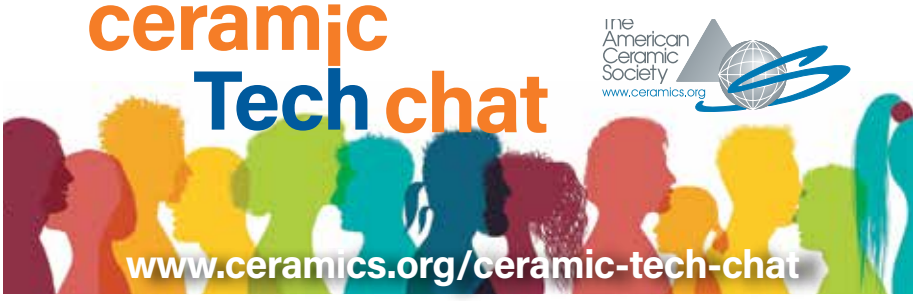
SOCIETY DIVISION SECTION CHAPTER NEWS

Welcome new ACerS corporate partners

ACerS is pleased to welcome its newest Corporate Partners:

- **GE Global Research**
- **PRCO America Inc**
- **Shandong Shengquan New Materials Co., Ltd**
- **Synthera Biomedical Private, Ltd**

To learn about the benefits of ACerS corporate partnership, contact Kevin Thompson, membership director, at (614) 794-5894 or kthompson@ceramics.org.



Ceramic Tech Chat guests highlight ACerS international scope

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. New episodes publish the second Wednesday of each month.

In the April episode of Ceramic Tech Chat, Rattikorn Yimnirun, dean of the School of Energy Science and Engineering at Vidyasirimedhi Institute of Science and Technology, and his colleagues Naratip Vittayakorn and Jakrapong Kaewkhao discuss the current state of the ceramics industry in Thailand, how they cofounded the Thailand Chapter of ACerS, and what role they see the Chapter playing in the country's local ceramic community.

In the May episode of Ceramic Tech Chat, Scott McCormack, assistant professor of materials science and engineering at the University of California, Davis, discusses how he overcame learning challenges during his elementary school years, how he helps his own students learn the sometimes scary topic of thermodynamics, and his experience setting up a university research program as a young professor.

Listen to Yimnirun and McCormack's interviews—and all of our other Ceramic Tech Chat episodes—at http://ceramictechchat.ceramics.org/974767.

Remembering Della Roy, Distinguished Life Member and Fellow

Della M. Roy, ACerS Distinguished Life Member and FACerS, died March 27, 2021, at age 94. She was a Pennsylvania State University emeritus professor of materials science, founding member of the Penn State Materials Research Laboratory (now the Materials Research Institute), and research professor at Arizona State University.

"Della was one of our true pioneers in materials," says Clive Randall, FACerS, director of MRI and distinguished professor of materials science and engineering. "Her research gave her many accolades in the past, but it also laid down the foundation for the development of lower-CO_2 emission production methods of cements, which are critical to creating future infrastructure with lower climate impact."

Roy was born Nov. 3, 1926, as Della Marie Martin in Merrill, Oregon. After graduating high school at age 16, she enrolled at the University of Oregon, where she earned a bachelor's degree in chemistry in 1947. From there, she went to Penn State, receiving her master's degree in minerology in 1949.

During her graduate work, she shared an office and lab with fellow graduate student Rustum Roy, who also became a significant figure in materials research as a Penn State professor and founding member of the MRL. They married in June 1948, a marriage that spanned 62 years until Rustum's death in 2010.

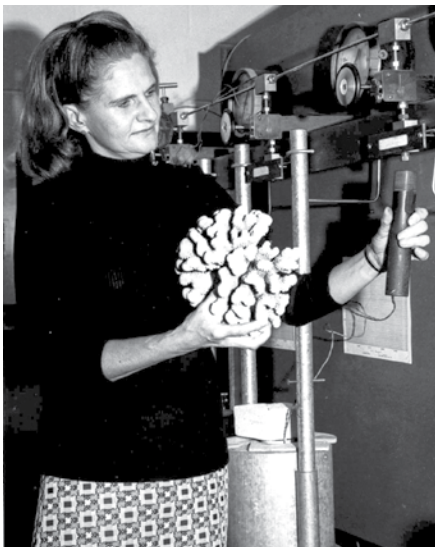
Roy was known for her work in advanced concrete materials for pavements, chemically bonded cements, ancient cement-based building materials, and high-temperature cements for geothermal wells. Her patents range from porous biomaterials for bone repair to methods for radioactive storage. Other areas of research include chemically bonded ceramics, crystal growth and crystal chemistry, and phase equilibria.

Della Roy's Penn State career inspired other female scientists, and her work led to a series of pioneering moments for women in STEM. In 1987, she was the first female materials scientist and the first Penn State woman to be inducted into the National Academy of Engineering. With Rustum Roy's induction into the NAE in 1973, the Roys were the first spousal couple to be so honored.

In 1971 she cofounded the journal *Cement and Concrete*, the first in its field, and served as its editor until 2005. She authored more than 400 publications and was the first woman elected to the World Academy of Ceramics.

She received the ACerS Jeppson Medal in 1982 and the Cements Division L.E. Copeland Award in 1987. She was an honorary member of the Institute for Concrete Technology and a recipient of the first annual Golden Goose Award, given by Congress to honor federally funded research leading to major breakthroughs in scientific, technological, medical, public health, and other fields of benefit to the public.

The legacy of the Roys as leaders in science continues through the Rustum and Della Roy Innovation in Materials Research Award at Penn State to honor interdisciplinary materials research that yields innovative and unexpected results.



Three awards are granted annually—two graduate student awards and one postdoctoral or junior faculty award. Memorial contributions to the award fund may be made to Penn State's Office of Donor and Member Services.

Roy is survived by two sons, their wives, and two grandchildren.

Adapted from a Penn State Materials Research Institute obituary by Jamie Calvin Oberdick published April 9, 2021. https://www.mri.psu.edu/mri/news/penn-state-mourns-loss-della-roy 100

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Meet the 2021–2022 officers and Board members

President-elect


Mathur

SANJAY MATHUR
Director and chair
Institute of Inorganic Chemistry
University of Cologne
Cologne, Germany

ACerS has played a decisive role in the formation of my professional career and in the propagation of my research interests in ceramic and glass. Therefore, it is a privilege to seek the support of the membership to serve The American Ceramic Society as the president-elect. My engagement with ACerS has shown me the strength of productive and ever-lasting global networks, which forms the basis of my aspiration. Inheriting the strong legacy of the past presidents and other leaders and mentors with whom I had served the Society in different capacities, I am committed to making ACerS membership more valuable to all ceramics and glass professionals worldwide.

The post-pandemic phase will bring new paradigms in scientific communities that will affect our operations, and it is crucial that the Society stays agile to respond to emerging challenges and to maintain its attractiveness as the first stop address for professionals in the field. In this context, ACerS' professional networks and global partnerships are more relevant than ever to promote its vision and mission of being an inclusive organization. The diversity reflected in our membership portfolio brings new opportunity to expand our human network through dynamic local sections and vibrant international chapters.

One of the flagship activities of the Society includes the journals and *Bulletin*, and I will work with the editors to increase the visibility and impact of our scientific publications. I will strive to focus on the educational and professional priorities of our younger members across the globe and across backgrounds by implementing new volunteering and reward programs.

I will contribute to the core mission of ACerS by intensifying cooperation across all divisions of ACerS and with other international professional societies. My core belief is that continuing progress in ceramic and glass industries is imperative for addressing some of the most pressing needs of our planet in the energy, mobility, and health sectors, and therefore strengthening industry–academia partnerships will be an absolute priority of my term. I believe that The American Ceramic Society, with its strong industrial base and association with Ceramic and Glass Industry Foundation, is well-positioned to create a global network of corporate members and to be proactive in scientific advocacy, which I will make a priority by interacting with international scientific organizations.

Over the years, ACerS generously rewarded my volunteering engagements, and should I get the opportunity to serve as the ACerS president, I will work hard to reciprocate my enriching experiences and will continue my campaign for bringing new perspective of internationalization and diversity to make ACerS a home society for our members and to support career advancement of young professionals.

Directors


Breder

KRISTIN BREDER
Senior principal scientist
Saint-Gobain Research North America
Northborough, Mass.

ACerS has been my primary professional organization for most of my career. I have experience from working on ceramic research in industry, national labs, and academia in three different countries.

ACerS has given me the opportunity to network, attend conferences, publish, and participate in committees. I would like to take my experience to the Board to contribute to strengthening and growing ACerS as a preferred professional organization for industrial and academic professionals alike. I would like to contribute to the opportunities for members to be able to participate and exchange research and ideas. I also think it is important that students discover the many options for doing industrial research.

A stronger organization is a more diverse organization. I would like to work on that aspect, to make everyone not only feel that they belong in ACerS but that they belong in our profession. Increasing diversity will require welcoming and acceptance of new groups of professionals. I would like to explore collaborations with organizations whose mission it is to increase diversity in the STEM fields.

Ceramics research and education in the U.S. have traditionally been very strong; however, a continued focus is needed to keep the field active and relevant. I would like to see ACerS collaborating with other professional groups and organizations like the National Science Foundation to push for a better national strategy for ceramics research in the U.S.


Graeve

OLIVIA A. GRAEVE
University of California, San Diego
Professor in the Department of Mechanical and Aerospace Engineering
Director of the CaliBaja Center for Resilient Materials and Systems
Faculty director of the IDEA Engineering Student Center
San Diego, Calif.

I joined the American Ceramic Society in 1997 as a doctoral student and became immediately involved with the local Northern California Section, which provided a great deal of encouragement and support for my doctoral work. This early interaction shaped my views about ceramic science and engineering and what it means to work in this field as a scientist, but also as an advocate for the field, especially among underrepresented minorities and women. As a member of the Society's Board of Directors, I plan to work closely with the entire Board to develop and implement new advocacy strategies, especially those that will nurture and grow the next generation of diverse ceramic scientists.

During the past six years, it has been my privilege to serve as director of UC San Diego's IDEA Inclusion, Diversity, Excellence, and Achievement Engineering Student Center. During this time, I have been responsible for establishing a strategic plan for the IDEA Center; implementing a variety of new programs in support of all engineering students, including the Engineering Learning Communities, the Summer Engineering Institute, and the Academic Achievement Program, among many others; and to champion and help promote the success of underserved students.

From these experiences I learned about developing human resources; establishing effective collaborations among staff, faculty, and students; implementing actionable agendas that inspire and motivate; and defining purposeful visions that support students in the best possible way. It is my hope to offer these experiences and acquired skills to the Society by serving on the Board.


Jiang

SHIBIN JIANG
President and CEO
AdValue Photonics Inc.
Tucson, Ariz.

As an active ACerS member since 1993, I served in various societal and divisional capacities. I integrated my professional career with The American Ceramic Society. My professional career and my businesses benefit significantly from ACerS while I devoted time and resource to ACerS as a volunteer. I am enthusiastic about the potential growth and the continued success of ACerS, and I am willing to contribute more to ACerS. It is a privilege to be considered for the Board of Directors.

To ensure ACerS as a long-term, global leading professional society, one of the key issues is to further strengthen the collaboration among students and professionals in both academia and industries in the world. My industrial and academic working experiences and multinational background enable an in-depth understanding of each part's needs and concerns, which can help ACerS to plan and foster initiatives and professional outreach that will advance ACerS' mission and organizational growth.

As a member of the Board of Directors, I will contribute my time, experiences, and resources to ACerS long-term and short-term plans and strategies. Specifically, I would devote my energy toward (i) enhancing industrial participation in ACerS activities, especially for exhibits at various ACerS meetings, which can improve industrial and academic interactions and generate more revenue for ACerS; (2) broadening technical conferences coverage to drive ACerS become more relevant in the world of materials science and engineering; (3) raising funds to support more young professionals, especially students, to attend ACerS conferences and encouraging them to be actively involved in ACerS activities at different levels; (4) developing new joint technical conferences with other societies such as SPIE, OSA, and IEEE to promote materials applications; (5) strengthening international collaborations with other countries to ensure ACerS long-term global leadership. 100

more SOCIETY DIVISION SECTION CHAPTER NEWS

2021–2022 ACerS officers

The new slate of ACerS officers for 2021–2022 has been determined. There were no contested offices and no write-in candidates, automatically making all nominees "elected." ACerS rules eliminate the need to prepare a ballot or hold an election when only one name is put forward for each office. The new term will begin Oct. 21, 2021, at the conclusion of ACerS Annual Meeting at MS&T.

ACerS President-elect

To serve a one-year term from Oct. 21, 2021, to Oct. 13, 2022

Sanjay Mathur

ACerS Board of Directors

To serve three-year terms from Oct. 21, 2021, to October 2024

Kristin Breder
Olivia Graeve
Shibin Jiang

Division and Class Officers

To serve a one-year term Oct. 21, 2021, to Oct. 13, 2022, unless otherwise noted

Art, Archaeology and Conservation Science Division

Chair: **Marie Jackson**
Vice chair: **Jamie Weaver**
Secretary: **Christina Bisulca**
Treasurer: **Fumie Iizuka**
Trustee: **Darryl Butt**

Basic Science Division

Chair: **Yiquan Wu**
Chair-elect: **Wolfgang Rheinheimer**
Vice chair: **Edwin García**
Secretary: **Amanda Krause**
Secretary-elect: **Ricardo Castro**

Bioceramics Division

Chair: **Ashutosh Goel**
Chair-elect: **Bikramjit Basu**
Vice chair: **Kalpana Katti**
Secretary: **Annabel Braem**

Cements Division

Chair: **Shiho Kawashima**
Chair-elect: **Dimitri Feys**
Secretary: **Wil V. Srubar III**
Trustee: **Jeffrey Thomas**

Education and Professional Development Council

Co-chair: **Ashley Hilmas**, 2021–2022
Co-chair: **TBD**

Electronics Division

Chair: **Claire Xiong**
Chair-elect: **Jenny Andrew**
Vice chair: **Ed Gorzkowski**
Secretary: **Matjaz Spreitzer**
Secretary-elect: **Elizabeth Paisley**
Trustee: **Steven Tidrow**

Energy Materials and Systems Division

Division chair: **Kyle Brinkman**
Vice chair: **Krista Carlson**
Secretary: **Eva Hemmer**
Program committee chair: **Yang Bai**

Engineering Ceramics Division

Chair: **Hisayuki Suematsu**
Chair-elect: **Palani Balaya**
Vice chair/Treasurer: **Thomas Fisher**
Secretary: **Jie Zhang**
Trustee: **Michael Halbig**
Parliamentarian: **Dileep Singh**

Glass & Optical Materials Division

Chair: **Gang Chen**
Chair-elect: **Joseph Ryan**
Vice chair: **Irene Peterson**
Secretary: **Michelle Korwin-Edson**

Manufacturing Division

Chair: **William Headrick**
Chair-elect: **Weston Wright**
Vice chair: **Ashley Hampton**
Secretary: **Joseph Szabo**
Counselor: **William Carty**

Refractory Ceramics Division

(term begins March 2021)

Chair: **Dawn Hill**
Vice chair: **Kelley Wilkerson**
Secretary: **Robert Hunter**
Program chair: **Austin Scheer**
Trustee: **Louis J. Trostel, Jr.**

Structural Clay Products Division

(term begins March 2021)

Chair: **Jed Lee**
Chair-elect: **Holly Rohrer**
Vice chair: **Jim Krueger**
Secretary: **Bryce Switzer**
Trustee: **John Dowdle**

IN MEMORIAM

Ronald Caporali
Mark J. Davis
Robert DeVries
Lyle Ramon
Iles Haber
Kirby Nesbitt
Michel Poulain
Della Roy

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

Volunteer spotlight

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


Jones

Julian Jones is professor of biomaterials at Imperial College London. His research group focuses on 3D-printed biomaterials for regenerative medicine (bone, cartilage, wound healing) and bioactive nanoparticles for cancer therapy.

