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2014

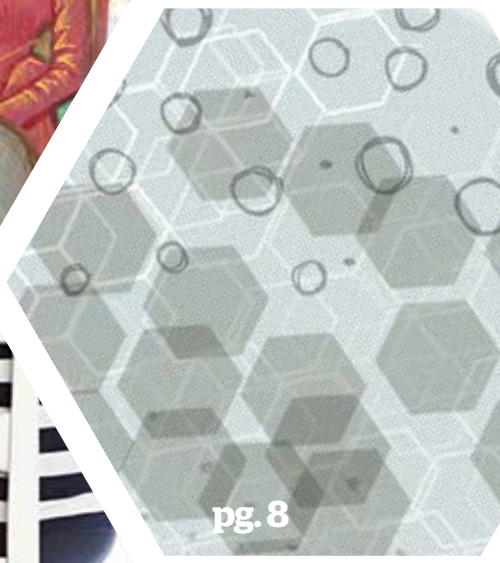
Breakthrough

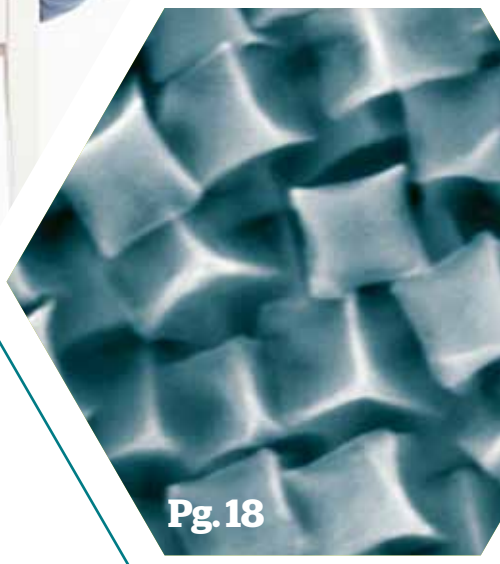
UNIVERSITY OF SOUTH CAROLINA / RESEARCH

Thin has its limits

Also in this issue

- Shaken, not disturbed
- It's everyone's fault
- Inability to love





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In this issue

Prakash Nagarkatti, Ph.D.
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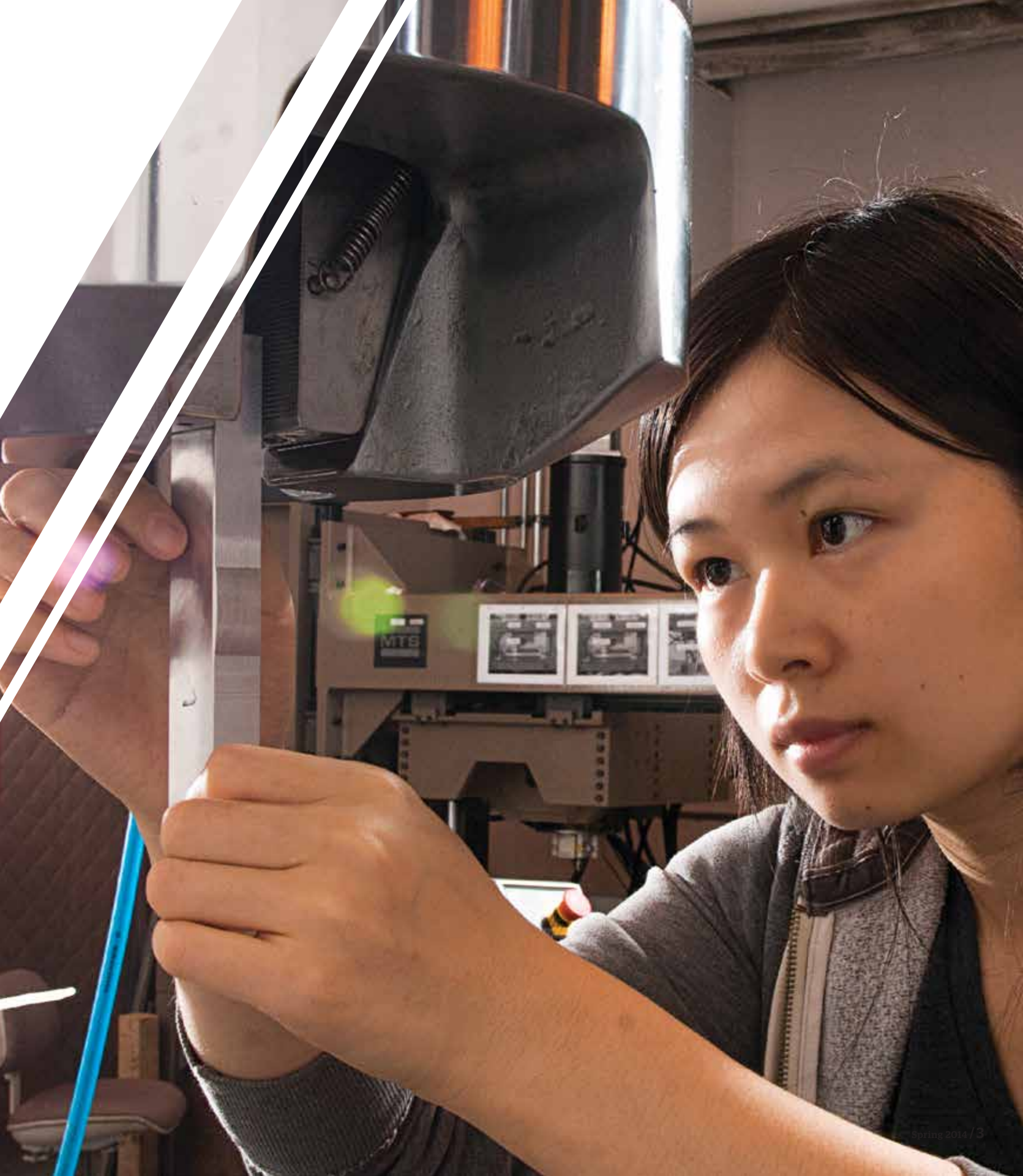
www.sc.edu/research

Our office is proud to present a new issue of Breakthrough, the University of South Carolina's research magazine that highlights some of our faculty's most fascinating scholarship. As the following pages illustrate, research and scholarly activity in every discipline is thriving at Carolina.

