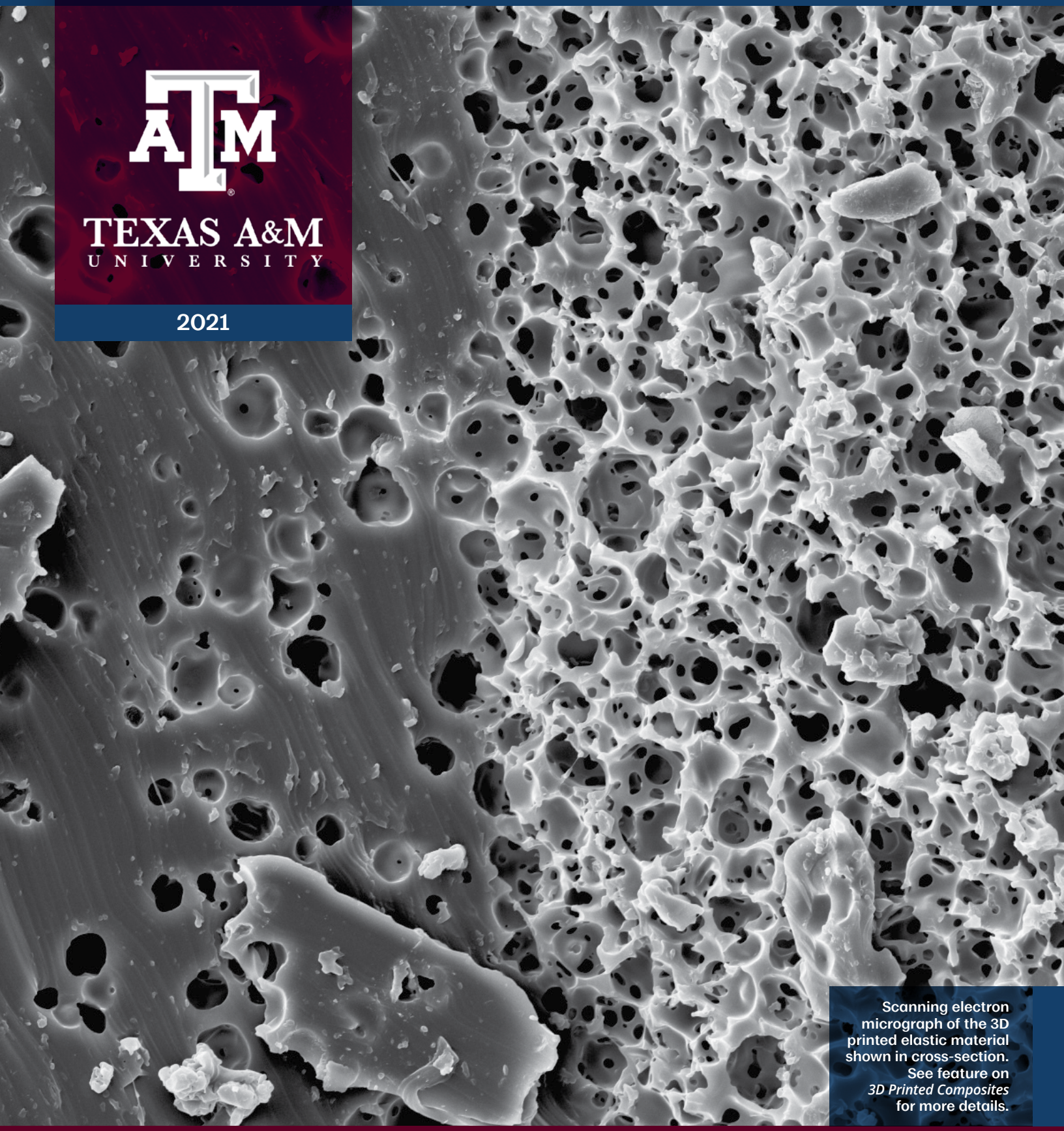
TEXAS A&M UNIVERSITY

2021



Scanning electron micrograph of the 3D printed elastic material shown in cross-section. See feature on *3D Printed Composites* for more details.

DEPARTMENT OF

MATERIALS SCIENCE & ENGINEERING

LETTER FROM THE DEPARTMENT HEAD

We are excited to start the fall 2021 semester with a schedule of in-person classes and activities. We are hopeful we can maintain everyone's health and minimize risk, and there is more good news.