In addition to his role as chair of the Bioceramics Division, Jones serves on ACerS Panel of Fellows, and he is chair of the 2021 Ross Coffin Purdy Award subcommittee. He also served the International Commission on Glass as chair of TC04 (Bioglasses) and as a member of the Coordinating Technical Committee, where he is currently vice-chair.

Jones was named an ACerS Fellow in 2015 and is a Fellow of the Society for Glass Technology. His awards include an International Society for Ceramics in Medicine Excellence Award, the Vittorio Gottardi Award from the International Commission on Glass, and the ACerS Robert L. Coble Award.


Perry

Chris Perry is president of both Christy Refractories and Industrial Services. Previously, he held the role of vice president of engineering with additional responsibilities for R&D and quality control. He began his career at Christy Refractories as an application engineer and holds a Bachelor of Science degree in ceramic engineering from Missouri University of Science and Technology.

Perry has been active with ACerS since 2014. He served as the chair of the St. Louis Section for the past three years. He previously held the vice-chair and secretary positions. Perry also volunteered with the planning and coordination of the annual St. Louis Section/Refractory Ceramics Division annual refractories symposium.

We extend our deep appreciation to Jones and Perry for their service to our Society! 100

ACerS Dayton/Cincinnati/Northern Kentucky Section announces new leadership

New officers were elected March 4, 2021, at the annual meeting of the ACerS Dayton/Cincinnati/Northern Kentucky Section. The section also established a Social Outreach position. Congratulations and welcome to the new officers.

- President: **Derek King**
- Treasurer: **Kara Martin**
- Secretary: **Ashley Hilmas**
- Social Outreach: **Tulsi Patel** 100

Names in the news

Members—Would you like to be included in the Bulletin's Names in the News? Please send a current head shot along with the link to the article to mmartin@ceramics.org. The deadline is the 30th of each month.


Padture

Nitin Padture, Otis E. Randall University Professor of Engineering and the director of the Institute for Molecular and Nanoscale Innovation, was presented the Presidential Faculty Award at Brown University on April 8.


Laurencin

Cato T. Laurencin, Van Dusen Distinguished Professor at The University of Connecticut, was elected to the National Academy of Sciences. Laurencin is the first surgeon in history to be elected to the National Academy of Engineering, the National Academy of Medicine, the National Academy of Sciences, and the National Academy of Inventors. 100

more SOCIETY DIVISION SECTION CHAPTER NEWS

ACerS Colorado Section hosted a proposal writing webinar on April 28

Amy Brice, proposal coordinator at Colorado School of Mines, shared a methodical approach to proposal development for any funding opportunity. Access a recording to the webinar as well as links to valuable resources at https://ceramics.org/sections/colorado. 100

Mentoring opportunities available to Colorado Section members

The ACerS Colorado Section Mentorship Program connects professionals and students. The first 20 graduate students to sign up for a mentor will receive TWO FREE years of membership to ACerS. The deadline for the program is May 30. Applications are located at https://ceramics.org/sections/colorado. Sign up for a mentor or a mentee today!

This program is only available to members residing in the Colorado Section. 100

AWARDS AND DEADLINES

Division	Award	Nomination Deadline
Basic Science	Roland B. Snow/ Ceramographic Competition	October 8
Basic Science	Graduate Excellence in Materials Science (GEMS)	August 15
Bioceramics	Young Scholar	July 1
Bioceramics	Global Young Bioceramicist	July 1
Bioceramics	Larry L. Hench Lifetime Achievement	July 1
Bioceramics	Tadashi Kokubo	July 1
Engineering Ceramics	Jubilee Global Diversity	July 1
Engineering Ceramics	James I. Mueller Lecture	July 1
Engineering Ceramics	Global Young Investigator	July 1
Engineering Ceramics	Bridge Building	July 31
GOMD	Norbert J. Kreidl Award for Young Scholars	July 31

FOR MORE INFORMATION:

ceramics.org/members/awards

Northern California Section Young Professionals Seminars

The Northern California Section began hosting weekly webinars with young professionals beginning May 6. These webinars are an opportunity for young professionals to present their work to undergraduate and graduate students.

For a list of presenters, topics, and the link to the presentations, visit https://ceramics.org/sections/northern-california-section. 100

ACerS Serbia Chapter to cohost ACA IX Conference

The ACerS Serbia Chapter and the Serbian Ceramic Society will host the ACA IX Conference, "New frontiers in multifunctional material science and processing," Sept. 20–22, 2021. The deadline to submit an abstract is **June 15, 2021**. Visit https://ceramics.org/wp-content/uploads/2021/05/ACA-IX-2021First-announcement.pdf for more information. 100

Save the date! ACerS Thailand Chapter plans ICAPMA-JMAG for December 2021

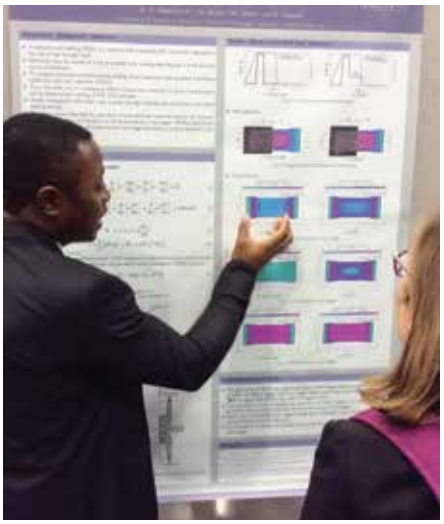
The ACerS Thailand Chapter is planning the Joint International Conference on Applied Physics and Materials Applications & Applied Magnetism and Ferroelectrics for Dec. 1–4, 2021. The abstract submission deadline is **Aug. 31, 2021**. Learn more at https://ceramics.org/wp-content/uploads/2021/05/Thailand.jpg. 100

Contacts	Description
Klaus van Benthem benthem@ucdavis.edu	The Roland B. Snow award is presented to the Best of Show winner of the Ceramographic Exhibit & Competition, an annual poster exhibit to promote the use of microscopy and microanalysis as tools in the scientific investigation of ceramic materials.
John Blendell blendell@purdue.edu	The GEMS awards recognize the outstanding achieve ments of graduate students in Materials Science and Engineering. The award is open to all graduate students who are making an oral presentation in any symposium or session at the ACerS Annual Meeting at Materials Science & Technology (MS&T) meeting.
Julian Jones julian.r.jones@imperial.ac.uk	The award recognizes excellence in research among current degree-seeking graduate students and postdoctoral research associates.
Julian Jones julian.r.jones@imperial.ac.uk	The award recognizes the outstanding young ceramic engineer and material scientist, who has made significant contributions to the area of Bioceramics, for human healthcare around the globe.
Julian Jones julian.r.jones@imperial.ac.uk	The award is presented to a deserving individual(s) in recognition of lifetime dedication, vision, and accomplishments in advancing the field of Bioceramics, particularly towards innovation in the field and contribution of that innovation to translation of technology towards clinical use.
Julian Jones julian.r.jones@imperial.ac.uk	The award is presented in recognition of their outstanding achievements in the field of bioceramics research sand development.
Michael Halbig michael.c.halbig@nasa.gov	The award recognizes exceptional early- to mid-career professionals who are women and/or underrepresented minorities (i.e. based on race, ethnicity, nationality and/or georaphic location) in the area of ceramic science and engineering.
Valerie Wiesner valerie.l.wiesner@nasa.gov	This award recognizes the enormous contributions of James I. Mueller to the Engineering Ceramics Division and the field of engineering ceramics. It is the intent of this award to recognize the accomplishments of individuals who have made similar contributions.
Palani Balaya mpepb@nus.edu.sg	The award recognizes the outstanding young ceramic engineer and scientist whose achievements have been significant to the profession and to the general welfare of the community around the globe. Nominations are open to candidates from industry, academia, or government-funded laboratory across the world.
Hisayuki Suematsu suematsu@vos.nagaokaut.ac.jp	The award recognizes individuals outside the United States who have made outstanding contributions to engineering ceramics.
John Mauro jcm426@psu.edu	The award recognizes research excellence in glass science and is open to all degree-seeking graduate students (MSc or PhD).

more AWARDS AND DEADLINES

Society Awards	Nomination Deadline	Contacts
Darshana and Arun Varshneya Frontiers of Glass Lectures	Sept. 1, 2021	Erica Zimmerman ezimmerman@ceramics.org
ACerS Fellow	Sept. 2, 2021	Erica Zimmerman ezimmerman@ceramics.org

STUDENTS AND OUTREACH



ACerS PCSA #MaterialsLifeChallenge

Are you a student interested in winning a free registration to ACerS Annual Meeting at MS&T21? ACerS President's Council of Student Advisors (PCSA) is running the **#MaterialsLifeChallenge** with a free student registration as the grand prize. The aim of this challenge is to celebrate the diverse experiences of life as a student, scientist, engineer, researcher, or all of the above.

Each month, from April to September, the PCSA will post a challenge prompt. To enter, create and post a short video or reel responding to the month's specific prompt using the hashtag #MaterialsLife and tagging @acerspcsa on Instagram before the last day of the month. The person whose video receives the most "likes" each month will receive a $25 Amazon gift card. Additionally, points will be assigned to the top three videos each month (three for 1st place, two for 2nd place, and one for 3rd place). The person with the most points at the end of the challenge will receive free registration to MS&T21 in October.

Anyone may enter, but only students are eligible to win the grand prize. To see the monthly prompts, follow ACerS PCSA on Instagram at www.instagram.com/acerspcsa.

By posting a video with the tag #MaterialsLife, you are consenting to allow ACerS to save and use your video for educational purposes.

ACerS offers complimentary membership for recent graduates and those who are new to the Society

Did you know that ACerS offers a one year complimentary Associate Membership for those who have recently completed their studies with plans to enter the workforce, and also for individuals that have never before been ACerS members?

ACerS is a truly global community, and an Associate Membership connects you to more than 10,000 professionals from more than 75 countries. More than 35% of our members live and work outside North America. They collaborate and inspire one another through participation in Divisions, Classes, Sections, and Technical Interest Groups. Learn more about Associate Membership at http://

FOR MORE INFORMATION:

www.ceramics.org/students

Description
The Frontiers of Glass Science and the Frontiers of Glass Technology lectures encourage scientific and technical dialog in glass topics of significance that define new horizons, highlight new research concepts, or demonstrate the potential to develop products and processes for the benefit of humankind.
Elevation to ACerS Fellow recognizes outstanding contributions to the ceramic arts or sciences; through broad and productive scholarship in ceramic science and technology, by conspicuous achievement in ceramic industry, or by outstanding service to the Society.

ACerS 2021 Society awardees announced

Congratulations to the latest group of Society awardees! The 2021 awardees are available at https://bit.ly/2021societyawards. Biographies and photos of the 2021 awardees will be posted on www.ceramics.org over the next few months, and they will be featured in the September 2021 issue of the *Bulletin*. The awards will be presented October 18 at the ACerS Honors and Awards Banquet at ACerS Annual Meeting at MS&T in Columbus, Ohio. Be sure to purchase your banquet tickets before the MS&T meeting. 100

www.ceramics.org/associate—and be sure to share this information with your colleagues who are not yet enjoying the many benefits of ACerS membership. For more information, contact Yolanda Natividad, member engagement manager, at ynatividad@ceramics.org. 100

PCSA Humanitarian Pitch Competition at MS&T21

The President's Council of Student Advisors is hosting the Humanitarian Pitch Competition for you to pitch your ideas to a panel of judges about solutions to a challenge that a community is experiencing.

Assemble a team of up to four participants to develop a solution to a real-world problem using materials science. Both undergraduate and graduate students are eligible to participate. Visit www.ceramics.org/pitchcomp to submit your abstracts by **Sept. 10, 2021.** 100

2019 Humanitarian Pitch Competition 1st place winners: The PSU Piezos from Penn State University.

Credit: The PSU Piezos from Penn State University

CERAMIC AND GLASS INDUSTRY FOUNDATION

CGIF and ACerS developing new scholarship for minority students

The Ceramic and Glass Industry Foundation and ACerS established the Underrepresented Student Scholarship Fund to offer new scholarship opportunities for student members of two vital organizations: the National Society of Black Engineers (NSBE) and the Society of Hispanic Professional Engineers (SHPE).

Initially, the scholarship fund will provide at least one $5,000 scholarship each year to a materials science student member of each organization. In the future, we hope to expand this initiative to include additional groups of underrepresented students to further strengthen the diversity of our ceramic and glass materials community.

To demonstrate our commitment to this valuable program and encourage the support of our members, ACerS and the CGIF will contribute up to $10,000 each in matching funds for the Underrepresented Student Scholarship Fund in 2021. In short, this means that your gift in support of this new scholarship will be tripled! Please join us in this important effort by giving online at https://ceramics.org/donate or contact Marcus Fish at 614-794-5863.

NSBE, founded in 1975, strives to stimulate and develop student interest in the various engineering disciplines while supporting and promoting the aspirations of collegiate and precollegiate students and technical professionals in engineering and technology. The organization encourages members to seek advanced degrees in engineering or related fields and to obtain professional engineering registrations.

SHPE, founded in 1973, has grown to be the largest association in the nation for Hispanics in STEM. The organization empowers the Hispanic community to realize its fullest potential and to impact the world through STEM awareness, access, support, and development. SHPE's vision is a world where its members are highly valued and influential as leading innovators, scientists, mathematicians, and engineers.Please give generously to the Underrepresented Student Scholarship Fund and have your gift tripled.

There is no better way to show your support of the Society's efforts to embrace inclusion of all people as a core value to the advancement of our discipline, our industry, and the global society in which we live and work. Donate online at https://ceramics.org/donate. 100

CALL FOR ABSTRACTS

DEADLINE SEPT. 6, 2021

ELECTRONIC MATERIALS AND APPLICATIONS (EMA 2022)

JAN. 18–21, 2022 | DOUBLETREE BY HILTON | ORLANDO, FLA., USA

Organized by the ACerS Electronics and Basic Science Divisions

The American Ceramic Society
www.ceramics.org

ceramics.org/ema2022

Ceramics and graphene open up new possibilities for bone-like materials

By Letizia Diamante, science writer and coordinator of the "Diversity in Graphene" initiative

This article originally published April 1, 2021, on the Graphene Flagship website. Republished with permission.

Graphene Flagship Partnering Project CERANEA develops graphene-filled ceramic sandwiches that deliver materials with enhanced properties and functionalities.

The mineralized structures of some bones, seashells, and trees have something in common: their composition varies gradually throughout their volume, providing multiple functional roles at once. These are classified as functionally graded materials (FGMs) and can also be artificially engineered with tailored properties for numerous applications, including biomedical implants, optoelectronic devices, sensors, and batteries.

The Graphene Flagship Partnering Project CERANEA was funded through FLAG-ERA Joint Transnational Call 2017 to develop FGMs with graphene in ceramic matrices. The project involves researchers at the Graphene Flagship Partners Eotvos Lorand Research Network, the Centre for Energy Research (ELKH CER, Hungary) and the Fraunhofer Institute for Ceramic Technologies and Systems (Fraunhofer IKTS, Germany), and Graphene Flagship Associate Member Slovak Academy of Sciences (Slovakia).

We speak with Csaba Balázsi, CERANEA Project Leader and scientific advisor at Graphene Flagship Partner ELKH CER, to learn more about their strategies, accomplishments, and the potential application of ceramic-graphene FGMs in coatings and orthopedics.