A geology lab team is scouring photos from the devastating 1886 Charleston, S.C., earthquake and studying today's seismic data to enhance the state's earthquake preparedness. Chemical engineering researchers are developing ultrathin membranes of graphene oxide for gas filtration applications. An undergraduate researcher is studying sustainable, structurally sound "no bake" masonry bricks that can be made with common soil types.

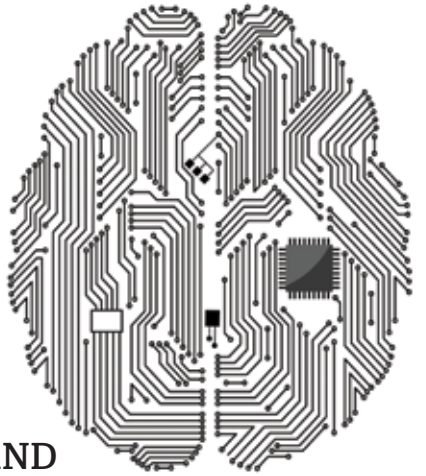
It's easy to imagine the benefits South Carolinians stand to reap from the fertile ground of these research projects: an improved route to safety after natural disasters, better ways to reduce greenhouse gas emissions and sustainable and affordable building material that can be made anywhere clay soil is plentiful. Basic research like this informs the advances we rely on to ensure a sustainable, healthy, productive future for our state, nation and world.

We are pleased to showcase these and USC's many upcoming research projects in the new Breakthrough magazine format, which is designed for a wider audience than ever before. This is our second issue in the redesigned format, which features custom illustrations, infographics, large artistic photos from USC's microscopy center, and interviews with top researchers. We couldn't be happier with Breakthrough's makeover, and as you page through this issue, we hope you will agree.


MTS

GOOGLE THIS

Imagine slipping on a pair of special glasses outside a club and being able to identify who's got extra tickets for the concert simply by looking around. Once inside, you scan the crowd and find friends and acquaintances from afar, even when their backs are turned. If the notion sounds far-fetched, consider that Google is already investing in technology at USC that could make scenarios like these a reality. Srihari Nelakuditi, an associate professor in the Department of Computer Science and Engineering, is a recipient of a Google Faculty Research Award and is developing the app for Google Glass with fellow researchers from Duke University. "There has been a lot of interest among students, and I think this will help with recruitment to the program. Students want to do research, yes, but they also want to work on something that's cool," Nelakuditi said.



HAVING YOUR DATUM AND COMPUTING IT, TOO

Computing speed has increased tremendously in the past few years, but the fact that memory is stored separately from the central processing unit (CPU) remains a fundamental bottleneck. The time it takes to transfer data is wasted time.

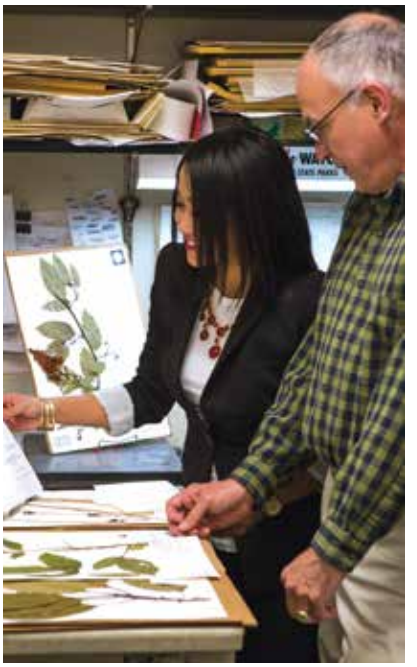
But USC theoretical physicist **Yuriy Pershin** and his collaborators at the Oak Ridge National Laboratory are working to eliminate the transfer bottleneck altogether. They recently published a paper in the journal Nature Physics showing a new way to store information and process it in the same place.

The team at Oak Ridge found that bits of data stored on a ferroelectric material interacted with each other. Under the right conditions, attempting to write a consecutive series of ones resulted instead in an alternating series of zero, one, zero, one, and so on.

"This is nothing more than the NOT operation," Pershin says. "Using this observation, we have extended this mechanism to different binary logic gates, like AND and OR. So one can realize universal logic gates based on these ferroelectric domains."

Which means, in essence, that the memory and computing function can happen in the same place in the computer — no more wasted time to transfer data back and forth. The work is a contribution to the field of memory-computing, or mem-computing.

"Mem-computing is close to the operation of the brain," Pershin says. "In the human brain, we do not have any physical separation between computing units and information storage units, and the brain works in parallel. This is what we're trying to develop in electronics."



GROWING CONNECTIONS

SCIENCE AND CULTURE THRIVE AT A.C. MOORE HERBARIUM

John Nelson likes to think of the massive collection of plant samples under his care as a kind of non-living garden.

But the work he and his team at USC's A.C. Moore Herbarium are doing is far from lifeless. Last year, Nelson reached out to the Vietnam Academy of Science and Technology's Institute of Tropical Botany in Ho Chi Minh City seeking — and finding — a partnership with growth potential.

"It wasn't easy. I sent out a lot of feelers, and finally got a pretty strong nibble," he said.

That became a hook, line and sinker deal this past summer with a formal memorandum of understanding, pledging mutual exchange of at least 1,000 plant specimens between the A.C. Moore Herbarium and the Institute of Tropical Botany over a five-year period.

"They were looking to have some collaboration in the United States specifically, so we're it," Nelson said.

Adding the first Southeast Asian tropical plant specimens to the A.C. Moore Herbarium was not Nelson's primary goal; he is more interested making connections. He believed USC's students of Vietnamese ancestry "might have some interest in seeing plants from their homeland or their parents'," and he was right. USC's Vietnamese Student Association got involved, helping the herbarium team complete the documentation and preservation process of the first batch of specimens, collected from Vietnam's Khanh Hoa Province.