This past May, our first class of bachelor's degree graduates walked the stage and received their diplomas. We had 32 students graduate on time. Although graduations were modified to provide social distancing and safety — we celebrated with a "Grab and Go" celebration in the department. In 2021 we also broke the 200-student barrier in our graduate program. We have 205 graduate students enrolled, 167 doctoral and 38 master's students. An 8% increase as compared to the fall of 2020.

Even as we struggled through the last year of unknowns, our students and faculty have been focused and have excelled in many areas. Three students from the department were recognized by the National Science Foundation's Graduate Research Fellowships Program. Suzanne Peterson and Jordan Brito were both awarded fellowships and Gregory Wong received an honorable mention.

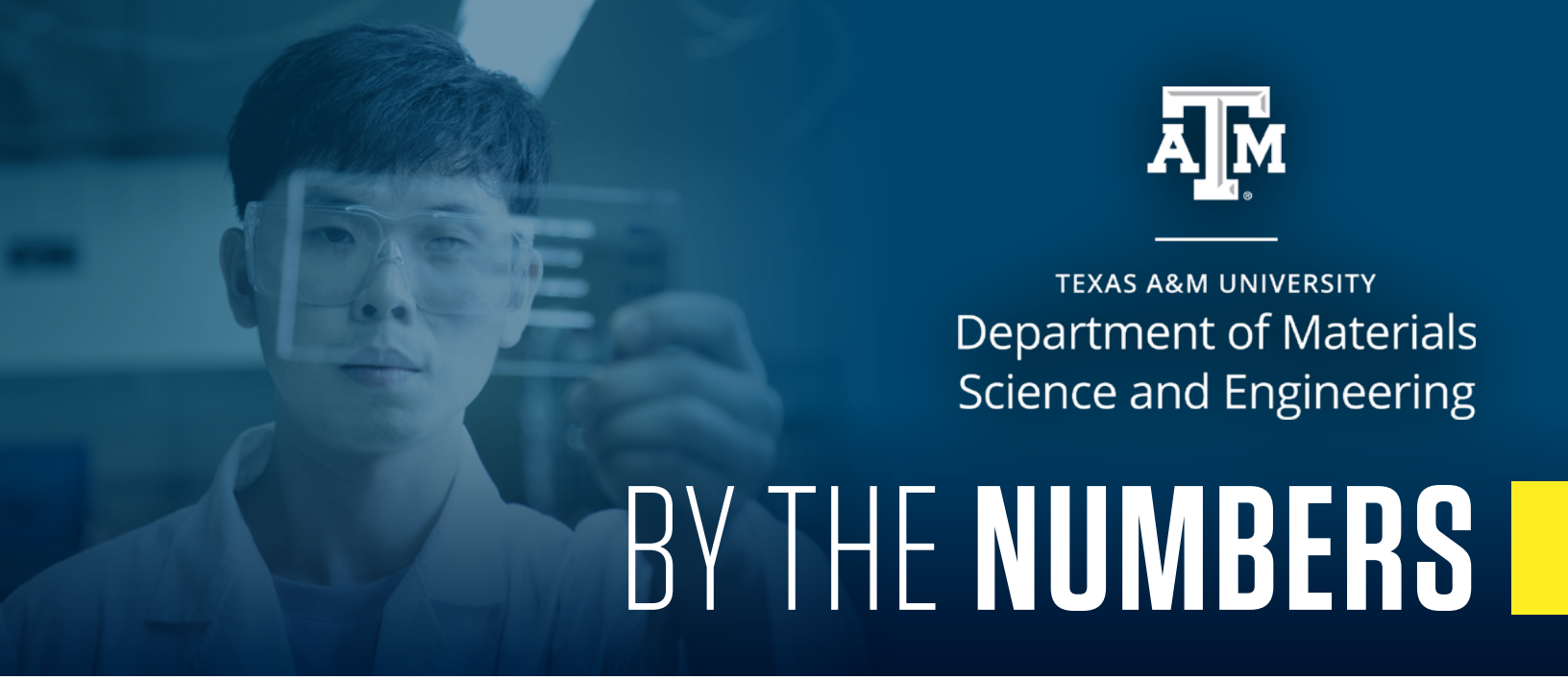
Kartik Kumar Rajagopalan and Xiuzhu Zhu, graduate students in the department, were named winners of the American Chemical Society's Division of Polymeric Materials: Science and Engineering's best poster award for spring 2021. Also, the Texas A&M Foundation Board of Trustees chose Nathaniel Lies '21, a recent graduate from the first cohort of undergrad students, as recipient of its Trustees' Outstanding Student Award for 2021, and former Texas A&M University graduate student Courtney Kunselman '20 was named a Conference of Southern Graduate Schools' 2021 outstanding master's thesis award winner in the mathematics, physical sciences and engineering category.