Q: *Which type of functionally graded materials are you studying?*

A: FGMs are sandwich-structures made of several functional layers. We produce different stacks for novel types of composites, optimized for the desired combinations of electrical, thermal, and mechanical properties.

These stacks contain graphene, hexagonal boron nitride (h-BN), or other layered materials, as well as ceramics, such as silicon nitride, silicon carbide, and zirconia. Graphene additives are important fillers that increase the wear resistance and conductivity of ceramic matrices. Graphene also improves the thermal quality and the ability to withstand cracking. The key lies in the careful composition of these composite materials, which defines their porosity and conductivity.

For example, we can create a sandwich-structure made with ceramics as the bottom layer, a mixture of ceramics and graphene as the intermediate layer, and a foam-like structure of graphene as the top layer. As the graphene concentration increases from bottom to top, so does the porosity and conductivity of the material.

Q: *Why are these graphene-enabled layered structures important?*

A: Layered structures can deliver the performance desired by industry. These materials are more resistant than current ceramics against damages caused by electrical arcing, so can be used as long-lasting coatings for contacts, switches, or wearable parts.

In CERANEA, we are demonstrating the feasibility of producing these coatings at an industrial-scale and in an economically affordable manner. Graphene can replace precious metals, such as gold or silver nanoparticles, leading to a more sustainable and resource-efficient fabrication. These composites will be suitable for engineering applications, such as structural health monitoring systems.

Furthermore, composites with graphene, silicon nitride, or silicon nitride–zirconia are being studied as novel biomedical implants in orthopedics. The shape, morphology, and composition of natural bone vary: certain parts are denser, while others are more spongy. Similarly, varying amounts of graphene in the ceramics-graphene

Research News

Transforming atmospheric carbon into industrially useful materials

Researchers at the Salk Institute transformed tobacco and corn husks into silicon carbide and quantified the process with more detail than ever before. The three-step process, which requires about 177 kW/h of energy to make 1.8 g of SiC, involves 1) growing the plants; 2) freezing and grinding the harvested plants into a powder and then treating it with several chemicals, including a silicon-containing compound; 3) petrifying the powdered plants, a process that involves heating the material up to 1,600°C. The team hopes to explore this process with a wider variety of plants. For more information, visit https://www.salk.edu/news. 100

Strategic formulation of common cement could have a big impact on water purification

Researchers from C-Crete Technologies and Rice University created cement that does double duty as a structural material and as a passive photocatalytic water purifier with a built-in means of replenishment: simply sand down the material's surface to refresh the photocatalytic quality. Of five readily available cements, White Portland Cement, two types of volcanic ash-based Portland Cements, and a commercially available photoactive cement all proved to have the replenishable photocatalytic quality. The most common cement, ordinary Portland cement, did not. For more information, visit https://phys.org/chemistry-news/materials-science. 100

composite result in different porosity. For this reason, our sandwich-structures made with ceramics and graphene could be applied to bone reconstruction.

Q: *What is novel and unique about your approach?*

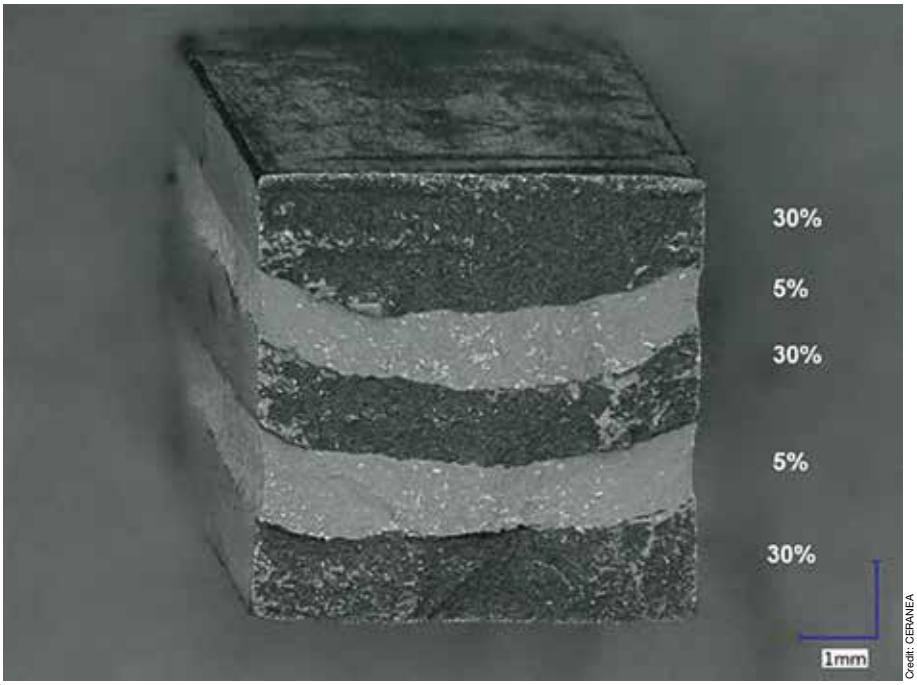
A: We evaluated the concept of sandwich structures in composites in terms of synthesis procedures, functionalities, and microstructures. These investigations can give new insight into the design of new-generation composites made of ceramics and layered materials, and identify possibilities for further optimization.

We are producing graphene via conventional powder technologies, and we manufacture these FGMs with one-step sintering and hot isostatic pressing. In this way, we obtain different layers with varying compositions, from 5% to 30% graphene by weight. These show improved mechanical properties and electrical and thermal conductivity, compared to the state-of-the-art functional ceramics.

To reach the desired performance, we analyzed these materials at all scales, from the macro to the micro-level. We gathered information about their morphology, components' type and homogeneity, graphene oxidation level, and porosity.

Q: *Which have been your most important achievements so far?*

A: We devised a new method for preparing multilayered graphene and graphene oxide (GO) starting from commercially available microsized graphite powder. We mill it to reduce its particle size and promote the intercalation and exfoliation of graphite into multilayered graphene particles. This simple and efficient process leads to the production of 100 grams of multilayered graphene in one batch, but it can be easily expanded to 100 kilograms in industrial processes. The graphene particles are then oxidized into GO using a combination of strong oxidizing agents, thermal oxidizing and sonication. We also carried out comprehensive morphological characterizations to reveal GO's structure and size.



Credit: CERANEA

Sintered sample made of five-layered Si_3N_4/graphene composite with 5% or 30% graphene by weight.

We also studied ceramics based on silicon nitride and zirconia with varying amounts of multilayered graphene. We identified the optimal graphene, silicon nitride, and zirconia 'sandwich'—a layer of 30% multilayer graphene (MLG) by weight sandwiched between two layers of 5% MLG. This configuration resulted in a two-to-three-fold improvement in mechanical properties, compared to the opposite ratio (30-5-30 wt.% MLG). Sandwich composites are valuable models for understanding the relation between composition and structure of materials, especially in the context of potential health monitoring applications.

In our most recent publication, we used X-ray microscopy in a state-of-the-art synchrotron source to study our ceramic–graphene composites in 3D, as well as their cracking and degradation mechanisms. Our method for preparing these carbon-rich samples could be relevant for other researchers working in this field.

References

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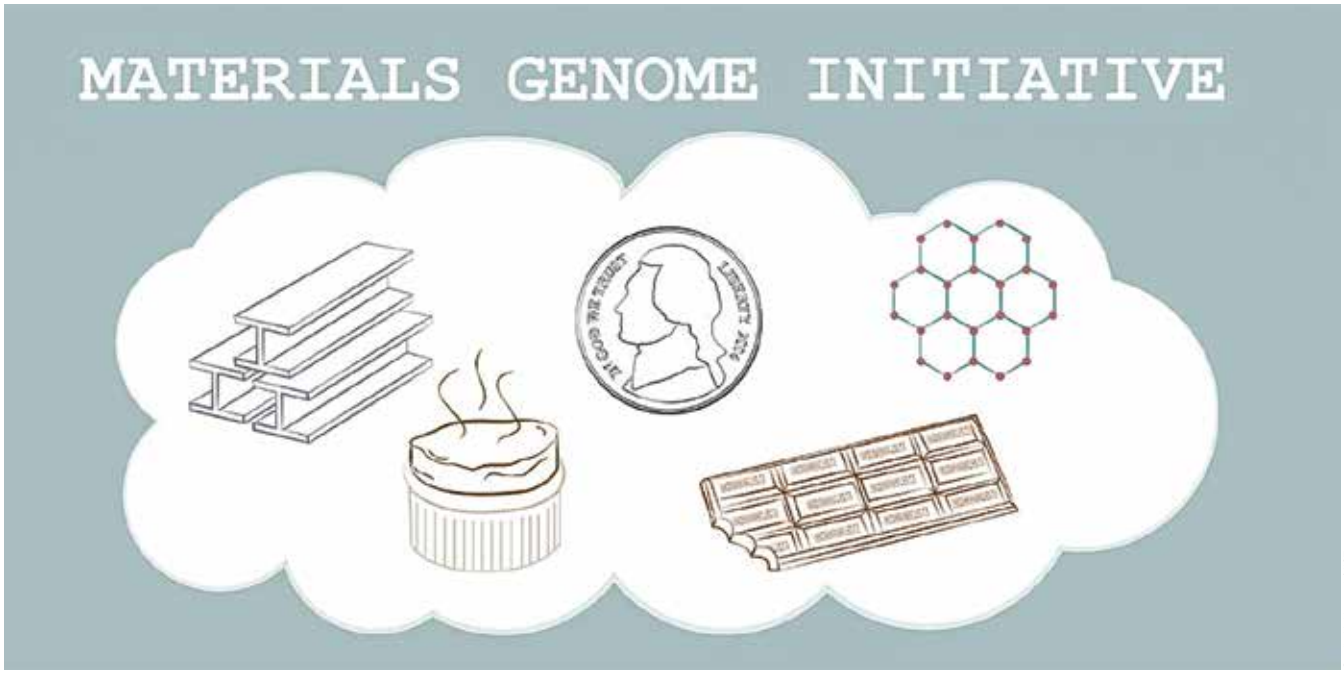


Credit: N. Hanacek/NIST

Materials Genome Initiative 10 years later:

An interview with James Warren

By Eileen De Guire

In June 2011, President Barack Obama's Office of Science and Technology Policy released a white paper called "Materials Genome Initiative for Global Competitiveness" that got the attention of the materials science community.[1]

The goal of the MGI was to reduce the time for materials development-to-deployment by 50%, or about 10 years—and for less cost. The MGI was motivated by a vision to accelerate the pace of new materials development to address urgent national challenges in clean energy, national security, and human welfare. Those developing the MGI concept to catalyze quicker lab-to-market products using new materials understood that success would require building an infrastructure of computational tools, experimental tools, collaborative networks, and digital data.

The white paper was prepared by an ad hoc group of the United States National Science and Technology Council (NSTC) with representation from most federal agencies that fund significant materials research, including several offices each from Department of Energy, Department of Defense, National Science Foundation, and Department of Commerce. A four-part strategic plan drove the first decade of MGI:

- Equip the next-generation materials workforce;
- Enable a paradigm shift in materials development;
- Integrate experiments, computation, and theory; and
- Facilitate access to materials data.

NSTC established the Subcommittee of the Materials Genome Initiative, which maintains a website of interagency activities and resources pertaining to the MGI (https://www.mgi.gov). Since 2011, the MGI grew to include more federal agencies and broader participation from the original agencies. The subcommittee is working on a new strategic plan to guide the MGI into its second decade and leverage the significant advances of the first decade.

As the MGI stands on the threshold of a new decade, ACerS marks this milestone with an interview with James Warren, director of the NIST Materials Genome Program. Warren was part of the 2010 ad hoc interagency committee that produced the original MGI whitepaper. Since then, he has tirelessly advocated for the MGI, working with government, academic, and industry stakeholders to build the infrastructure to realize the vision set 10 years ago. Warren talks about the genesis of the MGI, the journey of the first 10 years, and what the future holds.

This interview is condensed from a longer conversation, which will be published as an ACerS Ceramic Tech Chat podcast on June 9, 2021. Find it at https://ceramics.org/ceramic-tech-chat.

Q. *The Materials Genome Initiative is 10 years old. What drove the idea behind the MGI and how did the materials community react to the white paper?*

A. The MGI, when it was rolled out, was a collection of ideas that were not terribly new. There had been a large number of reports over the last few decades that preceded the rollout looking at how one could accelerate the design, discovery, and deployment of new materials faster by tightly integrating modeling with experiment and better data management.

These ideas were starting to bear enormous fruit. The early- to mid-2000s started to see reports coming out calling for integrated computational materials engineering. A lot of the database efforts in the computational regime, mostly around density functional theory, were yielding true payoffs. And so the idea for the initiative had been sort of bubbling in the firmament of materials science and related disciplines like chemistry.

When the Obama Administration approached the National Science Technology Council saying, "Hey, we think something like a materials genome initiative would be a good idea," there were a lot of people in government who thought, "Yes, we can make that work."

And, I am laughing now because, of course, the one thing that we did not love was the name!

I think there was a great deal of delight over a major initiative in materials coming out of the government. The only other one really at that point was a nanotechnology initiative, which was very substantial. The notion that there would be something that went beyond nano and also had an emphasis on computation was very exciting.

Q. *One of the goals of the MGI right from the start was to build an infrastructure that would support its goals. What progress has been made on building some of these computational tools, the experimental tools, the collaborative networks, the digital databases, and data access that was part of the vision?*

James Warren

A. The MGI is a bit sneaky compared to a lot of these other initiatives because the focus is really on the evolution of this infrastructure. In that sense it is a "meta" initiative. That is, we are trying to build the things that allow us to make the materials. It is a little bit abstract.

A lot of these tools are about managing data, or how you do a computation. It's not like we want to make the next great battery. We want to make the technologies that allow somebody to make the next great battery.

In terms of specific infrastructure, they are all over the place. One of the marquis examples is the DOE's Materials Project. There are a lot more resources, like the Materials Data Facility and Materials Commons, which NIST and the DOE fund, respectively, which are more sort of generic data hosting efforts that have made a great deal of progress.

There are a lot of efforts at NIST and at other places trying to think about better ways of curating and managing data so that other people can find that data and reuse that data in ways that are more efficient and robust.

How do you merge data sets? How do you gain extra value from that information? There is a tremendous amount of effort. You mentioned software tools and computational tools. We fund a lot of these sustainable software efforts, which the MGI is happy to build upon for computational research in predictive materials research.

And then there is also this whole community building activity. And that is almost a whole separate conversation about how we engage. (See sidebar: Materials Research Data Alliance)

Q. *You talked about the MGI predating or anticipating some of the big advances in artificial intelligence, machine learning, and deep learning. Do you think those changes were coming anyhow or did the MGI help push them forward?*

A. I don't want to take too much credit! In other words, I think they would have happened. And I think that the MGI is a framework for understanding how to accelerate materials discovery, design deployment, etc. Essentially all AI is a system to use data to develop a model. Well, the MGI is largely about taking advantage of modeling and integrating with experiment to accelerate materials discovery. So, AI as a paradigm is just another suite of tools to allow us to do that acceleration.

Plus, the MGI is to a large extent about data management. AI needs data. The MGI also is poised to provide the raw materials for an AI effort and you have to make the MGI data "AI ready." And the AI itself can be integral to an MGI effort. It is that twofold aspect that I think is the overlap. I think the MGI provides an incredibly useful template for articulating what can be done and can also be integrated with the broader efforts.

Materials Genome Initiative 10 years later: An interview with James Warren

Q. *What kind of impact has the MGI had on data-to-data driven discovery of ceramic and glass materials?*

A. Can I point to some broad-base answers to that question? Probably not. Can I find superb articles of recent provenance that do precisely what you are talking about? Yeah, sure. One of my colleagues Jason Hattrick-Simpers and collaborators have a very nice paper that came out a couple of years ago. It was about a glassy metal they discovered using a combination of high-throughput experiment and machine learning to find and then to fabricate.