Amanda Van, the Vietnamese Student Association president, has never visited her ancestral country, but said she is feeling "more connected with [her] heritage," after getting her hands dirty at the herbarium.

"I have always wondered what kind of plants and animals derived from there, and being able to work with them has helped me develop an awareness and appreciation of the Vietnamese culture," she said.

The herbarium has sent 300 samples, mostly from South Carolina, to the Institute of Tropical Botany and is looking forward to growing deeper connections with their new collaborators.

"Maybe this could lead somehow to actual visits, a kind of exchange. I don't know that the university has much of a connection with Vietnam otherwise, but this might be a good way for that to start," Nelson said.

BREAKTHROUGH STARS

Fifteen faculty members from academic disciplines across the university have been selected as 2014 Breakthrough Stars by the Office of Research.

This is the fifth year of the program which recognizes junior faculty members for their achievements in research and scholarly pursuits. "As an institution dedicated to exceeding expectations and making differences in the lives of our students, we salute these up-and-coming members of our faculty and their many achievements," said **Prakash Nagarkatti**, vice president for research at Carolina.

The research office also recognized 14 doctoral candidates, nominated by their graduate directors, as Breakthrough Graduate Scholars for excellence in their creative and scholarly work.

2014 BREAKTHROUGH STARS

1 Anthony Nyberg
management, Darla Moore School of Business

2 Daping Fan
cell biology and anatomy, School of Medicine

3 Darlene Amendolair
nursing, USC Upstate

4 Elaine Chun
linguistics, College of Arts and Sciences

5 Heidi Rae Cooley
media arts, College of Arts and Sciences

6 Hexin Chen
biology, College of Arts and Sciences

7 Hui Wang
chemistry and biochemistry, College of Arts and Sciences

8 Jun Zhu
psychology, College of Arts and Sciences

9 Kevin Huang
mechanical engineering, College of Engineering and Computing

10 Michael Bizimis
earth and ocean sciences, College of Arts and Sciences

11 Seth John
marine science, College of Arts and Sciences

12 Sharon DeWitte
anthropology, College of Arts and Sciences

13 Yan Tong
computer science and engineering, College of Engineering and Computing

14 Yuriy Pershin, physics and astronomy, College of Arts and Sciences

15 Steven Harrod
psychology, College of Arts and Sciences

2014 BREAKTHROUGH GRADUATE SCHOLARS

Adrian Gomez
S.C. College of Pharmacy

Amira Osman
health promotion, education and behavior, Arnold School of Public Health

Carole Sox
hospitality management, College of Hospitality, Retail and Sport Management

Chaz Yingling
history, College of Arts and Sciences

Claire Robinson
education administration, College of Education

Frank May
marketing, Darla Moore School of Business

Fred Tabung
epidemiology, Arnold School of Public Health

Jennifer McLeer
sociology, College of Arts and Sciences

Xin Chen
mechanical engineering, College of Engineering and Computing

Michael Chance
inorganic chemistry, College of Arts and Sciences

Paul Reed
linguistics, College of Arts and Sciences

Robin Dawson Estrada
College of Nursing

Steven Bellomy
English, College of Arts and Sciences

Travis Johnston
mathematics, College of Arts and Sciences

THE "SILENT" LIVER DISEASE

Affecting as many as 5 percent of Americans, NASH (nonalcoholic steatohepatitis) resembles the type of liver disease prevalent in alcoholics, yet occurs in people who drink little or no alcohol.

Saurabh Chatterjee, an assistant professor in the Arnold School of Public Health, leads a laboratory that is the first in the country to establish connections between environmental toxins and NASH, which is increasing in prevalence because of the obesity epidemic.

"Approximately one-third of American adults are obese. If the trend continues, 62 percent will be obese by 2025. As a result, our research on NASH is increasingly important," said Chatterjee, whose lab team has published 11 peer-reviewed studies in the past 18 months.

One of the most prevalent aspects of NASH is fat in the liver. Although liver inflammation and damage can occur, most people have no symptoms. The danger is that the damage can lead to cirrhosis, a condition in which the liver no longer functions properly.

Less serious is a condition known as nonalcoholic fatty liver disease (NAFLD), characterized by having fat in the liver but with no inflammation or liver damage. Between 10 and 20 percent of Americans have fat in their liver, which can lead to metabolic complications, including insulin and leptin resistance, and make an individual susceptible to chronic inflammatory diseases.

Thin has its limits

and this filter is almost there

It is one of the thinnest membranes ever made — and it's also a highly selective gas filter. Made of graphene oxide, the membrane constructed by a team of engineers at USC is a little more than two carbon atoms thick and can readily separate hydrogen from carbon dioxide molecules.

"The membrane behaves like a sieve," said **Miao Yu**, a chemical engineer in the College of Engineering and Computing. "Bigger molecules cannot go through, but smaller molecules can."

The researchers, led by Yu, reported in the journal Science that the membrane's selectivity is based on molecular size. Hydrogen and helium pass through it with relative ease, but carbon dioxide, oxygen, nitrogen, carbon monoxide and methane move much more slowly.

The membrane was constructed on the surface of a porous aluminum oxide support. Flakes of graphene oxide, with widths on the order of 500 nanometers but just one carbon atom thick, were deposited on the support to create a circular membrane.

It's something of an overlapping mosaic of graphene oxide flakes, like the surface of a table covered with playing cards. In the past, that kind of membrane has typically been "leaky." Gas molecules are looking for holes anywhere they can be found, and in a membrane made up of graphene oxide flakes, there would be two likely places: holes within the flakes, or holes between the flakes.

The potential industrial applications of Miao Yu's research include hydrogen purification for fuel cells and carbon dioxide sequestration from smoke stacks.

Having membranes so thin is a big advantage in separation technology. It represents a completely new type of membrane in the separation sciences." — Miao Yu

It's the spaces between flakes that have, in the past, been a real obstacle to progress in the science of separating of light gas molecules. That's why microporous membranes designed to discriminate between objects on the molecular scale have typically been very thick.