We have a 100% success rate for NSF CAREER awards among our assistant professors before they are promoted. Dr. George M. Pharr was recognized by the Minerals, Metals and Materials Society with the 2021 William D. Nix Award. Dr. Svetlana Sukhishvili was chosen as the Former Student's Distinguished Achievement in Research Awardee for 2021. Also, Dr. Emily Pentzer received a 2021 Rising Star Award from the American Chemical Society's Women Chemists Committee. She received the honor for contributions to the field of polymer and materials science, for educating students and for service to the scientific community.

Though we are not back to a typical year yet, we approach this academic year with appreciation and compassion. It is a complicated time for everyone and we are working together for the health and well-being of our entire Aggie community.

Sincerely,

Dr. Ibrahim Karaman
Department Head
Chevron Professor I



TEXAS A&M UNIVERSITY

Department of Materials Science and Engineering

BY THE **NUMBERS**

RANKINGS

#14 Graduate Program
Ranked No. 14 (Public)
(*U.S. News & World Report*, 2022)

NEWLY RANKED

#13 Undergraduate Program
Ranked No. 13 (Public)
(*U.S. News & World Report*, 2022)

ENROLLMENT* (FALL 2021)

**preliminary, 5th class day*

181 Undergraduates

38 M.S.

167 Ph.D.

FACULTY (FALL 2021)

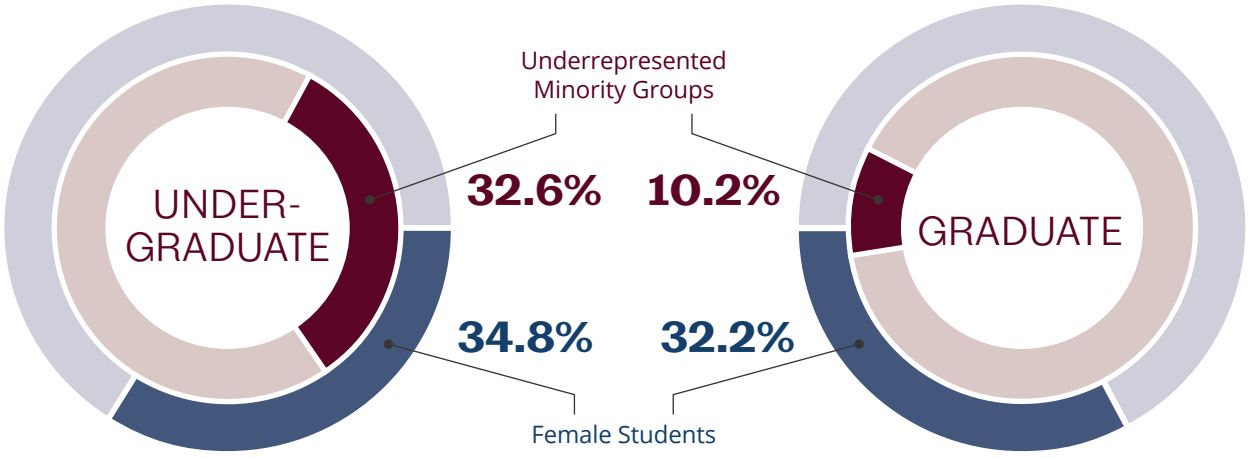
10 Professors | **6** Associate Professors