That is just one example. The number of people now who are trying to use these techniques is large because it is clear that for materials discovery, anything that can increase your efficiency is something worth exploring. Adding robotics and intelligent systems to help you decide which experiments to do next is where a lot of the action is on this front.

I do not want to sell theory short because I am a theorist. One of the fun challenges, and where you will see a lot of the intellectual energy going right now, is how do you fuse classical theory and predictive models using AI techniques, which are purely data driven. How do you merge those two efforts? There are a lot of smart people thinking about it, but it is not like there is a canonical known answer. And whether there will be eventually, I do not think we know the answer to that.

Q. *Do you think we will ever be able to design a material for an application from first principles?*

A. If you are talking to somebody who is trying to make a semiconductor material for application in a nanoscale electronics, we are already doing that. We are already using quantum mechanics and designing materials and manufacturing.

In those cases, you are effectively using modern technology to build materials atom by atom. And there you can immediately see the connection between some of these tremendously fundamental computations and the material itself. The materials are existing at the nanoscale or smaller even. The wires and the vias in microelectronics, these are now down to three nanometers. The process is just mind boggling. I can guarantee that semiconductor companies are modeling these things all the way down. In other words, they are using MGI techniques. They have to be, right? The effects of the sizes are quantum. You know the leakage issues that they are suffering have got to be all there.

As for structural materials? If I told you that you needed to design a plane wing or build the alloy for a plane wing using molecular beam epitaxy, you would say "I can't afford that. It is not a good idea." So instead you take the material, melt it in a bucket, and pour it in a mold. You are trying to make mass quantities and you have to make compromises. This processing technique is going to end up with a mess inside that system, a mess that you probably would rather not have in there. But you are going to have to live with it. [Integrated computational materials engineering] is about managing the costs by being able to predict these internal structures.

Am I ever going to be able to do a first principles computation of a turbine blade? The answer is no, never. You are going to have to make all sorts of compromises and intermediate calculations now.

I've dreamt for 30 years that computation would eventually be good at internal pattern recognition and can do its own coarse graining. You could imagine doing a calculation at a level, then it [AI] finds a pattern and does the next order calculation at the next pattern level up.

Materials Research Data Alliance—MaRDA

A grassroots community grows in response to MGI

MaRDA—the Materials Research Data Alliance—coalesced from discussions and working sessions at the 2019 NSF-funded Summit on Big Data and Materials Cyberinfrastructure, which brought together 80 leaders from across the materials data landscape. That event revealed a community with similar values and goals interested in building a culture of data sharing and the kind of work it enables.

MaRDA aims to connect and develop the community needed for sharing materials research data to foster a materials data infrastructure combining software, hardware, and community-wide standards for access, interoperation, and use of materials data.

"That's a big goal, but that's why it takes a community effort. In fact, a central outcome of the 2019 Summit was agreement that there are shared incentives that span academia, industry, national labs, beamlines, publishers, funders, and anyone interested in materials research and associated data," says David Elbert, research scientist at Johns Hopkins University and chief data officer of PARADIM (Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials), an NSF Materials Information Platform.

MaRDA held its first Annual Meeting in February 2021 via WebEx. Co-organizer Cate Brinson says, "Over 130 people attended the three day meeting, covering the significant topics of FAIR materials data, connecting materials data infrastructure, and integration into education. The strong participation in a virtual event is evidence of the urgent need and passion for a grassroots approach to solving materials science data challenges." Brinson is Sharon C. and Harold L. Yoh, III Distinguished Professor in the Department of Mechanical Engineering and Materials Science at Duke University and co-founder of MaterialsMine.

The work to advance specific aspects of these goals will be done through Working Groups. Any MaRDA member may propose or join a Working Group. Membership in MaRDA is open and free to anyone interested in a community approach to accelerating data-driven materials research. To date, five MaRDA Working Groups (below) have been established.

1. MDI Provider Integration and Interoperability
2. Documenting Interoperable Data and Modeling Resources
3. Workflow Interoperability
4. Materials Data Repository Priorities
5. Data Dictionaries Working Group

For information about MaRDA and Working Groups, visit https://www.marda-alliance.org.

If you look at what AI is doing right now, it is kind of like that. It is finding patterns in systems and effectively trying to coarse grain. That is how you can get these predictions out. So I may have to eat my words where I said "never." It could be again in my lifetime that we see computations that can start with Schrödinger's equation, and some few other things, and really make macroscale calculations or predictions.

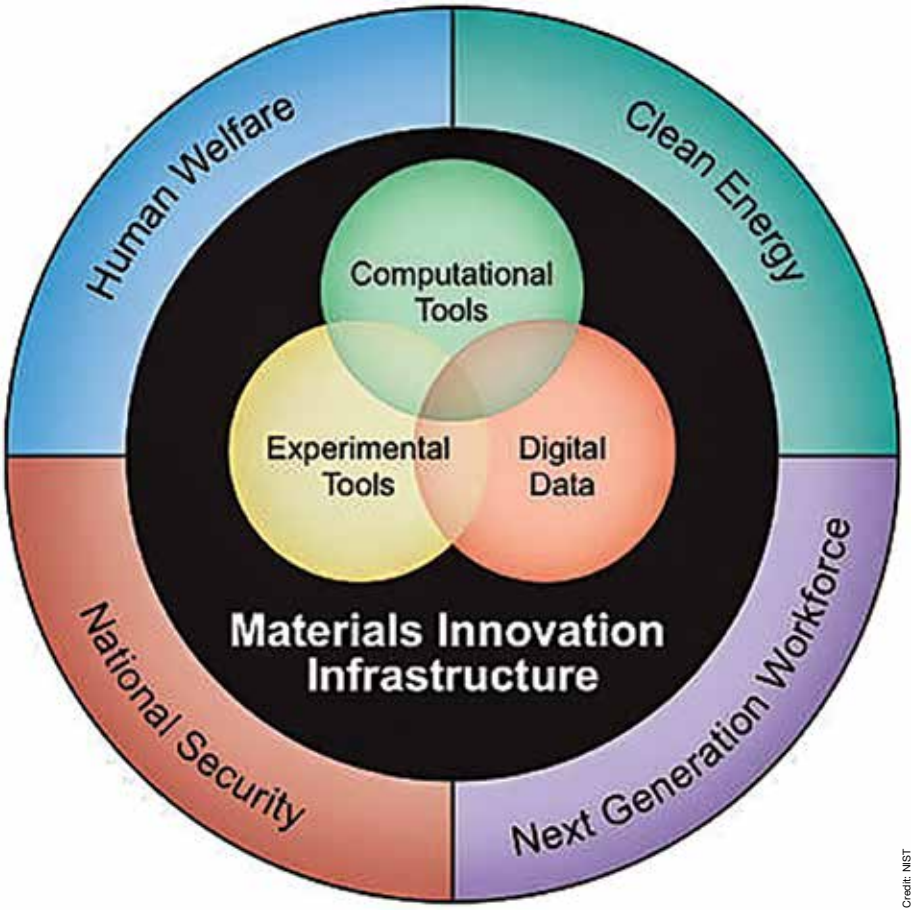
Q. *We have mostly talked about basic science and research. How do the MGI principles apply to engineering situations? For example, QuantumScape [San Jose, Calif.] recently announced development of new ceramic electrolyte materials for high-density, solid-state lithium-ion batteries. While the company did not reveal their R&D methodology, how could some of the ideas we have discussed have been used?*

A. It turns out that the company [QuantumScape] has an explicitly MGI approach. That is, they are doing computation to predict the materials and then down selecting and doing real experiments on a much-reduced number of potential compounds. And if they are not already, they are going to be using AI. I can guarantee it.

Companies are trying to use these techniques because they can actually make money and make new materials for their designs. A major aerospace company I am aware of is now doing simultaneous design of new materials and the rocket engines that they are building. I think they got the materials development insertion time down to 18 months from what used to be about 30 years. It is completely, unbelievably mind boggling.

This is the goal of the MGI. We are really trying to make it easier for people, companies, researchers, whomever, to use these ideas and tools. The government is funding this initiative to lower the barrier to entry for these ideas so that more manufacturers can do it with lower resources [initial upfront costs] so they can see the return on the investment quicker. This will help the billion-dollar revenue companies, and it also will allow more players in the field.

So you asked me about engineering impact; that is what this is about. It is already demonstrable.



Credit: NIST

Q. *What are some of the barriers to realizing the MGI's full potential, including workforce development needs?*

A. Workforce development is a big piece of this. You have to have the people that can use the infrastructure to reap the benefits of these developments. To make that happen, there have been a number of efforts, and there are more and more all the time. Another wonderful benefit of the AI revolution is more interest in that field. Because of that, there are programs that are springing up in materials design and the application of AI to materials design at a number of universities.

I think you are going to see materials departments, chemistry departments, lots of different kinds of engineering, any place there are materials looking at these things and trying to figure out ways to de-silo the AI efforts, which mostly have been taught by electrical engineering or computer science. It is just going to become another tool.

Computational work is part of most undergraduate and graduate training, including some undergraduate programs in materials. The same thing is going to be true for the MGI-style design. It would be crazy not to.

Q. *What does the future of the MGI look like, as it turns that corner of 10 years and looks to the future?*

A. At least two ideas are in the front of my mind. One is this deeper integration with manufacturers. We need to figure out the engagement models and the discussions needed to get them these tools. We must figure out what the barriers are to adoption, what are their incentive problems. It's complicated, and it's very company dependent. A big focus of the MGI going forward is getting us all the way out on the TRL [technology readiness level] scale.

Beyond that, I want to see a lot more focus on the integration piece. It always has been at the heart, but there are a lot of gaps. The distance between the gaps is now starting to become small enough that we can really start to knit this thing together. And as we start to see more interoperation of various resources and

scales, I think this is going to start to accelerate the MGI.

In the Human Genome Project, there were some very nonlinear moments in how the cost of sequencing changed. It started at nearly a billion dollars for the first one, and now you do your cat for 100 bucks or something like that.

And I would imagine that we are going to see similar kinds of changes, where suddenly something that is going to drive the cost of certain pieces way down and then you start to attack some other element in the structure. As people start to see the value proposition in these kinds of approaches, it becomes obvious to people and we start to see real disruptive rapid change in the way that things get done. There is no question in my mind that materials science is likely one of the most lucrative aspects of the application of AI because you are going to make stuff that people want. It is really that simple.

The economic potential is so enormous that I do not think most companies have been able to really grapple with it yet, although you're starting to see it. The capacity to make things more cheaply and easily, which is what the MGI is about, has got to be at the center.

Q. *What role do you see the federal agencies having for the future of MGI?*

A. We are trying to be very careful to figure out what is the government's role. Certainly, the government's role is not to say that this kind of research is important, without understanding what the community thinks is important. All the agencies have missions, and how do we fund the research that will meet our missions? We will think about the technologies there and also understand what the industry needs so that we are there for them. And if that means understanding AI and how everyone can use it more easily and more intelligently, then that's where we'll go.

So then the question might be when does the government step back? And usually, the answer is when the private sector stepped in and solved the problem so it's not a precompetitive situation any longer. That's great. That's called winning, right?

In a certain sense, you could say the MGI would be done when everyone says "yeah, that is the way we do things" and "we have all these tools at our disposal."

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Erin Congdon

B.S Ceramic Engineering 21'

Following a successful internship at **Corning Incorporated** focused on glass fractography, Erin will be joining Corning's **Gorilla Glass Development Group**. Working with Dr. Darren Stohr, Alfred's SEM Microscopist, Erin performed a range of mechanical testing, data analysis and fractography analysis projects which provided her the experience needed in her new position at Corning.

Ryan Fordham

B.S. Mechanical Engineering 19'
Masters Degree, Materials Science and Engineering 21'

Ryan will be joining **Lithoz**, a leader in the development of lithography-based ceramic additive manufacturing equipment, this year as a Lithography-Based Ceramic Manufacturing (LCM) Engineer. In this role, Ryan's work will focus on R&D, feasibility, and application development projects. During his time at Alfred, Ryan worked as a data manager at the **Finger Lakes Institute**, and later interned at **Oak Ridge National Laboratory.**

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Chair's update on PCSA activities and welcome to the student *ACerS Bulletin* issue

By Michael Walden, PCSA Chair

Virtual PCSA business meeting of the PCSA annual meeting in October 2020.

The June/July issue of the *ACerS Bulletin* offers students a chance to document their experiences entering the field of ceramic and glass materials.

These students, who began or continued their scholarship during the COVID-19 lockdowns, faced uncertainty in navigating remote-learning college classes and the challenge of conducting in-lab research during a global pandemic. While these reasons for feeling uncertain may be rather new, the common thread of uncertainty which persists even in more "normal" times serves to connect the students of today to students who have gone before.

The articles in this year's student issue of the *Bulletin* explore the many ways students face uncertainty while undertaking a college degree program, whether moving to a new country, changing one's major, or dealing with stalled experiments, among other challenges. In many cases, students have paved their own roads: not the road more traveled or even the road less traveled, but new roads that were not even on the map before.

One of the main difficulties that students face when transitioning from undergraduate studies to professional occupations or graduate research is the absence of an "answer key." Success is not a quantitative measure of performance (a "grade") that adheres to some universal standard. Rather, success is like using a pottery wheel—it is formed by one's own hand, rather than through the use of a mold. The students who have written the following articles, like many of their peers, are forming their careers by their own hands. Their careers may be international or multidisciplinary; through a diversity of experience, the future of the ceramics field is made stronger and all the brighter.

This outlook on the future has been a unique focus of the ACerS President's Council of Student Advisors (PCSA) during the 2020–21 term, ever since the quarantines led to our welcoming the new class of delegates with a virtual rather than in-person annual business meeting last October. The PCSA currently comprises 41 delegates, representing 25 universities and four countries. Despite never meeting in-person, these delegates successfully maintained the status quo set by the Council in previous years and also extended and strengthened the operations of the Council in virtually all facets. For example,

- **The Programming Committee** supported new opportunities for networking and professional development at virtual conferences, substituting for in-person analogues of activities which could not take place this year.
- **The External Partnerships Committee** expanded the size of its mentorship program by over 60% since 2019–20.
- **The Outreach Committee** presented technical demonstrations and information about access to STEM and ceramics studies in more classrooms than ever before. The new trial liaison program with the Colorado Section of ACerS is exploring a range of opportunities for implementing the existing national programs of the Council at a more focused, local level.

We hope that the following articles remind you of the types of uncertainty you may have faced at the beginning of your career in ceramic and glass materials. For current students, the following articles may serve as lampposts, illuminating newly-paved boulevards as well as well-trodden paths walked by students of all backgrounds and in all corners of the world. The PCSA is and shall long be an organization focused on connecting current and future leaders of The American Ceramic Society.

Michael Walden is a Ph.D. candidate at Colorado School of Mines, located in the city of Golden, Colo. As the 2020–21 chair of the PCSA, he strives to encourage the creative ambitions of its delegates. His vision of the best version of the PCSA is one that continuously looks toward the future, anticipating all the roads it may travel next. 100

Congressional Visits Day 2021 recap

By Yolanda Natividad
ACerS liaison to the Material Advantage Student Program

The Material Advantage Student Program's Virtual Congressional Visits Day (CVD) was held this year from April 20–22, 2021. The CVD is an annual event that gives students an opportunity to visit Washington, D.C., to educate congressional decision makers about the importance of funding for basic science, engineering, and technology. While we were not able to physically be in D.C. this year, we did offer a virtual CVD program for Material Advantage students.