"At least 20 nm, and usually thicker," Yu says. Anything thinner and the gas molecules would readily find their way through spaces between flakes. In earlier membranes, the flakes were distributed in such a hodge-podge manner that laying down many layers was the only way to fill the gaps.

Yu's team devised a method of preparing a much more uniform mosaic of flakes atop the membrane support. That way, those "inter-flake" leaks were prevented. Gas molecules were only able to pass through holes in the graphene oxide flakes themselves.

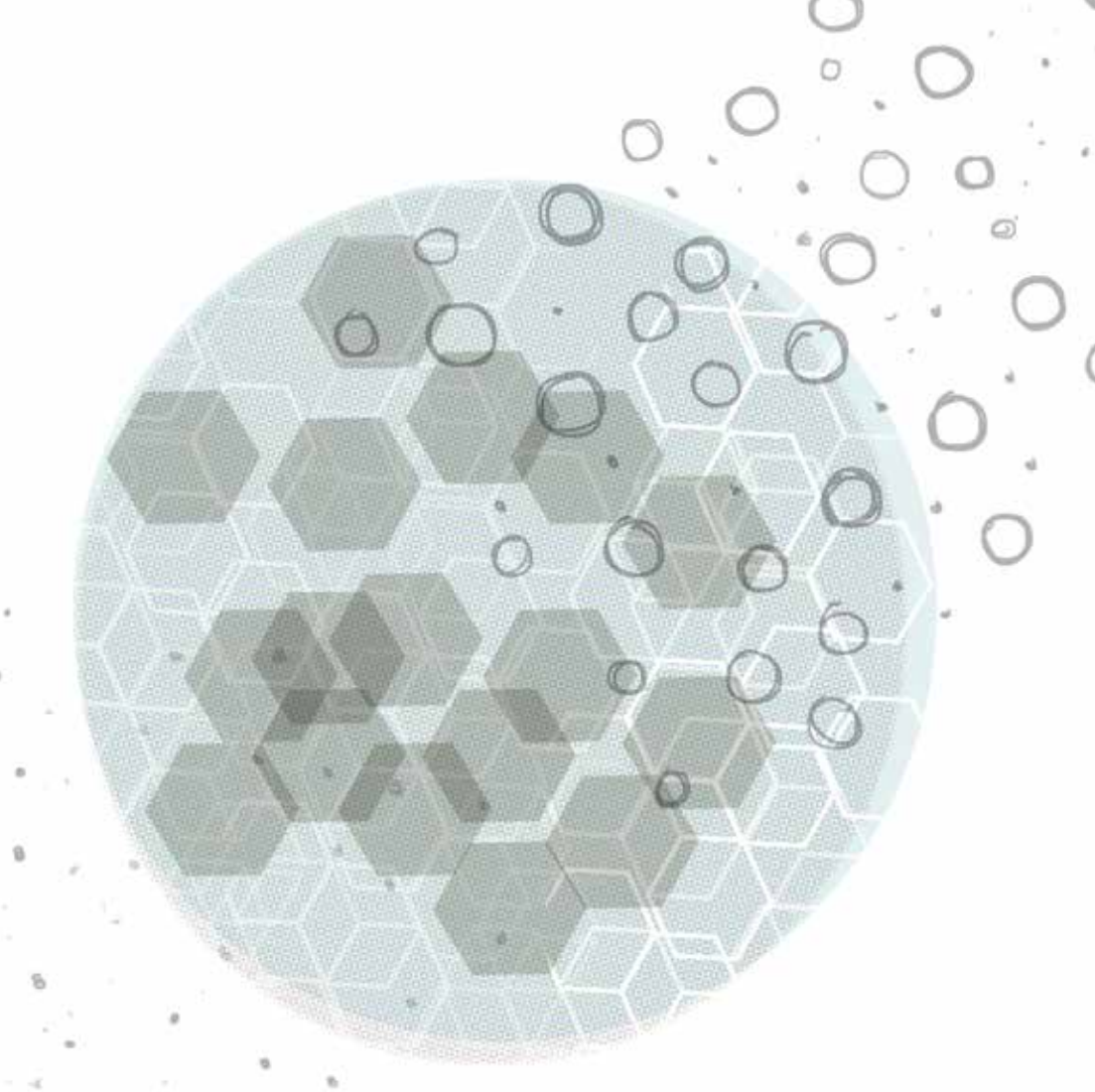
The width of the full membrane is readily measured with a ruler: about two-and-a-half centimeters in diameter, or nearly an inch. Its breadth, however, is on another scale altogether. Their thinnest membrane was only 1.8 nm thick, the thickness of just a few sheets of graphene oxide.

To put that number into perspective, a typical sheet of printer paper is about 100,000 nm thick. A relative thickness comparison of the membrane to a sheet of paper would be akin to the height of a quarter-of-an-inch-thick welcome mat laid in front of the Empire State Building.

The membrane has a range of potential applications. Carbon dioxide, a major greenhouse gas, could be efficiently separated from other gases. Hydrogen could be readily purified from gas mixtures, which is necessary in a variety of highly efficient energy systems, such as fuel cells.

Another possibility is water purification, because the holes in the molecular sieve are on the order of the size of water molecules. Yu thinks the membrane might be well suited for purifying the copious amounts of tainted water produced by hydraulic fracturing (fracking).

Being able to reduce membrane thickness — and by an order of magnitude — is a big step forward. "Having membranes so thin is a big advantage in separation technology," Yu says. "It represents a completely new type of membrane in the separation sciences."



Graphene to graphene oxide: poking holes into a solid wall

Graphene is a remarkable material, consisting of carbon atoms connected in a two-dimensional array. A sheet of it is like a sheet of wrapping paper — if the wrapping paper were only one carbon atom thick.

As a filter, though, graphene is not the way to go. It's impermeable to even the smallest of molecules. Yu and his team instead used graphene oxide, a partly oxidized derivative of graphene. Careful oxidation of graphene creates small holes in the two-dimensional sheet, gaps through which molecules can move.