3 Assistant Professors | **5** Endowed Professors

RESEARCH EXPENDITURES

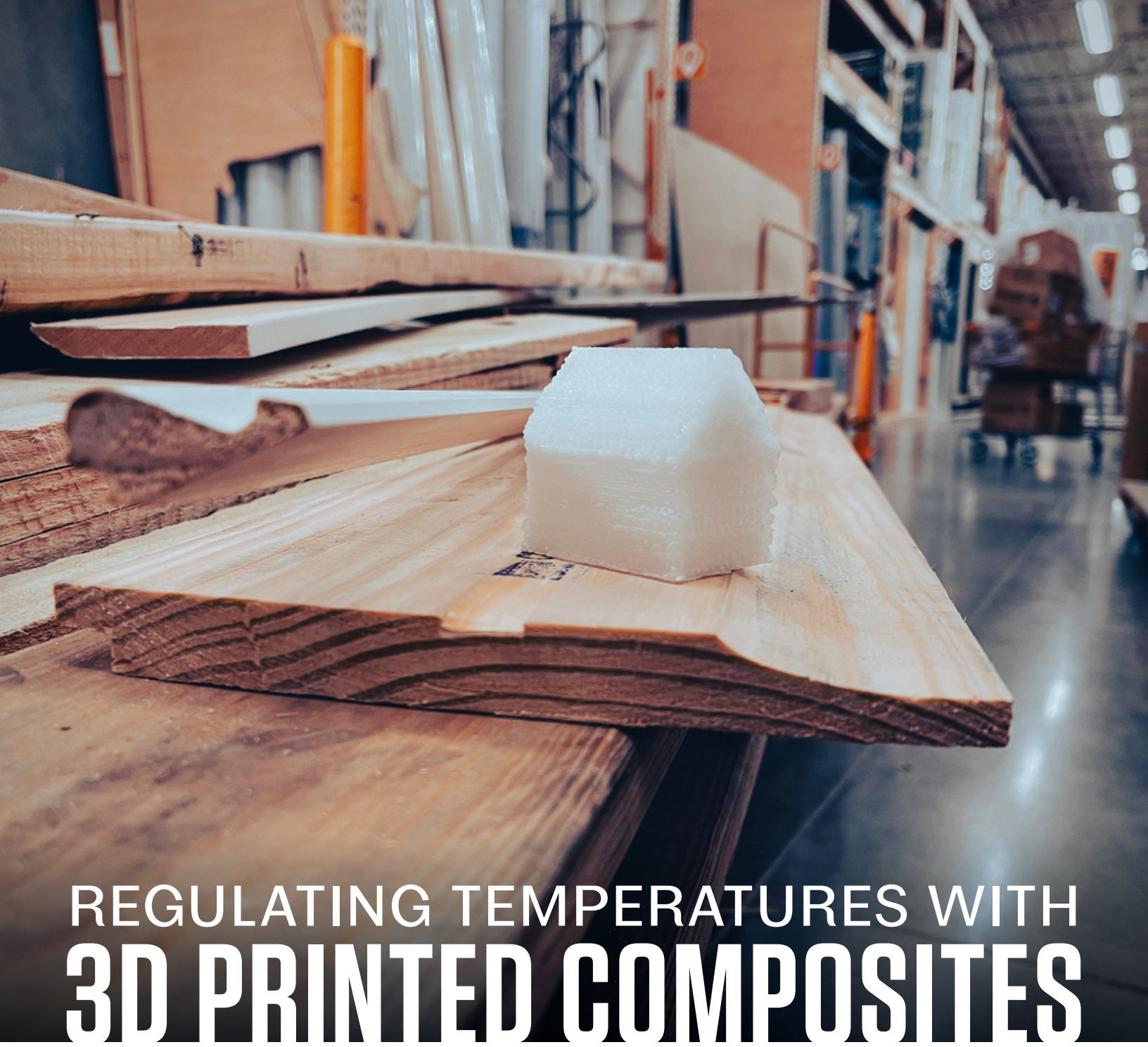
$15.7 MILLION (2020)

DIVERSITY (FALL 2021)



58.5% International Graduate Program Students

41.5% Domestic Graduate Program Students



REGULATING TEMPERATURES WITH 3D PRINTED COMPOSITES

Changing climate patterns have left millions of people vulnerable to weather extremes. As temperature fluctuations become more commonplace around the world, conventional power-guzzling cooling and heating systems need a more innovative, energy-efficient alternative that, in turn, lessens the burden on already struggling power grids.

In a study funded by the NSF, researchers at Texas A&M have created novel 3D printable phase-change material composites that can regulate ambient temperatures inside buildings using a simpler and cost-effective manufacturing process.

Furthermore, these composites can be added to building materials, like paint, or 3D printed as decorative home accents to seamlessly integrate into different indoor environments.