The CVD experience began with a virtual welcome event on April 20, featuring talks by

- Alex Martin, 2019–2020 TMS/MRS Congressional Science & Engineering Fellow
- Matthew Hourihan, American Association for the Advancement of Science
- Megan Malara, 2020–2021 TMS/MRS Congressional Science & Engineering Fellow

After the talks concluded, the students were provided with a chance to go into break-out rooms to further organize their teams and to do some role-play in advance of their appointments in the following days.

This year's student attendees worked hard to schedule congressional visits with legislators and staffers for April 21 and 22. Despite their hard work, it proved to be a difficult task to schedule congressional visits due to a variety of factors outside of attendees' control.

On the evening of April 22, the Washington, D.C. Chapter of ASM International and the Washington, D.C./Maryland/Northern Virginia Section of The American Ceramic Society cohosted an event, which gave the students an opportunity to network with local professionals in the D.C. area. Additionally, the Washington, D.C. Chapter of ASM arranged for a speaker from the Defense Advanced Research Projects Agency, who presented a talk on Advances in Personal Protection (PPE) Strategies and Technologies.

The Material Advantage CVD event was attended virtually this year with a total of 27 students and faculty from the following universities:

Boise State University
California State Polytechnic University, Pomona
Iowa State University
Michigan Technological University
Missouri University of Science and Technology
Purdue University
San Jose State University
University of Tennessee, Knoxville
University of Maryland, College Park
University of Michigan
University of Minnesota, Twin Cities

Credit: Pexels (left, Lea Bonzer; right, Andrew Neel)

Continued thanks to David Bahr, head and professor of materials engineering at Purdue University, and Iver Anderson, senior metallurgist at Ames Laboratory and adjunct professor in the materials science and engineering department at Iowa State University, for conducting the training on how to visit with legislators and for their assistance over the years in helping to coordinate CVD. Bahr and Anderson both serve on the Material Advantage Committee, the advisory committee that provides recommendations and feedback about the program to the four partnering organization's leadership.

An additional thank you to Stephen Kampe, chair and professor of materials science and engineering at Michigan Technological University, for helping to cohost the virtual CVD welcome event this year.

We hope to be back in-person in D.C. again for the 2022 CVD event. If you are a student and did not get a chance to participate this year, make sure that you plan to register EARLY for the 2022 CVD event. Or if you are a professor/faculty advisor, make sure to plan on gathering a group together from your university.

For future updates, visit the Material Advantage website at www.materialadvantage.org. It is an opportunity that you will not want to miss! 100

Embracing growth when experiments stall

By Kimberly Gliebe

Gliebe

As a Ph.D. student studying thin film deposition, I feel fortunate that the internships I had during my undergraduate studies enabled me to experience research early, which confirmed that research is the career path I want to pursue. The internships also introduced me to the uncertainty that is inherent to research when things do not go as planned.

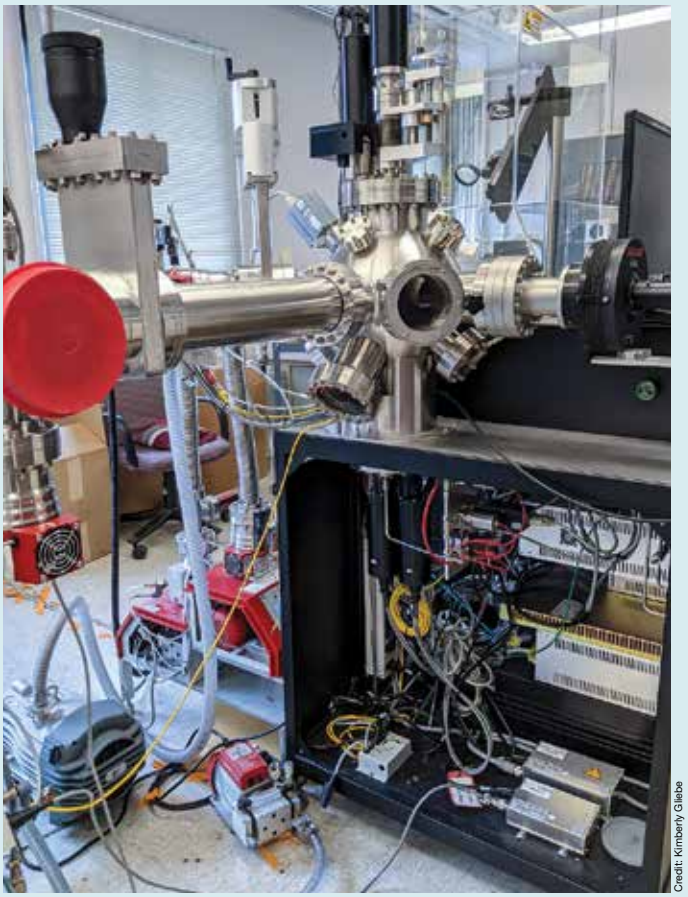
My first big experience with uncertainty was during a project at the Wright Patterson Air Force Base in Ohio, which took place during and after the senior year of my undergraduate degree. The Air Force project involved laser annealing a premade film to change its electronic properties for use in an integrated circuit. Several months after the project started, the laser that was central to my experiments began experiencing problems—it was unable able to reach its maximum level of power. I had no knowledge of the technology behind lasers and could not fix the problem myself. After weeks of discussions with the company that manufactured the laser and thousands of dollars, a company representative came to inspect and fix the laser.

This problem was unavoidable on my part, and yet it set my work back several weeks. I had to learn to be patient with this process and find other ways to use my time, such as reading literature about laser annealing and teaching myself basic Python programming skills. These activities enabled me to better plan experiments once the laser was fixed.

The Air Force experience prepared me for the beginning of my Ph.D., when a pump that was central to the deposition setup for growing my thin films was sent out for repairs (Figure 1). Initially we thought the pump would be repaired in a few weeks to a month, but it ended up taking almost half a year before we got the pump back. Because of my internship, I had learned other ways to fill my time when experiments stall. I enrolled in more classes, took my qualifying exam a year earlier than necessary, and heavily focused on literature searches, which gave me a better foundation of knowledge for writing proposals for fellowships.

Although I kept busy, this period was very difficult for me. Sometimes my successfulness as a Ph.D. student feels tied to how many experiments I am doing and the quality of my lab work. I had to remind myself that even though results from experiments are important, it is not the only aspect of a Ph.D.

The papers that I read about novel oxide structures and the application of machine learning to microscopy helped me to see how crucial data science is becoming for materials work—something I could never have envisioned back when I started my Ph.D. It guided my research from being about doing as many physical experiments as possible to instead spending more time critically analyzing results through machine learning. I have enjoyed this aspect of my work so much that I now am considering a career in data science for materials in the future.



Credit: Kimberly Gliebe

Figure 1. Pulsed laser deposition setup. The spherical chamber (center) is where deposition takes place, and the two red turbo pumps connected to the back of this chamber (lower left) bring it all the way to vacuum. One of the turbo pumps is what needed to be sent for repairs at the beginning of my Ph.D. research.

I am glad that I learned to use times of uncertainty as periods of growth and reflection rather than setbacks. I hope that regardless of the uncertainties I may face in the future, I will push forward and find creative ways to keep working and learning.

Kimberly Gliebe is a third-year Ph.D. student in the materials science and engineering department at Case Western Reserve University. Her research focuses on understanding the growth of thin films by pairing data science with microscopy techniques. When not researching, she likes to run and play board games, as well as host events through her university's Graduate Materials Society. 100

Building confidence when facing the uncertainty of switching fields

By Nathaniel Olson

Olson

In a career, especially in research, there is little certainty except for the inevitable uncertainty. Uncertain situations can be either sprung on you or jumped into willingly, yet both types can pose a serious challenge to your comfort and confidence. However, your perception of and reaction to this challenge can make uncertain situations an opportunity for growth.

My story is an example of jumping into uncertainty willingly by switching fields for my Ph.D. I majored in chemical engineering as an undergraduate, but during my studies, I saw glimpses of materials science through research at the Ohio State University on catalysts. In 2017, an internship experience at NASA Glenn Research Center on high-temperature aerogels and composite materials helped me realize that I wanted to learn about and work in the field of materials science. To pursue this path, I had to pivot my education and pursue a Ph.D. in materials science.

When starting my Ph.D., I felt woefully unprepared on fundamental knowledge that I believed my peers and mentors would expect me to have, such as not knowing one unit cell from another or what a "grain" is. Now in my third year, I have come to realize how to make the most of uncertainty and how to use it as an opportunity for personal and professional growth.

I will offer three pieces of advice that I find particularly useful in overcoming uncertainty. First, be unafraid to ask questions. This advice is applicable to all parts of life, but it is especially important when you do not know something and are surrounded by people that do. In my experience, conversations with my research group members have proved extremely fruitful in identifying new and interesting routes for my research that I otherwise would not have pursued. Remember, it is important to consider questions on your own first to develop intuition, but do not overthink yourself out of asking.

Second, seek out the right mentors and colleagues, as they can guide you and provide tools to overcome uncertainty. My mentors have been a crucial part of my growth thus far. My undergraduate mentor introduced me to research, showing me how to ask questions and design experiments to answer them. My mentor at NASA allowed me to explore research in materials science and expanded my connections in the field. My Ph.D. mentor advanced my skills in project development and challenged me to think deeper about my work.

Credit: Nathaniel Olson

Nate at the NASA Glenn Research Center during his 2017 summer internship.

Third, do not forget your own value and what you may be able to teach others based on your own background. We each have a unique story and lessons learned from it. A fresh perspective and enthusiasm can often make up for shortcomings of formal training. My background in chemical engineering allows for a unique systems-level perspective and has equipped me with fundamental knowledge of thermodynamics and transport phenomena that continues to inform my research in materials science.

While I try my best to consistently implement this advice, I often waver in my ability to take on uncertainty. I sometimes doubt myself and will choose to struggle on my own rather than reach out to peers and mentors for help, fearing I will give the impression of ineptness. However, when I do follow my advice and I reach out to mentors, friends, and peers, I am able to make the most of uncertainty by simultaneously learning from others while expressing my own ideas.

Ultimately, while putting yourself in uncertain situations does not make future ones any less uncertain, they build your confidence by letting you know you can succeed in handling them.

Nathaniel Olson is a third-year Ph.D. student in the Department of Materials Science and Engineering at the University of Illinois at Urbana-Champaign. His research focuses on developing porous materials (aerogels) with improved thermal stability for use as insulation in aerospace applications. Outside of research, Nate is a major LEGO enthusiast and amateur race car driver, racing with the National Auto Sport Association and the Illini Motorsports Formula SAE team.

Finding jobs and traveling as an international student in the US

By Iva Milisavljevic

Milisavljevic

"You're starting a new chapter in your life! That must be so exciting!" When a friend of mine said this to me right before my move four years ago from Serbia to the United States to start my Ph.D. in ceramic engineering, excitement was certainly one of my top emotions. But though the decision to pursue a doctorate in another country was one of the best decisions I have made, there are a few aspects of it I had not considered that ended up affecting my life very much.

I knew that Ph.D. studies and research would be hard at times and fails would be almost inevitable. However, for an international student, the uncertainties are not bound only to the Ph.D. After earning their degree, international students face uncertainties finding a job so that they can stay in the country. Not so many companies are willing to hire a person who is still on a student visa, which significantly reduces the number of job opportunities an international student can apply for. Fortunately, in the United States, international students that graduate with a degree in one of the STEM fields have the opportunity to stay for an additional three years to gain more experience through an initiative called Optional Practical Training.[1] However, if the student does not secure a job right after graduation, they then are required to leave the country and lose a chance to stay a bit longer. Therefore, preparing for the long process of a job search during the Ph.D. studies is one of the tactics that international students use to make the whole period less stressful.

In light of the current COVID-19 pandemic and dozens of imposed restrictions, especially in terms of traveling, international students faced additional uncertainties when the government started debating whether international students would be able to stay in the U.S. or even enter the country if their university only offered online courses.[2] As explained in the previous paragraph, physically being in the country plays a huge role in securing a job after graduation, so the possibility that international students would have to leave created much confusion and fear for the students. Fortunately, the government ultimately rejected this decision,[3] so international students, including myself, were able to continue with their work and studies.

However, for me and many students, staying in the country was only a partial win—the ability to travel back home to visit family remains a challenge. Specifically, it is returning to the U.S. after traveling that I see as the greatest challenge. In most cases, my one-year visa expires during the time when I would travel back for the holidays. So, my return to the U.S. would require me to apply again for a U.S. visa and go to the embassy for an interview. Although I am sure my name would not raise a red flag during the background check, there is still that small percent of a chance that I might get rejected and not be able to come back to the U.S. This small possibility has always given me a sense of discomfort, but I personally am willing to take the risk to travel home. The current pandemic, though, has only complicated travel even more.

Credit: Iva Milisavljevic

Even though traveling to my home country can be challenging, being a graduate student in the United States provides me many opportunities to travel in this country instead, such as to the Kennedy Space Center in Florida.

In the end, I want to emphasize that, usually, international students can manage these uncertainties fairly well through forethought and careful planning. By staying informed about current policies and opportunities, you will know how to act and not lose your nerve when the time comes.

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Iva Milisavljevic is a fourth-year Ph.D. student in ceramic engineering at Alfred University. Her research focus is on novel solid-state single crystal growth technique and transparent ceramics for various optical applications. In her spare time, she enjoys practicing yoga and drawing funny doodles, as well as hiking, camping, and all sorts of outdoor activities. 100

The two-body problem: Planning a career when married

By Riley Winters

Winters

As an undergraduate student studying materials science and engineering at Boise State University, I faced uncertainty in many ways through my education, from changing majors (from finance to materials science) to research focus (electrical properties to nuclear energy). These choices often are very personal decisions that are decided based on how it will shape your future career plans. However, these choices do not always just affect you—when you are married, you must consider how your decisions align with your spouse's plans as well.

In my case, I originally was certain that I wanted to work in the semiconductor industry, and I set out to learn as much as possible about electrical properties of materials. However, in my second semester of undergrad, I joined the Advanced Materials Laboratory (AML) as an oxide nuclear fuels student researcher, which led me to intern at Oak Ridge National Laboratory (ORNL) as an expansion on my research in the AML. I spoke with many researchers and other students while interning at ORNL, and I toured the University of Tennessee Nuclear Engineering graduate program. These experiences ignited my passion for nuclear energy research given that the motivation for such research is to develop an emission-free, consistent, and reliable energy source. So, I decided that getting a Ph.D. was the best option for pursuing a career in nuclear energy.

However, while my personal feelings about the decision were set, I needed to consider how pursuing a Ph.D. would affect my husband. He graduated in 2018 with a bachelor's in materials science and engineering and already had a job in the semiconductor industry in Boise, Idaho, which is 4+ hours from any nuclear-related industries. If I went the nuclear route, we would have to move, and most likely he would have to switch industries.

After a lot of discussion, it was clear that we were both supportive of each other's career goals and were willing to make compromises for each other. We each made of a list of what was important to us in a career choice, including things like location, industry, materials type, and education level. The most important factors to us were location and industry. We wanted a location that we could enjoy outside of work and be near our families, as well as one that supported our desired industries. To supplement both factors, we also considered material type. If I were to compromise on the industry, I would still like to work with ceramic materials.

Part of the decision was made easy when I received an email from my university's advising department letting me know about a ceramics engineering R&D internship at a company that manufactures thermistors, located in Boise. I was excited when I realized that many of the skills and experiences I gained when working with oxide nuclear materials would transfer seamlessly to working on thermistors, so I applied.

Credit: Riley Winters

Riley with her husband and Australian Shepherd dog at their home in Boise, Idaho.