In their article in Science, Yu's team reported how finely discriminating the holes in graphene oxide can be. Hydrogen has a kinetic diameter (essentially the breadth of the narrowest hole through which it can fit) of 0.29 nm. Carbon dioxide's is just a hair more, at 0.33 nm. Despite a difference of just 0.04 nm, hydrogen went through their most selective filter almost 3,500-times more quickly than carbon dioxide.

Q&A

With Scott Gwara

College of Arts and Science
University of South Carolina

Interdisciplinary research is the buzzword of academic research, but it's not every day that a chemical engineering student, an English professor and a chemistry professor find themselves working on the same project.

This one began when Adam Glenn, an Honors College student, took a medieval manuscripts course taught by Scott Gwara, an expert in the history and aesthetics of illuminated parchments.

"I asked the class if anyone might be interested in pursuing a Magellan Scholar grant focused on these manuscripts, and Adam spoke right up," said Gwara, who has mentored several students over the years who have won the undergraduate research awards through the Office of Research.

Glenn, working under the direction of Gwara and analytical chemist Stephen Morgan, is focusing on the chemical components of blue pigments used in late 15th-century manuscripts from France, Germany and Italy. Turns out there is more to these vividly colored illuminations than meets the eye.

So why the interest in this particular blue pigment in the medieval parchments?
Two primary sources of blue pigments were available in the late 15th-century. One of them came from azurite, a common copper ore that has a deep blue color. The other is lapis lazuli, a rare mineral that was mined in Afghanistan. Obviously, the second one was much more costly. Adam expects to determine whether paint recipes for the color blue were consistent in the same period across Europe, and, if not, what reasons might have motivated artists to use expensive or economical materials.

Tell us something about the manuscripts.
One is a common music manuscript from Germany. Another was written and illuminated by a Catholic bishop in Naples, southern Italy. And the third is a "Book of Hours" or prayer book illuminated by Robert Boyvin, whose chief patron was Cardinal Georges D'Amboise, prime minister of France. The prayer book was acquired through the generosity of the B.H. Breslauer Foundation in New York. The other two folios were purchased from a Camden estate in the 1970s. By the 13th century, illuminated manuscripts had become a professional business. Clients would special order a book with instructions as to how many illuminations or paintings they wanted.

How will the student analyze the manuscripts without harming them?
Adam's research will be carried out in Steve Morgan's chemistry lab. Morgan is an internationally recognized analytical chemist who has a number of forensic techniques to examine surfaces without altering them in any way. Two of these noninvasive methods include polarized light and Raman spectroscopy.

Have you ever worked with a student outside of the humanities before on a Magellan Scholar Award?
This is the first time with a student from engineering. It's different for me because I'm typically more interested in the texts and the dialogue between the images and the texts. This is an extraordinary opportunity to work not only with Adam but also with Dr. Morgan who recently attended a conference on historical pigments.

Why do you devote time to mentoring Magellan Scholars?
It's time consuming and labor intensive and incredibly rewarding when you connect

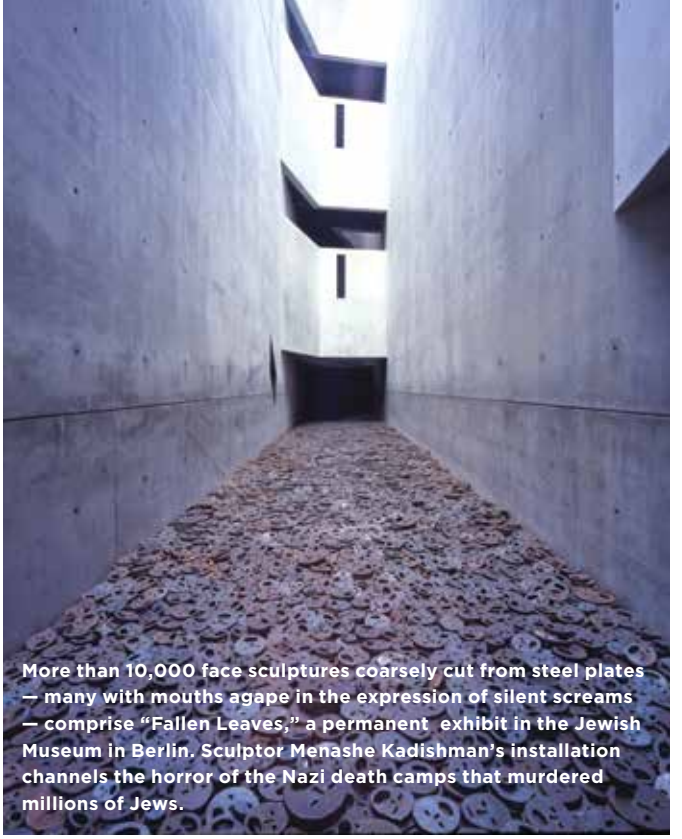
these students with their passion for learning. They find definition, something to connect to and that's a powerful thing. I had one student who created a card game based on the theme of Beowulf and another student who found the first attestation of the pronoun "she" in medieval manuscripts.

One of the great secrets of excellence is that the earlier you find your passion, the better you can be. But finding it is the important thing.

And your passion for medieval manuscripts began when?

At 16 I knew I wanted to be a medievalist, and I bought my first manuscript. I've been at USC for 20 years and I love the fact that 200 years from now someone like me will be studying these same pages and some of the documents I've donated to the library's special collections. And they'll be introducing students to the same thrill of discovery.

Image provided by Irvin Department of Rare Books and Special Collections, University of South Carolina Libraries



More than 10,000 face sculptures coarsely cut from steel plates — many with mouths agape in the expression of silent screams — comprise "Fallen Leaves," a permanent exhibit in the Jewish Museum in Berlin. Sculptor Menashe Kadishman's installation channels the horror of the Nazi death camps that murdered millions of Jews.

Inability to love

Forthcoming book sheds light on German angst over anti-Semitic stereotypes

In the nearly 70 years since the end of World War II, German guilt and shame over the Holocaust remains — though some modern German literature reflects a more casual attitude toward the stereotyping of Jews.