"The ability to integrate phase-change materials into building materials using a scalable method opens opportunities to produce more passive temperature regulation in both new builds and already existing structures," said Dr. Emily Pentzer.

This study was published in the journal *Matter*.

FEATURED RESEARCHER

Dr. Emily Pentzer

Associate Professor,
Materials Science & Engineering and Chemistry
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UNEXPECTED BLACK SWAN DEFECT DISCOVERED IN SOFT MATTER

In new research, Texas A&M University scientists revealed for the first time a single microscopic defect called a "twin" in a soft-block copolymer using an advanced electron microscopy technique. This defect may be utilized in the future to create materials with novel acoustic and photonic properties.

"This defect is like a black swan — something special going on that isn't typical," said Dr. Edwin Thomas. "Although we chose a certain polymer for our study, I think the twin defect will be fairly universal across a bunch of similar soft matter systems, like oils, surfactants, biological materials and natural polymers. Therefore, our findings will be valuable to diverse research across the soft matter field."

The results of the study are detailed in the *Proceedings of the National Academy of Sciences*. This research was supported by a grant from the NSF.

FEATURED RESEARCHER

Dr. Edwin L. "Ned" Thomas

Professor, Materials Science & Engineering,
Erle Nye '59 Chair II Hagler Fellow

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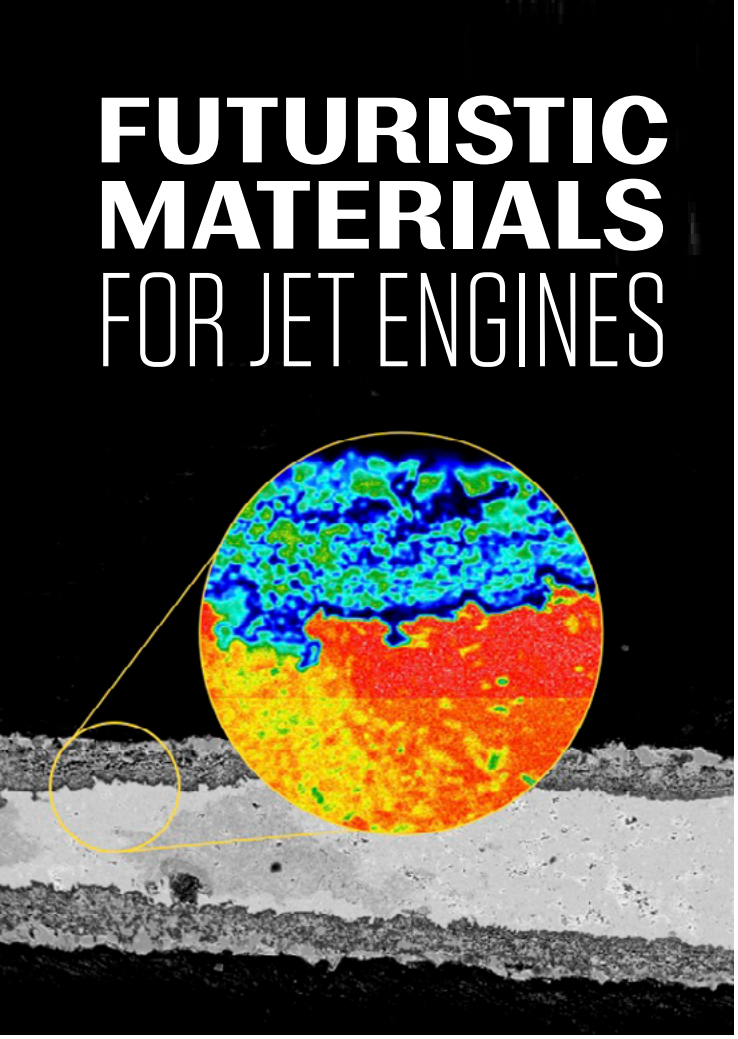
FUTURISTIC MATERIALS FOR JET ENGINES



In a study published in the journal *Nature Computational Materials*, researchers described a computational tool to evaluate a material's suitability for high-temperature applications, such as gas turbines for jet engines and electrical power generators. The computational framework, which incorporates artificial intelligence and basic physics, can forecast how materials will behave under harsh conditions in a fraction of the time compared to other algorithms.