I started the internship this past August and felt like it cleared up all my career path uncertainty. I feel fulfilled in this position, as I can conduct research and experimentation in addition to process improvements. While I am no longer connected with the nuclear industry, thermistors do have a significant impact in many areas, including military, medical, and countless everyday appliances. Additionally, this industry is one that I can be successful in with just a bachelor's degree, but I can remain open to getting a postgraduate degree in the future. Between these aspects and the fact that my husband can stay at his job, which he has been at now for two years, my choice was made. I will be graduating in May 2021 and my internship will become a full-time position as ceramics process engineer right here in Boise.

Riley Winters is ceramics process engineer at QTI Sensing Solutions. Her research focus is process development for thermistor manufacturing, including tape casting, rheology, and sintering. Outside of work, she enjoys gardening and does agility with her Australian Shepherd dog. 100

Harnessing the potential energy of uncertainty

By Elisa Zanchi

Zanchi

Uncertainty can be defined quite literally as the absence of certainty. In other words, someone experiencing uncertainty is unsure and/or ignorant of future developments or consequences following from a current situation, which leads to a state of doubt, insecurity, and anxiety.

While uncertainty can be experienced to varying degrees, it generally can be traced to either external or internal factors. External factors, such as when you are waiting for an answer from someone or the results of an experiment, often trigger uncertainty due to featuring an outcome beyond your control. But for uncertainty coming from internal reasons, such as when you find yourself at a crucial crossroads that requires major decisions on your personal or professional life, you can experience uncertainty because the outcome is entirely in your hands.

Two events of my academic life brought me face-to-face with these two types of uncertainty—first, the choice of my master's thesis; and second, the decision to do a Ph.D. The degree of doubt that I experienced on these two occasions differed noticeably and reflected the new strategies that I have matured over time to react to uncertainty.

Being born and raised in stable family conditions, neither external nor internal uncertainty played a significant role in my early life. Many of the choices I made both in personal life and career path were chosen in a light-hearted manner. However, when the time came to decide on my MSc thesis, for the first time I realized that a choice could have consequences on my future career.

On the one hand, I had the option to focus on an easy topic, allowing me to graduate quickly and find a job close to my family and friends. On the other hand, I could take the chance to go abroad and be part of an innovative project, involving a huge personal and financial investment. I found myself trapped in uncertainty, making lists of pros and cons that were influenced by an aura of insecurities: the fear of not being able to overcome possible obstacles (e.g., language, being independent, getting along with new people) and of meeting others' expectations.

After pouring over the pros and cons, I finally had a paradigm shift. I wanted to challenge myself and realized that embracing uncertainty was an opportunity to discover who I could become outside of my comfort zone. Thus, in the end, I decided for the second thesis option.

From that experience I learned that while a high level of uncertainty can cause high amounts of stress, it also entails a huge number of possibilities. Uncertainty and action are similar to how potential and kinetic energy are strongly dependent on each other: an uncertain situation holds a lot of potential to be transformed into the kinetic energy of our action.

Picture of the DTU Risoe Campus in Denmark, where I conducted research for my master's thesis and began to appreciate the opportunities to which uncertainty can open your eyes.

Credit: Elisa Zanchi

Following my master's, I was caught again in a moment of indecision when deciding whether to pursue more education or to find a job. Compared to my MSc thesis, which involved a lot of internal uncertainty, a Ph.D. project would introduce a lot of external uncertainties because, as a Ph.D. student, it is not only required to plan my own work but also that of collaborators, students, and technicians, which is a complex task with probabilities of failure that would have long-term consequences. Fortunately, the lessons I learned about handling my internal uncertainty when choosing a MSc thesis allowed me to accept this feeling as an alarm bell informing me that I was at a relevant crossroads and it was time to ponder over the next steps.

Now, at the beginning of my professional life, I see how uncertainty gives me the chance to make decisions based on my aspirations instead of going by default for the safest and most convenient option.

Elisa Zanchi is a second-year Ph.D. student in materials science and technology at Politecnico di Torino, Italy, under the supervision of Prof. F. Smeacetto. She works on the synthesis of innovative glass-ceramic sealants and ceramic coatings for steel interconnects and their integration in solid oxide cell stacks. In her spare time, she enjoys hiking, playing tennis, and crafting handmade jewelry. 100

Using themes to find comfort in uncertainty

By Collin Holgate

Holgate

There are few questions I find more frustrating than "What do you see yourself doing in five years?" Blessed-be those capable of constructing grand life visions—I am not one of them. I do not know what I want to do with my Ph.D. in materials science once I receive it.

Life transitions—especially those that are uncertain—are scary. But we can build some comfort with this uncertainty by changing the question. Rather than focusing on *what* you plan on doing later in life, you should explore what you want life to *feel* like. In other words, instead of choosing a specific goal or aiming for a particular job, you can develop a general theme for your life that helps to guide decisions when they come up.

Finding a theme can take quite a bit of self-exploration. Evaluating how you prioritize things like money, independence, time off, mentoring opportunities, location, and possibility for impact can help you identify the factors necessary for attaining long-term fulfillment. You will not have it all early in your career, so it is important to know which aspects you are willing to sacrifice for others. For example, one of the big themes in my live is helping people. I'm willing to sacrifice money to satisfy that desire. Priorities evolve over the years, but themes are flexible and can be reworked when the time feels right.

Once you have an idea of your priorities, explore career paths that offer some overlap. The point is not to find the perfect path but rather to discover your priorities in lots of different paths. For example, my desire to help people can be satisfied through mentoring others. Career paths as a professor, an industrial research scientist (at the right company), or as a teacher all offer opportunities to be a mentor, and I believe any of these roles would fulfill me. Be creative in your search and keep an open mind! Search within and beyond the scope of your technical expertise.

Credit: Mohammad Bagher Adib Behrooz, Unsplash

Your career is a labyrinth of different paths—but developing themes for your life rather than specific goals can help you navigate the many options.

However, be aware of education sunk-cost fallacies, or the belief that you must continue on a certain path because you've already invested a lot of time, effort, or money in it. This type of thinking—that your education is only good for one type of job—entirely discounts the personal growth and transferrable skills you have gained. Your education, no matter what you do after, is never wasted. As a starting point for exploring possible careers, I highly suggest visiting your university career center—such centers can be a repository of information and tools. (If you're not currently affiliated with a university, the career website through the University of California, Santa Barbara offers diverse and well-organized information, much of which is publicly available.[1])

Perhaps a couple of career paths have really piqued your interest. If so, pay attention to what skills and experiences would make you a competitive candidate; work to build these skills, especially those you are currently missing. Remember, our themes can guide us even if no particular path hit home. For example, I tried to maximize mentoring and leadership opportunities throughout graduate school, experiences which will help me in my future, regardless of the exact path I choose. Even if you are years away from graduating, start thinking about your themes now. Early introspection will allow you to catch more opportunities.

Developing a theme will not completely erase feelings of uncertainty, but hopefully those feelings will be more comfortable, especially for those unable to laser focus on a specific goal. Work on exploring yourself. Your career is a labyrinth of different paths. Even if the route ahead is foggy, when you arrive at a fork, your theme can illuminate the way.

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Collin Holgate is a Ph.D. candidate at the University of California, Santa Barbara, working under the direction of Professor Carlos Levi. His research investigates the thermodynamics and kinetics of how molten sand and ash degrade the protective coatings used in jet engines. Outside of research, he has been involved with organizing and running UCSB's annual Beyond Academia career exploration conference. He also enjoys spending time in nature by exploring the mountains and coast of California.

The difference in thinking between Chinese and German scientific research scholars when facing unknown challenges

By Bo Chen

Chen

My name is Bo Chen, a Ph.D. student in chemical engineering at the Karlsruhe Institute of Technology in Germany. I am originally from China, and I completed my bachelor's and master's degrees there before moving to Germany for my Ph.D.

I chose to pursue my Ph.D. in another country because I believe getting out of your comfort zone exposes you to new opportunities that broaden your academic horizons and comprehension of different cultures. I chose to study in Germany because Germans are known for their scrupulousness, which is a good characteristic to have when performing research.

In Germany, I have experienced a completely different scientific research atmosphere and way of thinking compared to China. In my opinion, both the Chinese and German approaches to research have their pros and cons, which means we can learn a lot from each other. I believe that this exchange of information is a necessity of international academic collaborations.

From what I have experienced, Chinese scholars spend far more time than German researchers in aggressively pursuing a solution to challenges—it is normal for some Chinese research scholars to work more than 12 hours a day, six or seven days a week. This diligence is due to cultural and national conditions that emphasize efficiency. In experiments, Chinese scholars usually pay more attention to the results because they like to pursue a high impact factor for the subsequent paper. In terms of social interactions with colleagues, there is an obvious hierarchy between superiors and subordinates in Chinese laboratories, both at universities and research institutions. I believe this hierarchy can greatly limit the enthusiasm and motivation of researchers, and it also can limit the communication between colleagues, which inhibits a lot of interesting ideas.

Credit: Bo Chen

Me traveling in the Czech Republic. I believe the process of actively interacting with various cultures exposes you to new opportunities that broaden your academic horizons.

After several years of study and exchange in Germany, I have identified several significant differences in the academic environment here compared to China. The most impressive thing about German scholars is their passion and enthusiasm for research. While scrupulously approaching unknown challenges step-by-step, they spend time looking to understand the reasons for their results rather than just focusing on the results themselves; they discuss intensely with their colleagues. I am excited to witness this kind of love for one's job. It is this kind of love that makes them full of passion for unknown challenges and also makes them full of possibilities in scientific research—professor and student alike can speak freely and humbly like friends and discover new possibilities through comparing their different viewpoints. However, because German scholars attach great importance to family and personal time, they typically spend less time in the lab than Chinese scholars, which often leads to slower progress.

These differences are just a few of the ones that I have observed in how the scientific research process is conducted in China and Germany. In the process of actively interacting and colliding with various cultures, I developed my own approach to research that I will likely take with me after graduation. I hope that more international young scholars will give up their prejudices and communicate with each other seriously and profoundly. When we face unknown challenges, we can walk hand-in-hand to overcome difficulties. I firmly believe that the future will be full of possibilities.

Bo Chen is a Ph.D. student at the Karlsruhe Institute of Technology, Germany. His research focuses on solid electrolytes for batteries. He likes traveling and reading. 100

Facing uncertainty in new types of jobs

By Aubrey L. Fry

Fry

I am a first-generation college student. I cannot remember having a conversation about college with anyone—not a parent, teacher, or friend—before my junior year of high school. I grew up in farm country, and a four-year college was not the default expectation for high school graduates in my town. Like many of my peers, I grew up working physically demanding jobs—gardening, mowing, throwing hay, tending to animals. Though I am extremely grateful for these jobs, I knew I didn't want to do such work forever. However, I didn't know what I *did* want to do either.

When I started research for my master's in materials science and engineering, the work was unlike my previous job experiences. This type of exercise was unfamiliar to me, and I felt much more uncertain of my aptitude to succeed. Unlike manual labor, the fruits of performing scientific research did not culminate at the end of each day—I could work 50+ hours a week and feel that I had accomplished nothing. But accomplishments did come over time, and they were marked with great satisfaction and pride.

When I neared the end of my master's program, my advisor offered me to stay in his group for a Ph.D. I declined his offer because I wanted to explore other materials and other places before choosing a Ph.D. program. While I enjoyed research, I felt that I needed more experience to know if I wanted to dedicate my life to such a career. So I interviewed for a research position at a government lab after just one year in materials science.

The position involved fundamental research in glass and ceramics, and it was my first "real world" interview. The interview process was intense. The day's agenda was set to last only a few hours, but it ended up going all day.

Credit: Aubrey Fry

My visit to the USS Midway Museum during the International Conference on Sintering 2017 in San Diego, Calif.

I met with branch heads and senior scientists, gave a presentation on my research, and toured the labs. That was the first time I presented my research (or any research, in any capacity), and to my pleasant surprise it was the most enjoyable part of the interview process. "Wow, maybe I could really be good at this," I thought to myself.

That glimmer of confidence was quickly snuffed out during my one-on-one interviews, which felt like one long oral exam—I was bombarded with hours' worth of questions. I gave my best responses and hypothesized about things I did not know the answers to. The most stressful interview was when one scientist pointed out every materials-related word I misused or mispronounced; I felt so over my head, and my inferiority complex grew. Later that afternoon, hours after the designated end time, I left the building and walked to my car in a nearly empty parking lot. I felt so unprepared and like a fraud, and I was sure everyone there thought the same.

After what felt like three months—which was only three weeks—I got a call from the government lab, offering me the position. Even though I felt so behind during the interview, what mattered is that I demonstrated my potential and willingness to learn—key qualities for growing in any job.

That was the best first job I could have asked for. Research became more familiar to me and I became more comfortable knowing that the delayed reward of fundamental research was truly satisfying. I learned so much in my two years at that job, and at the end of the experience, I earned a Department of Defense SMART scholarship, which allowed me to return to graduate school for my Ph.D.

I am immensely grateful for those in my life that have seen potential in me even when I do not see it myself. I must constantly remind myself to face uncertainty as an opportunity. And when I do, I count it as a success.

Aubrey Fry is a Ph.D. candidate in the Department of Materials Science and Engineering at The Pennsylvania State University. She researches silicate glass composition–structure–mechanical property relations with a focus on exploiting topological adaptability under stress. Aside from glass science, she is passionate about music and painting, and enjoys camping and water sports. 100

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20–22 Serbian Ceramic Society ACA IX conference – Serbian Academy of Sciences and Arts, Serbia, Belgrade; http://www.serbianceramicsociety.rs/index.htm

October 2021

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

17–21 ACerS 123rd Annual Meeting with Materials Science & Technology 2021 – Greater Columbus Convention Center, Columbus, Ohio; https://ceramics.org/mst21

18–20 Flourine Forum 2021 – Pan Pacific Hanoi, Vietnam; http://imformed.com/get-imformed/forums/fluorine-forum-2020

25–27 China Refractory Minerals Forum 2021 – InterContinental, Dalian, China; http://imformed.com/get-imformed/forums/china-refractory-minerals-forum-2020

November 2021

1–4 ➨ 82nd Conference on Glass Problems – Greater Columbus Convention Center, Columbus, Ohio; http://glassproblemsconference.org

December 2021

12–17 14th Pacific Rim Conference on Ceramic and Glass Technology (PACRIM 14) – Hyatt Regency Vancouver, Vancouver, British Columbia, Canada; www.ceramics.org/PACRIM14

January 2022

18–21 Electronic Materials and Applications 2022 (EMA 2022) – DoubleTree by Hilton Orlando at Sea World Conference Hotel, Orlando, Fla.; https://ceramics.org/ema2022

23–28 46th International Conference and Expo on Advanced Ceramics and Composites (ICACC2022) – Hilton Daytona Beach Oceanfront Resort, Daytona Beach, Fla.; https://ceramics.org/icacc2022

March 2022

15–18 17th Biennial Worldwide Congress Unified International Technical Conference on Refractories – Hilton Chicago, Chicago, Ill.; https://ceramics.org/unitecr2021

May 2022

22–26 Glass and Optical Materials Division Annual Meeting (GOMD 2022) – Hyatt Regency Baltimore, Baltimore, Md.; https://bit.ly/3ftnJql

June 2022

22–26 ACerS 2022 Structural Clay Products Division & Southwest Section Meeting in conjunction with the National Brick Research Center Meeting – Omni Charlotte Hotel, Charlotte, N.C.; https://bit.ly/31zyfob

July 2022

24–28 Pan American Ceramics Congress and Ferroelectrics Meeting of Americas (PACC-FMAs 2022) – Hilton Panama, Panama City, Panama; https://ceramics.org/PACCFMAs

July 2024

14–19 International Congress on Ceramics – Hotel Bonaventure, Montreal, Canada; www.ceramics.org

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

Entries in **BLUE** denote ACerS events.