That's what **Agnes Mueller** uncovers in her latest book, "The Inability to Love: Jews, Gender, and America in Recent German Literature," to be released in late summer by Northwestern University Press.

Mueller, a professor in languages, literatures and cultures, reviewed popular German literature since the 1990s to gain an insight into the personal views of younger, post-war German writers. What she found isn't a popular topic in her home country, but sheds light on today's generation of Germans and their feelings about their country's checkered past regarding Jews.

"So many years after the end of WWII and after generations have acknowledged German guilt over the Holocaust, you have these young writers who write novels that still contain stereotypical references to Jews, that still bring up some of the mixed feelings that I think a lot of Germans still have, without really acknowledging it," Mueller said. "Below the surface of a culture that prides itself on having dealt with the Holocaust, you see that in a more personal space there is a lot resentment and a lot of unworked through emotions."

Mueller found that newer generations of authors, who don't have as much personal experience with German Jews because of that population's depleted numbers, tend to include more stereotyping of Jews in their writing.

"Presumably that's when you would have the most worked through and unproblematic treatment of the subject," she said. "The first generation [after the war] was still deeply involved with rejecting guilt, so there were still a lot of obvious problematic emotions. My generation and younger tend to still be grappling with the same issues."

Mueller's research uncovered many texts containing offensive representations of Jewish women as promiscuous and of Jewish men as weak and effeminate, she said.

"People acknowledge that there's injustice and they try to address it," she said. "And even after generations of trying to do that, they still can't. The larger lesson we need to learn from this is that we need to look at what is beneath the surface.

"We see memorials and we see nations putting on ceremonies or making statements, yet the personal space is still often infiltrated with remnants from what it was that led to the problem in the first place. I think that's something that happens all over."

Shaken, not disturbed

Growing up in Cambodia, **Narong Phal** saw buildings that he considered, as an aspiring engineer, structurally unsound.

After moving to South Carolina at age 20, the civil engineering undergraduate sees similar risks in the most seismically active state on the East Coast. He's pleased that his undergraduate research at USC could contribute to solutions in both nations.

Phal is working under the tutelage of civil engineering professor **Fabio Matta** in the Structures and Materials Laboratory at USC's College of Engineering and Computing. Matta has done extensive research with stabilized earth masonry, which has a number of advantages over other kinds of masonry, such as concrete blocks or bricks fired in an oven.

Matta's team prepares stabilized earth blocks suitable for earth mortar-based construction by compressing clay-containing soil with a small amount (just 6 percent by weight) of cement.

"We use little cement and the blocks are not fired, so they have a very small carbon footprint," Matta says.

And the primary raw material is plentiful. "South Carolina has a lot of this soil, you can find it almost everywhere," Phal says. Remote regions and farmlands will be particularly well served because earth masonry can be prepared locally. Although they're still working with prototypes, Matta says all these factors together should make earth masonry very affordable, but also high quality and energy efficient.

There's still a hurdle that might prevent widespread acceptance, though. Consumers might be uncertain about the strength of structures made of stabilized earth blocks and mortar in the face of natural disasters, such as tornadoes and earthquakes.

But Matta's structural engineering research is showing the sturdiness inherent in the system. Ongoing research supported by the National Science Foundation is demonstrating that earth masonry can withstand the fury of gusts and debris from extreme winds. Matta and his team are now looking at the earthquake resistance of earth masonry walls.

Matta and doctoral candidate **Mabel Cuéllar** helped Phal prepare a successful Magellan Scholar grant proposal for a study of seismic resistance in earth masonry. Phal is working with Cuéllar and Matta on a one-year pilot project to test their idea on small walls of plain and fiber-reinforced earth bricks under shear and compressive loads. Reinforcing plastic fibers might be sourced from recycled bottles, greening the system even more.

Mary Beth Poston, M.D., associate professor of clinical internal medicine at the University of South Carolina School of Medicine; with third-year medical student, Jessica Demarest.

Stephen Smith

When seconds count

Trauma surgeon studying ultrasound protocol for evaluating critical chest wounds

A car crash victim with serious chest injuries is rushed into the emergency room where a trauma surgeon makes a fast but thorough assessment of her condition.

An ultrasound scan immediately reveals rib fractures and cardiac tamponade —a life-threatening pressure on the heart caused by a buildup of fluid around the organ. Within minutes the physician makes a series of critical treatment decisions.

"We're past the 'stethoscope of the future' reference when it comes to using ultrasound," said **Stephen Smith**, M.D., professor and chair of the Department of Surgery at USC's School of Medicine in Columbia. "It's essential for almost every specialty in medicine. We can't do oncology, obstetrics or trauma without it."

Smith has been pioneering the use of ultrasound in trauma care for the past 20 years, and he's participated in clinical research that has confirmed both its efficiency and accuracy. "The way ultrasound has been validated is by training people to compare ultrasound imaging to the standard approach of X-rays and CT scans," he said. "Those have been the gold standards of medicine — and ultrasound is faster and just as accurate."

Smith has also helped test the eFAST (extended focused assessment with sonography for trauma) protocol, which uses ultrasound technology to diagnose pneumothorax and other serious chest trauma conditions. This year he will attend three ultrasound congresses that focus on trauma care.

"eFAST is the premier method for the detection of fluid in the peritoneal cavity, and in some medical centers it's replacing the conventional chest X-ray for the diagnosis of pneumothorax," Smith said. "Studies have shown it to be 95-99 percent accurate."