"We have used an innovative and interdisciplinary approach for screening materials that is a million times faster than traditional techniques," said Dr. Raymundo Arróyave, corresponding author on the study. "Currently, these types of calculations, even for a small temperature above absolute zero, are an enormous challenge because they are computationally expensive."

This research is funded by the Designing Materials to Revolutionize and Engineer Our Future grant from the NSF.

FEATURED RESEARCHERS

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CHAMELEON-LIKE MATERIAL MIMICS BRAIN CELLS

Each waking moment our brain processes massive amounts of data to make sense of the outside world. By imitating the way the human brain solves problems, neuromorphic systems have tremendous potential to revolutionize big data analysis and pattern recognition problems for current digital technologies. For artificial systems to be more brain-like, they need to replicate how nerve cells communicate at their terminals, known as synapses.

In a study published in the Journal of the *American Chemical Society*, researchers have described a material called vanadium dioxide that captures the pattern of electrical activity at the synapse. Much like how a nerve cell produces a pulse of oscillating current depending on the history of electrical activity at its synapse, researchers said their material oscillates from metal to insulator at a transition temperature decided by the device's thermal history.

"We'd like to investigate whether the phenomenon we have observed with vanadium dioxide applies to other host lattices and other guest atoms," said Dr. Raymundo Arróyave, corresponding author on the study. "This insight can provide us with several tools to further tune the properties of these types of neuromorphic materials for diverse applications."

This research is funded by the NSF and the Air Force Office of Scientific Research.

FEATURED RESEARCHERS

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Dr. Patrick Shamberger
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Director of Undergraduate Programs,
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Dr. Xiaofeng Qian
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TURNING VIRTUAL REALITY INTO AN EFFECTIVE LEARNING TOOL

For Jaskirat Batra, the desire to pursue teaching was firmly cemented during childhood. Being a child of career educators, he was often immersed in the world of classrooms, chalkboards and textbooks. While deeply inspired by his parents, Batra's desire was always to go beyond conventional pedagogy. As a graduate student, he has established a unique style of teaching that might revolutionize how engineering courses are taught in classrooms. Further, he has received the 2020 IEEE New Faculty Fellow award for this research.

STUDENTS WIN POLYMERIC MATERIALS: SCIENCE AND ENGINEERING'S BEST POSTER

Graduate students Kartik Kumar Rajagopalan and Xiuzhu Zhu were named winners of the Division of Polymeric Materials: Science and Engineering's (PMSE) best poster award. Winners were chosen by judges appointed by the PMSE executive committee from a pool of student candidates who presented their posters at the Spring 2021 American Chemical Society National Meeting.