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

denotes virtual meeting

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INDUSTRY NEWS

O-I GLASS PLANS $75M EXPANSION IN COLOMBIA

O-I Glass, Inc. said it will invest approximately $75 million in an expansion at its facility in Zipaquirá, Colombia. The project, when completed by the end of 2022, is expected to add nearly 2% of capacity to the company's Americas segment and will produce about 500 million bottles annually. The expansion will add a fourth furnace to the plant, which was expanded in 2019. O-I said it is still committed to reducing debt and has expanded its divestitures target to $1.15 billion or more by the end of 2022 to support the Zipaquirá expansion.

Perrysburg, Ohio-based O-I Glass operates 72 plants in 20 countries.

AGI glaspac's Bhongir plant in southern India.

AGI GLASPAC EXPANDS ITS BHONGIR PLANT

AGI glaspac said it plans to invest Rs 55 crore (about US$7.4 million) to build a new furnace for its Bhongir plant in Telangana, southern India. It is part of an investment from its Gurgaon, India-based parent company, HSIL Limited, amounting to Rs 220 crore (about US$29.4 million). With the new furnace, the plant will be able to produce 154 tons of specialty glass for carbonated water, sparkling wine, pharmaceuticals, and cosmetics. AGI glaspac partnered with Germany-based machinery maker Horn Glass Industries AG for the technology.

VISY UPGRADES GLASS RECYCLING FACILITY

Visy plans to build a $35 million glass recycling facility at its complex in Laverton, Western Australia. It will double the center's recycling capacity from 100,000 tons of glass each year to 200,000, the company said. Visy is a packaging and resource recovery company with more than 120 sites across Australia, New Zealand, and Thailand, and offices in Asia, Europe, and the U.S.

The new facility in Laverton, Australia, will be able to sort glass down to 3 mm.

A rendering of Photocentric's planned research center.

R&D HUB FOR ADDITIVE MANUFACTURING PLANNED IN THE UK

Photocentric, a manufacturer based in Peterborough, England, is planning a 3D printing center of excellence and a research and development hub at its University of Peterborough site. The center of excellence will cost approximately 1.8 million pounds to build and will make the resins for printing, 3D printers, and 3D printed parts, the company said. It is expected to be completed in November. The R&D hub should be completed a year later and will feature three state-of-the-art print farms for industrial parts, dental aligners, and ceramics.

STOELZLE GROUP ACQUIRES PENNSYLVANIA GLASS PLANT

Austria-based Stoelzle Glass Group acquired the Monaca, Pa., glass factory from Anchor Hocking Glass Co., a subsidiary of the Oneida Group. It is Stoelzle's seventh glass plant, its first plant in the United States, and its first outside Europe. Stoelzle Glass Group is a producer of high-end packaging glass for the spirits, consumer, perfumery, cosmetics, and pharmaceutical markets.

Stoelzle said it will invest in and modernize the Monaca, Pa., plant.

LG said it plans to invest $4.5 billion in its U.S. business by 2025.

EV BATTERY MAKERS SETTLE LEGAL DISPUTES

LG Energy Solution and SK Innovation announced an agreement to settle all legal disputes relating to electric vehicle batteries in the United States and Korea. Under the agreement, SK Innovation will pay LG 2 trillion won (US$1.8 billion) in lump-sum payments and a running royalty. The companies agreed to withdraw all pending legal disputes in the U.S. and Korea. LG had accused Seoul-based SK of misappropriating technology related to electric vehicle batteries. Both companies supply electric car batteries to major automakers.

CORNING EARNS SECOND US GRANT FOR VIAL MANUFACTURING

Corning Inc. was awarded $57 million in additional funding from the Biomedical Advanced Research and Development Authority (BARDA), part of the Office of the Assistant Secretary for Preparedness and Response at the U.S. Department of Health and Human Services to further increase domestic manufacturing of pharmaceutical glass tubing and vials to support the COVID-19 mass vaccination effort. The award is in addition to a $204 million contract announced in June 2020, for a total of $261 million invested in Corning's pharmaceutical vial and tubing manufacturing capacity. Corning said it has met every milestone to date under the original contract.


Corning is scaling up its vial and tubing capacity to meet demand.

KYOCERA CONNECTS WITH COOKING AND FOOD INFLUENCERS


Kyocera has offered ceramic cutlery since 1984.

Kyocera's U.S. consumer products group enlisted ExpertVoice, an advocacy marketing platform, to introduce the company's ceramic knives and kitchen tools to a variety of experts. The program will provide cooking, kitchen, and food experts with information and experience on Kyocera's proprietary ceramic knives and kitchen products. ExpertVoice connects brands with a network of more than 1 million influencers across more than 30 product categories.

VERALLIA PLANS TO EXPAND IN BRAZIL

Paris-based Verallia said it will invest about 60 million euros in its Jacutinga, Brazil, plant to build a second furnace. This investment will more than double the plant's production capacity from 1 million bottles per day to 2.3 million in 2023, when the furnace will be running at full capacity. The expansion aims to meet increased demand in the beer and alcoholic segments with amber and green bottles, the company said. Verallia operates 32 glass production facilities in 11 countries.

Verallia's plant in Jacutinga, Brazil.


PREPARING FOR CONTINGENCIES HELPED COMPANIES GROW DURING THE PANDEMIC

By David Holthaus

No one could have predicted a global pandemic. But a crisis? Those happen, in varying degrees, on a regular basis.

Companies that were prepared for the next crisis not only survived the last year but, in some cases, found new opportunities, and even grew. They did so against the odds during a once-in-a-hundred years emergency—the COVID-19 pandemic that has proven fatal to more than 3 million people and impacted business around the world.

Top: A rendering of CoorsTek's finished plant in Thailand. Bottom: Construction proceeds on CoorsTek's Thailand plant. *Credit: CoorsTek Inc.*

Despite restrictions on travel, CoorsTek, the Golden, Colo.-based maker of advanced technical ceramics, accomplished the planning, design, and initial stages of construction of a large, new plant in Thailand with few delays.

The company had wanted to expand its presence in the growing markets of Southeast Asia, and in mid-2019, its board gave the green light to a plan to build a large manufacturing plant in the province of Rayong, Thailand.

Before the virus emerged, CoorsTek already had a team in place in the region that was working on securing land and establishing vital relationships with the Thailand government and agencies that would be involved in the construction, says Andy Filson, CoorsTek's chief operations officer. It also had hired its first employee for the facility, the plant manager.

"Fortunately, pre-COVID, we had already selected Rayong, Thailand, as our location to expand, purchased land, and we began building relationships with the industrial park operators and government officials involved with foreign direct investments," Filson says.


Andy Filson

Some of leadership of the Thailand project team were already on the ground in South Korea working on a project in that country, where CoorsTek operates a large manufacturing facility. Even as COVID emerged, some countries in the region had reciprocal agreements to permit travel between them, Filson says. The CoorsTek team found a window to travel from South Korea to Thailand, quarantine for two weeks, and be tested to allow for travel within the country.

In April and May 2020, as the virus spread, Thailand closed its borders, which resulted in a slight delay in progress. After that, the country permitted a limited number of entries and mandated curfews and restrictions on in-person gatherings, efforts that limited the spread of the virus.

"CoorsTek got a jump on establishing protocols to keep people safe, even before public health agencies were prescribing such practices," Filson says. "Globally, we implemented strict guidelines around social distancing, even on the production floor, with flexible schedules and machine assignments, wearing of masks, entry screenings, and regular sanitizing of workspaces. We were ready when the Thailand mandates were announced," he says. "Our practice is to follow local regulations or our global standards, whichever has tighter restrictions."

The relationships that CoorsTek already established with government agencies and with the owners of the industrial park where the new plant would be built, connections that would be critical anytime, were especially important as travel and meeting restrictions were put into place.

"We needed to leverage these early relationships to continue expansion planning via online methods versus in person," Filson says. "We selected construction partners that already have a presence and extensive experience building in Thailand, so it all came together pretty seamlessly."

Like the rest of the world, the company made use of online meeting tools and other options for regular communication, including GoPro cameras and drone footage that permitted video from the site to be shared in near real-time.

"Use of such virtual tools got us close to having an onsite presence, so an expert on one side of the world could work with someone on the other side of the world, and both be looking at the same thing," Filson says. "This became critical not only for progress on the Thailand expansion, but also enabled CoorsTek to continue to move product lines around the world, improving our ability to keep employees safe, serve customers, preserve cash, and preserve jobs."

In the first phase, the company will build more than 110,000 square feet of manufacturing space, which is expected to be completed sometime in the third quarter of this year. Plans call for an expansion to more than 400,000 square feet over several years. "That will make Thailand one of the major manufacturing hubs for us and well-positioned for growth in that region," Filson says.

In addition to the expansion in Thailand, CoorsTek also continued to grow business throughout the pandemic. As a critical infrastructure business, the company kept the lights on even during the strictest portions of the lockdown to produce orders for critical components for medical equipment, semiconductor manufacturing, utilities, and other infrastructure.

"Keeping our employees safe during this time was our number-one concern, so we had to implement strict protocols almost overnight," says Filson. "The extraordinary flexibility and commitment shown by our employees around the world, working collaboratively with constant communications to all of our stakeholders, enabled the company to have far fewer internal COVID cases than what the world was experiencing, and prevent interruptions to our business."

In Saxonburg, Pa., the pandemic caused the leadership of Du-Co Ceramics to realize how essential its products are. The company makes ceramic insulators that are components of heaters, igniters, and sensors that wind up in larger products. The company often does not know what the end products are, but the pandemic changed that.

As shutdown orders came down in March 2020 across the U.S., many manufacturers were declared essential businesses and permitted to remain open. They needed parts.

"Within weeks, we had letters from more than a hundred of our customers saying they were essential manufacturers," says Du-Co president Tom Arbanas. "We were learning that our ceramic insulators were ending up in many critical applications," he says. "Pharmaceutical, medical, steel mills, defense products, foods, transportation, and energy."

One critical product they are used in is hospital ventilators. One of the first calls Du-Co received after the shutdown was from a customer that makes heaters for the machines that were suddenly in high demand. The customer needed as many parts as Du-Co could produce, and as quickly as it could make them.

"We did our best to fulfill orders quickly and keep our customers operating," Arbanas says.

It was able to do that partly because of decisions made long before the pandemic to keep a large amount of raw materials in its inventory. Du-Co ships a million parts a day out of its Saxonburg plant and burns through 300,000 pounds per month of talcs, clays, flux and other materials, Arbanas says. The pandemic disrupted the manufacturing supply chain, but the company's practice of stockpiling raw material meant it could continue to fulfill orders, sometimes when other vendors could not.

That spelled opportunity for the company. So did the decisions of some of its customers to "reshore" some of their purchases to U.S. companies as supplies from overseas became delayed or halted.

"Our sales team reached out to some of our customer base to tell them the benefits of buying their products within the United States," Arbanas says. "That was another area we've seen some growth in."

The sales team has not physically gone out on the road yet, but it will soon, he says.

Du-Co Ceramics president Tom Arbanas, far right, during a pre-COVID trip to the National Science Teachers Association Conference. *Credit: Du-Co Ceramics*

Du-Co management is continually looking for ways to become more self-sufficient, Arbanas says. It is working on making its own firing fixtures, for example, and is getting close to being able to do that.

Pandemics, thankfully, are rare occurrences. But supply chain disruptions are not, and Du-Co's efforts to be self-sufficient helped it weather the impact of the February storm in Texas, where some of its raw material is mined, and of the six-day blockage of shipping through the Suez Canal in March.

"Things like that seem to come up periodically," Arbanas says.

Supplying essential parts to essential manufacturers has provided a morale boost to employees through the pandemic. "It's given our workforce a sense of pride knowing we're helping keep America safe and running," Arbanas says.

Employees at Corning Inc. (Corning, N.Y.) are helping to get America—and the world—vaccinated.

Thanks to research efforts begun more than a decade ago, Corning was able to quickly step up its production of the glass vials needed to hold COVID-19 vaccines and get them to the vaccine makers to help meet the extraordinary demand.

Corning had been in the pharmaceutical vial business for decades, including the years in which the polio vaccine was being administered in the '50s and '60s. But the industry commoditized, and Corning exited it nearly 30 years ago.

But in 2010, executives from pharmaceutical maker Merck approached Corning CEO Wendell Weeks, who served on Merck's board of directors, and asked if Corning could help solve manufacturing concerns that Merck and other drug makers had with traditional vials made with borosilicate glass.

Friction on the outer surface of borosilicate vials can cause them to bunch together and create backups in the high-output manufacturing environments where vials are filled and capped, Corning says. That can cause damage and breakage. The glass can also flake, or delaminate, on the inside, potentially contaminating the drug. That led to an FDA advisory in 2011 on the potential for glass fragments in injectable drugs, and to several manufacturer recalls.

Corning researchers experimented with more than 200 different glass compositions before landing on an aluminosilicate glass that it says is 10 times stronger than conventional vials and more chemically durable on the inside, avoiding the delamination problem. In addition, Corning says a production line using vials made with this glass, which they call Valor Glass, can fill up to 750 vials a minute, nearly double the maximum speed that conventional vials

Corning's glass composition melting process. *Credit: Corning, Inc.*

Corning's Valor Glass lab. *Credit: Corning, Inc.*

can tolerate. That has put the product in high demand during the unprecedented national and global vaccination effort.

"We're fortunate to have a transformative product," says Brendan Mosher, vice president and general manager of Corning Pharmaceutical Technologies. "It wasn't really meant for pandemic response, but in hindsight, it's really the perfect packaging for a pandemic response. It's the strongest and fastest-to-fill vials ever made."

Drug maker Pfizer, whose COVID vaccine must be stored at ultracold temperatures, signed a long-term purchase and supply agreement with Corning for Valor Glass, the glass maker says.

The U.S. government took note, and in June 2020, announced a $204 million grant to Corning to ramp up manufacturing of the vials. The grant helped add capacity almost immediately at Corning's Big Flats, N.Y. plant, led to increased production at its glass tubing

Trade shows plan return to in-person events

Trade shows and conferences are slowly emerging from the pandemic-enforced virtual world.

Two of the largest ceramic industry events are currently planning to be held in person this year.

Ceramics Expo

Ceramics Expo is planning for an in-person event from Aug. 30 to Sept. 1 in Cleveland, Ohio. The sessions will focus on the theme of enabling a clean, efficient, and electrified future.

Conference organizers say they will follow physical distancing and crowd-density guidelines recommended by local government authorities, will minimize wait times at registration, and increase entry points to facilitate quicker admittance. They also plan to increase aisle widths and use dedicated travel lanes to help manage traffic.

As far as face masks, organizers say they "will take the necessary measures with regards to face coverings based on medical guidance at the time of the show."

Up-to-date information is available at www.ceramicsexpousa.com.

Read more about Ceramics Expo's response to the pandemic on p. 9, "The rocky road back to 'live.'"

ceramitec

The ceramitec conference and exhibition is scheduled to take place in Munich on Sept. 15–16.

Conference topics include technical ceramics, additive manufacturing, powder metallurgy, process control, and equipment supply and materials.

"Personal exchange and interaction are irreplaceable—especially in industries with short innovation cycles," Ceramitec says in announcing the event.

Current information and registration are available at www.ceramitec.com.

The American Ceramic Society rescheduled or canceled several events based on guidance from the World Health Organization and the Centers for Disease Control and Prevention, as well as from local government and public health authorities.

The Society maintained a series of professional development webinars and online events through the pandemic. A list of upcoming events is available at www.ceramics.org/meetings-events.

"We appreciate the efforts of our organizers, volunteers, vendors, and partners to work with us and respond to a fast-changing situation in a way that allows us to continue to serve our members and mission," says Mark Mecklenborg, ACerS executive director.

plant in Vineland, N.J., and will accelerate by roughly two years its plans for a high-volume manufacturing facility in Durham, N.C., Mosher says.