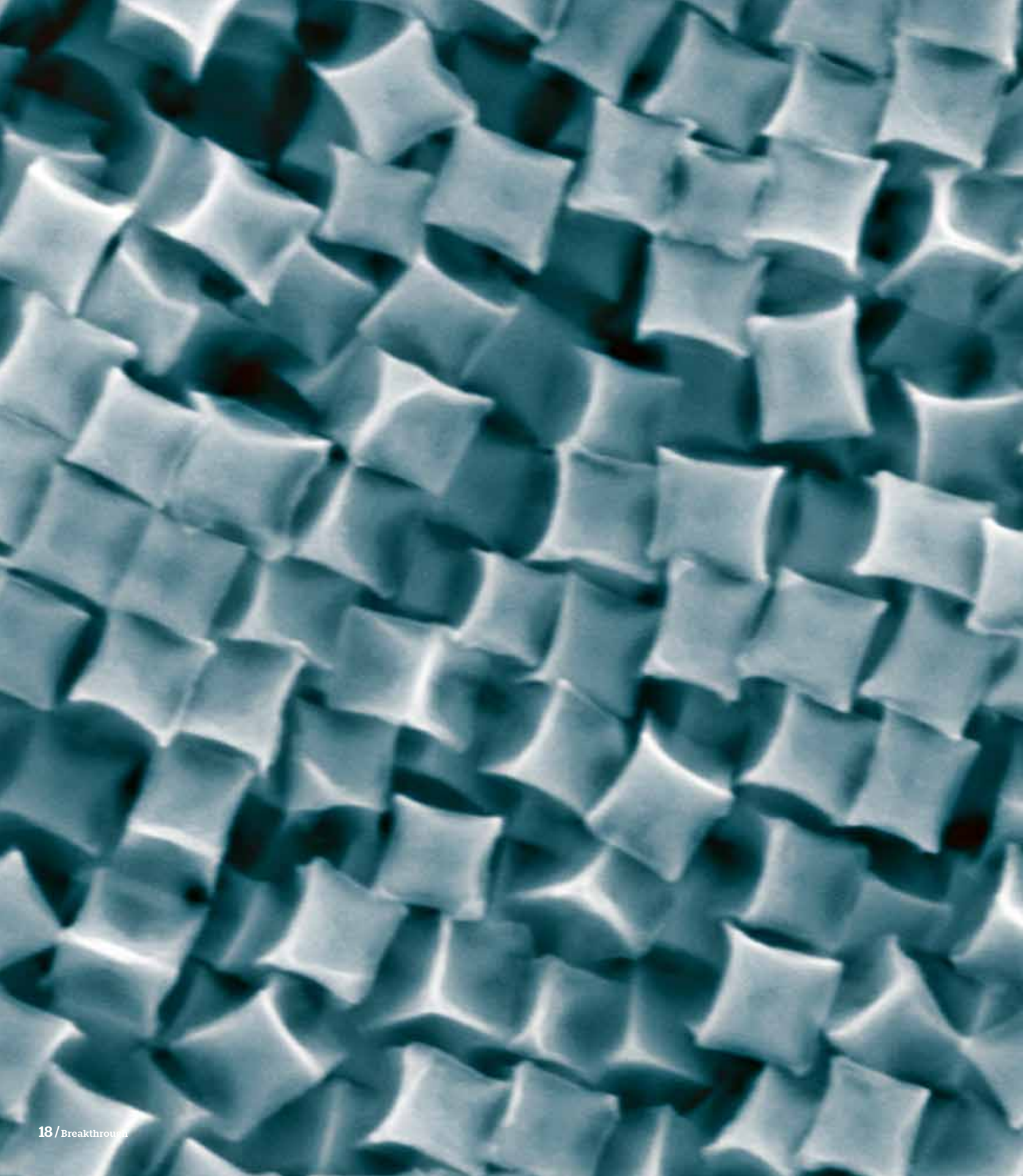
As part of the eFAST system, Smith and other trauma surgeons are developing a quick scoring system for chest wall injury patients who have sustained multiple rib fractures.

"You're assigned a score based on your age, the number and severity of rib fractures and level of pulmonary contusion," he said. "You would get a higher score if you have rib fractures on both sides, for example. This scoring system helps the trauma surgeon develop a prognosis in the first few minutes and offers guidance on whether to do a tracheostomy or put the patient on a ventilator.

"We're validating the scoring system with research and finding it helpful in planning treatment from the very beginning."

Smith remembers using ultrasound equipment that once was the size of a desk but has now evolved to the size of a small laptop — and even smaller.

"Now there's an application that will let you plug a transducer into a smart phone. It's not a great image, but in a remote area of a developing country it would be helpful," he said.



Gold catalytic

Gold, pictured here as nanoparticles magnified 200,000 times, is a chemist's treasure, especially in tiny nuggets. Gold nanoparticles sprayed onto a surface can dramatically boost sensitivity in the analysis of the surface's molecules. This property of the tiny gold granules has been used in areas as disparate as art preservation, pesticide detection, petroleum refining and cancer research. Different sizes and shapes of the nanoparticles can have varying effects on the reactions of nearby molecules. "The exposed crystalline facets of gold nanoparticles were found to be a key factor in determining their catalytic performances," says Qingfeng Zhang, a doctoral candidate in USC chemistry professor Hui Wang's research group, which is focused on designing efficient nanocatalysts for industry.

This image was obtained with a Zeiss Ultraplus thermal field emission scanning electron microscope at USC's Electron Microscopy Center, which provides analytical microscopy and imaging support for university clients and industrial scientists.

It's everyone's fault

It doesn't shake, rattle and roll like California, but South Carolina is the most seismically hazardous state in the eastern United States.


205

The most powerful earthquake ever observed on the East Coast struck in the Palmetto State, with an epicenter just north of Charleston.

Because the magnitude-7 temblor hit more than 100 years ago, in 1886, many people don't give it much thought these days. But geologist **Jim Knapp's** research is showing that public safety officials should definitely take the seismic landscape into account when they're drawing up emergency plans.

Pradeep Talwani, a professor emeritus at USC, did much of the pioneering work on seismicity in the eastern U.S., particularly in the Charleston region. "We're relative newcomers," Knapp says of his team of researchers. "Our interest grew very naturally several years ago out of our DOE-funded work on evaluating the feasibility of geologic storage of carbon dioxide in South Carolina."

In the course of the study, Knapp's group developed a new understanding of the geometry of buried faults in the seismically active Charleston area, called the Middleton Place Summerville Seismic Zone. Those faults are associated with the opening of the Atlantic Ocean some 200 million years ago, when the tectonic plate upon which Africa rests began to separate from the one on which North America rests.