ARRÓYAVE AWARDED $1.2M TO DESIGN ULTRAHIGH TEMPERATURE TOLERANT ALLOYS

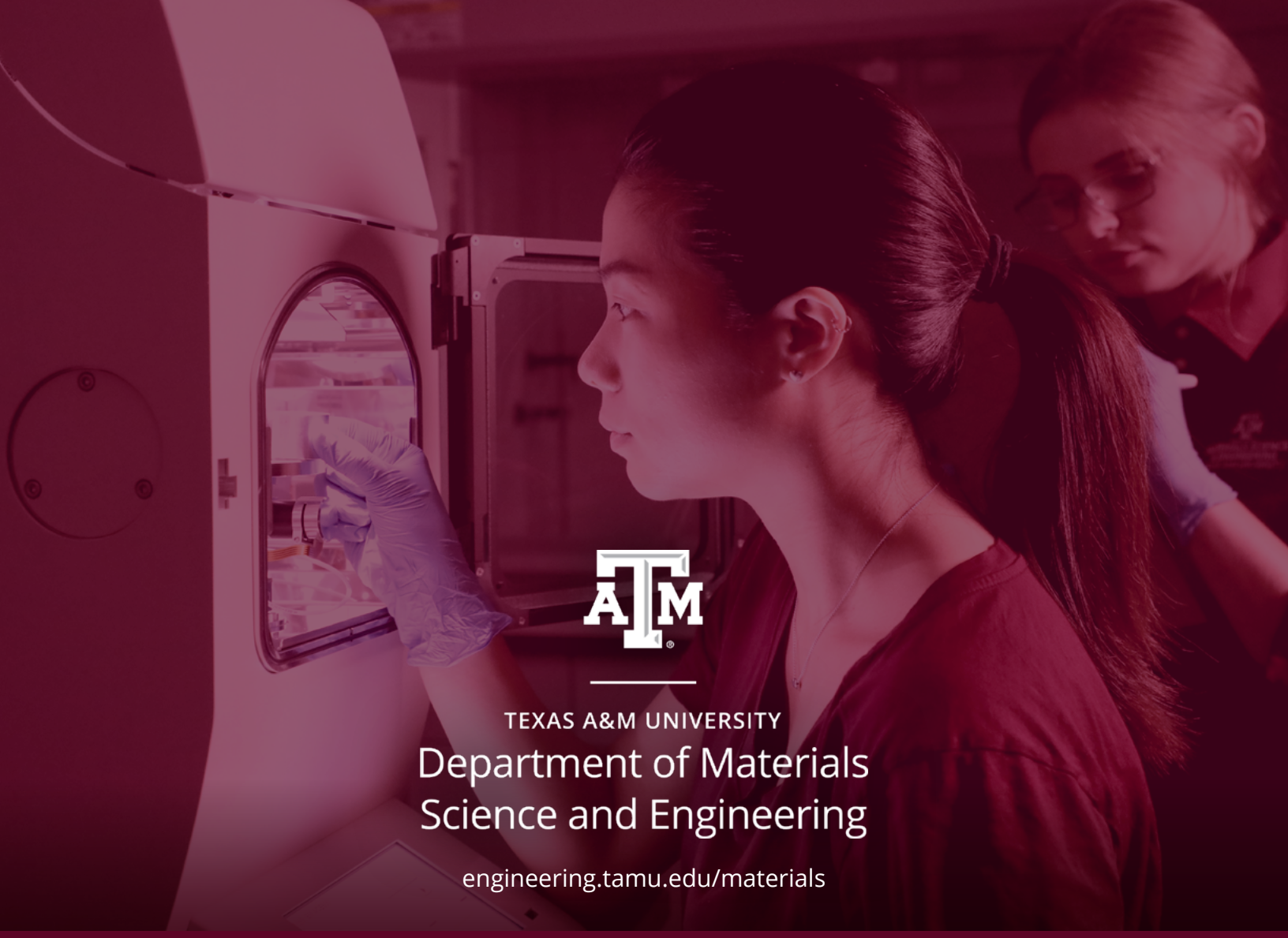
To develop ultrahigh temperature-resistant materials, particularly those that can tolerate 1,300 C or at 1,800 C with coatings, the U.S. DOE recently awarded $16 million to 17 projects as a part of Phase 1 of the Advanced Research Projects Agency-Energy's Ultrahigh Temperature Impervious Materials Advancing Turbine Efficiency program. A team led by Dr. Raymundo Arróyave has received $1.2 million to investigate a class of metals, called refractory high entropy alloys, that can withstand higher operating temperatures.

GRADUATE STUDENTS AWARDED NSF FELLOWSHIPS

Three students were recognized by the NSF's Graduate Research Fellowships Program. This prestigious and competitive program supports outstanding graduate students who are pursuing a research-based master's and/or doctoral degree in NSF-supported, STEM fields of study. The fellowship provides financial support, including an annual stipend and cost of education allowance to the institution.

IMPROVING HOW METALS WITHSTAND NUCLEAR REACTIONS

Researchers from Texas A&M and Los Alamos National Laboratory (LANL) Materials Science at Radiation and Dynamics Group are improving the metals used to construct nuclear technology. This collaboration is made possible by The Texas A&M University System National Laboratories Office and LANL. Dr. Michael Demkowicz and Dr. Kelvin Xie from Texas A&M, and Dr. Yongqiang Wang from LANL, are investigating hydrogen retention in metals that are exposed to nuclear processes with the intent of improving how these materials perform over time.



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Department of Materials Science and Engineering

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DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

AREAS OF FOCUS

- Advanced Structural Materials
- Biomaterials
- Ceramics and Ceramic Composites
- Computational Materials Science and Design
- Corrosion Science and Engineering
- Functional (Electronic, Magnetic, Optical) Materials
- Materials for Energy Applications
- Materials for Extreme Environments
- Mechanical Behavior of Materials
- Polymers and Composites

RESEARCH CENTERS

- Center for Intelligent Materials and Structures
- Materials Characterization Facility
- Microscopy and Imaging Center
- National Corrosion and Materials Reliability Consortium
- Polymer Technology Consortium
- Soft Matter Facility