The federal government's Biomedical Advanced Research and Development Authority (BARDA) followed up that grant with one for $57 million, announced in March.

In addition to Pfizer, Corning is supporting other leading vaccine producers, with glass tubing in some cases, and directly with vials in others, Mosher says.

"The expansion we're doing now would be challenging under any conditions," Mosher says. "It's probably one of the fastest, most aggressive expansions Corning has ever done."

Pandemic travel and meeting restrictions have made it more difficult to move people and equipment around the country and the world, but the company is four to five months ahead of plan on the new North Carolina facility, he says.

Other glass makers also responded to the global need for pharmaceutical vials. Schott AG, based in Mainz, Germany, is on track to deliver vials for more than 2 billion vaccine doses through 2021, the company says. In March, it announced that its pharmaceutical packaging business unit had delivered enough vials to provide more than 1 billion doses of COVID-19 vaccines.

In early 2019, Schott announced a multiyear, $1 billion global investment in pharmaceutical glass and packaging facilities.

"The entire industry is successfully working together to ensure an adequate supply," Frank Heinricht, CEO of Schott AG, said in March. "We're also working with our government partners to evaluate ways to improve the supply chain and expand production capacity."

In June 2020, Italy-based Stevanato Group agreed to supply 100 million glass vials to hold up to 2 billion doses of COVID-19 vaccine to the Coalition for Epidemic Preparedness Innovations, a global partnership that is funding and coordinating the development of COVID-19 vaccines.

Last September, in the midst of the pandemic, as vaccine demand ramped up, Stevanato inaugurated its Technology Excellence Center in Boston, where it works with pharmaceutical companies and others to improve drug-container systems and reduce the time to market.

"We can anticipate challenges, and present viable, robust solutions that save development time and resources," says Paolo Patri, Stevanato's chief technology officer.

The planning of these companies and many others will help end the pandemic and prepare them for whatever the next crisis will be.

THE ROCKY ROAD BACK TO 'LIVE': IMPACT OF THE PANDEMIC FROM A TRADE SHOW PERSPECTIVE

By Emma Stokes

Exhibition organizer Smarter Shows shares how they navigated the pandemic to continue bringing industry professionals together virtually while planning the return to live events.

During the early winter months of 2020, we here in the small city of Brighton on the south coast of the United Kingdom watched with increasing interest and, gradually, concern, the speed at which something called "coronavirus" grew in significance. By late February, we saw an undeniable shift in the communications we received from the advanced engineering and manufacturing communities that we serve globally.

Ceramics Expo 2019, pictured, took place in Cleveland, Ohio. The 2020 event took place virtually because of the COVID-19 pandemic. *Credit: Smarter Shows*

By early March, we faced an incredibly difficult decision. We were scheduled to run our B2B tradeshow Foam Expo alongside the Adhesives & Bonding Expo in Michigan just a few short weeks later. We had 450 exhibitors and many thousands of attendees ready and prepared to descend on the Suburban Collection Showplace exhibition center in Novi, just outside of Detroit, on March 24. With the global situation changing at pace, we needed to carefully consider our response.

On March 9, we formally took the decision to postpone that event—the health and safety of our attendees were paramount. A couple of days later, I took a call from my daughter's nursery. My youngest, then 4, was being sent home. She had a slight temperature, and under new guidance from the government, she now needed to stay away for a full two weeks. I left the office immediately. Little did we know that two days later we would close the office entirely and send all staff to work from home. It feels naïve to think back now, but we initially thought this situation would be an unusual one that we would need to carefully manage for a few short weeks. Here we are 14 months on—a live B2B events company with no live events to our name since November 2019.

The postponement or "deferral" of live events would become a regular occurrence for our business and so many others like ours across the world as we all tried to predict the unpredictable. We worked with venues to secure new dates; with hotel partners to secure new room blocks; with contractors to defer contracts; and with exhibitors, speakers, media partners, and attendees to try to understand and keep on top of the disparate and ever-changing regulatory environment related to live events. In addition, corporate policies concerning live events, as well as organizational and individual views on the topic, proved just as wide ranging. The "right" thing to do was never an easy answer to find.

Ceramics Expo was our second event to be postponed in the spring of 2020. Initially scheduled for early May in Cleveland, Ohio—as it has been since its inception in 2015—we postponed to September 2020 and finally had to accept that we could not successfully deliver a live event at all in 2020. Despite the regulatory environment in theory permitting events to happen in autumn, fundamentally live events were not what our communities wanted at that time.

Ceramics Expo is typical of our portfolio of events, being very much focused on advanced manufacturing and engineering challenges spanning a wide range of end-user industries. A great many of our exhibitors rely on meetings such as Ceramics Expo to meet with prospective clients, partners, and suppliers in a tangible, face-to-face environment.

So, what do you do if you are in the business of bringing people together but you cannot bring people together?

We set about getting back to basics and understanding the true value that we create via Ceramics Expo, along with our other events, and investigating ways in which we could replicate that value for our participants in the absence of being able to run the show in the normal way.

Ceramics Expo is planned to return in-person to Cleveland, Ohio, at the end of August. *Credit: Smarter Shows*

Such was the unanticipated nature of the pandemic. It's true to say that it caught the world and indeed almost every industry off guard. Hence, we first undertook to publish a series of free COVID-impact reports. Led by our highly experienced conference production team, the Ceramics Expo industry report involved extensive research with around 200 industry professionals from throughout the ceramics manufacturing supply chain. The report was highly insightful and enabled benchmarking against customers, competitors, partners, and suppliers, but it also permitted organizations to see the bigger picture and thus be able to plan and reprioritize their activities accordingly. The report was published in May 2020 to resounding success, and its findings were discussed in a complimentary webinar in the same month with valuable commentary from key industry players Cerion Nanomaterials, Kyocera, C Foam, and Precision Ceramics. We are incredibly proud of the contribution that the report made in informing and reassuring people at an unnerving and challenging time for all.

When the time came to admit that live events would not happen at all in 2020, our "Connect" virtual events were born. The digital answer to a B2B exposition in the middle of a global pandemic—Ceramics Expo Connect—enabled participants to hear from and interact with great speakers, browse and meet with exhibitors, and network with a wide range of attendees. I don't think the team will mind me saying that an unfamiliar and bumpy road lay ahead. We had some good experience already at running digital content via our webinars—however, this undertaking was much more significant. We tried to replicate practically every part of a live show in digital form.

The weeks leading up to the virtual shows proved incredibly challenging and, looking back, this experience was hardly surprising. We had to source and collaborate with a new technology platform to host and provide the technical infrastructure for the show. Many providers existed long before the pandemic, but none could have foreseen or been truly prepared for the uplift in demand that the pandemic would throw their way from event organizers the world over trying to pivot to the

new "norm." Furthermore, our own team had to quickly learn the platform from scratch and learn digital event delivery as did our speakers, exhibitors, and attendees. Despite a well-thought-out educational program, we saw an unprecedented level of questions, queries, and the ever-feared technical glitches.

Nevertheless, we are very pleased to say that the overwhelming response to the event itself was positive—delivering as it did to over 1,600 attendees involved in more than 30 hours of events, meetings, and sessions over four days, including 34 speakers from industry leaders such as Ford, DuPont, Samsung, and GE Aviation. The event achieved its objective in assisting businesses to collectively overcome the impact of travel restrictions and concerns around meeting face-to-face. There also were some very valuable lessons learned along the way.

First, we were very pleased to see a huge uplift in international participation in Ceramics Expo as a result of moving to digital last year. With location not being a consideration, we were able to see the true global appetite for learning and connecting across this industry, and this observation is certainly something that we are motivated to continue to develop and nurture.

We saw that content can be delivered in a highly effective and accessible manner online. We are now committed to a much more comprehensive digital content program spanning the entire year and thus better serving our communities by bridging the gaps between the live shows. This program will include tried and tested formats, such as our webinars and industry reports, in addition to new opportunities led by feedback from our communities, such as our Lunch & Learn product-focused briefing and Q&A sessions. Furthermore, we permanently developed the exhibitor listings on our websites to facilitate vital connections throughout the year via the new "Connect Exhibitor" functionality and further via the ability for exhibitors to upload a variety of rich content to educate browsing visitors on their products and services.

While we value the opportunities that the events of the past year have afforded us to improve and innovate, I am certain that I speak for the entire team in saying that we couldn't be happier to be looking eagerly ahead at running our full complement of eight live events this year, beginning in mid-July, and with Ceramics Expo 2021 ready to return August 30–September 1. We look forward to seeing you in Cleveland.

ABOUT THE AUTHOR

Emma Stokes is joint managing director at Smarter Shows. Contact Stokes at emma.stokes@smartershows.com.

ceramics expo

Ceramics Expo 2021

August 30–September 1

Advanced ceramics: enabling a clean, efficient & electrified future

We are delighted to bring Ceramics Expo back to Cleveland, Ohio, after a wait of more than two years. We are thrilled to say that the appetite to be back at the live show has never been greater within the ceramic manufacturing community that we serve.

Over 250 exhibitors will meet with thousands of attendees at the show's new home in downtown Cleveland—the Huntington Convention Center.

Visit the exhibition to source new materials, components, and technologies; network with like-minded professionals; discuss challenges and opportunities; and gain the latest industry intelligence and knowledge.

The theme of the event this year is "Advanced ceramics: enabling a clean, efficient & electrified future."

The industry-leading conference allows our speakers to share their technical expertise in ceramics and provide real-world case studies, profile new technologies and materials, and disseminate information on key industry trends. Speaking companies confirmed this year include Kyocera, GE Aviation, CoorsTek, Northrup Grumman, Skyworks, and Morgan Advanced Materials, plus many more.

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Ceramic & Glass MANUFACTURING

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April 2021	Additive manufacturing: Where are the opportunities?
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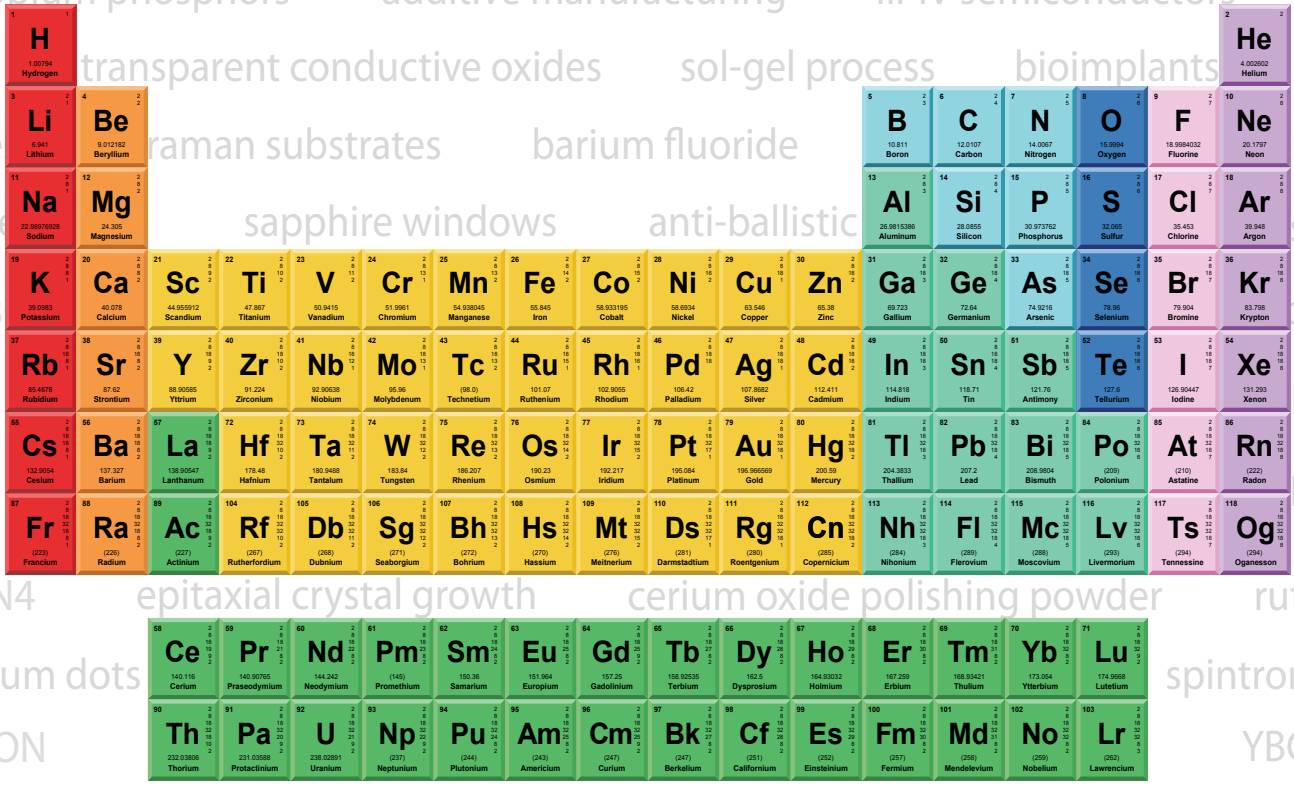

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Learn more about the position at https://bit.ly/2QEndfb. Those interested should send a cover letter and abbreviated CV to managing editor Jonathon Foreman at jforeman@ceramics.org by **June 1, 2021**. Questions can be directed to JACerS editor-in-chief Bill Fahrenholtz at billf@mst.edu or 573-341-6343.

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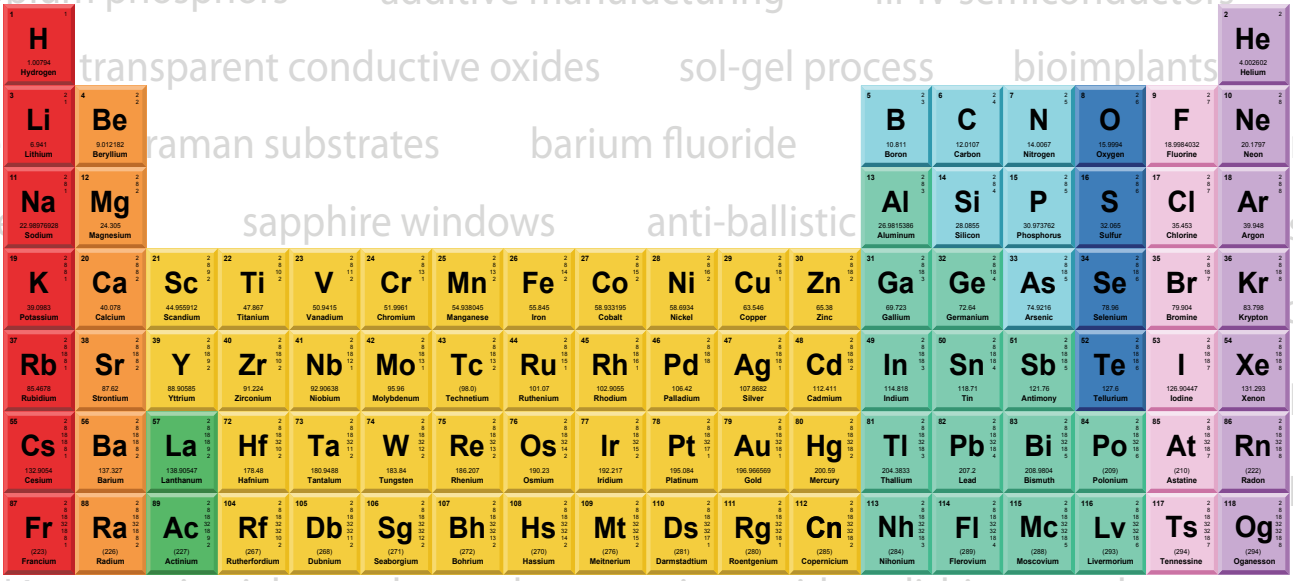

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