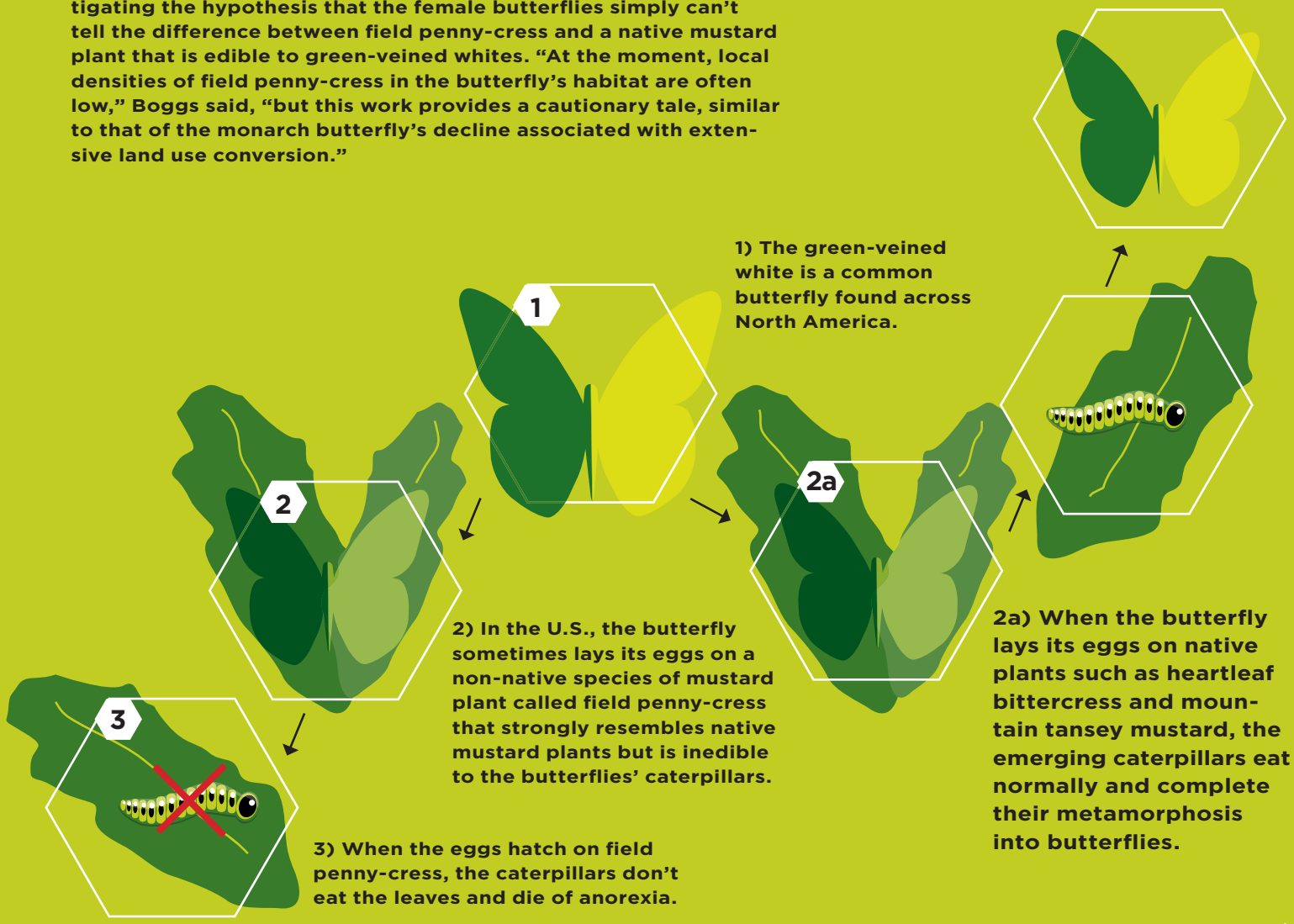
Knapp, doctoral candidate **Erin Derrick** and the rest of the research team are positing a new map of the faults underlying the region. Those faults cause frequent earthquakes in the area, but they're so small (magnitude 4 and less) that they often go unnoticed by the population at large. But that wasn't the case in 1886. And there's a distinct possibility that a similarly powerful quake might hit the now-heavily-populated region.

As part of her dissertation, Derrick is proposing the location and structure of a new fault, the Lincolnville fault. "It's actually quite important because it runs underneath, or along, Interstate 26, which is the major transportation artery in and out of Charleston," she says. "If a major earthquake were to hit that area, it's essential for public safety to make transportation plans that take that into account."

Choosing unwisely:

When butterflies lay their eggs on the wrong plant

Mothers don't always know best, says Carol Boggs, a USC biology professor and director of the School of the Earth, Ocean and the Environment. She and graduate student Rachel Steward are studying the green-veined white, a butterfly that sometimes lays its eggs on field penny-cress, a non-native mustard plant that won't sustain the butterflies' caterpillars. Boggs and Steward are investigating the hypothesis that the female butterflies simply can't tell the difference between field penny-cress and a native mustard plant that is edible to green-veined whites. "At the moment, local densities of field penny-cress in the butterfly's habitat are often low," Boggs said, "but this work provides a cautionary tale, similar to that of the monarch butterfly's decline associated with extensive land use conversion."



1) The green-veined white is a common butterfly found across North America.

2) In the U.S., the butterfly sometimes lays its eggs on a non-native species of mustard plant called field penny-cress that strongly resembles native mustard plants but is inedible to the butterflies' caterpillars.

2a) When the butterfly lays its eggs on native plants such as heartleaf bittercress and mountain tansey mustard, the emerging caterpillars eat normally and complete their metamorphosis into butterflies.

3) When the eggs hatch on field penny-cress, the caterpillars don't eat the leaves and die of anorexia.

John Richards

Jane Roberts

hs Health Sciences

Mapping the ultimate network

We're on the threshold of a new era in understanding the human mind. Magnetic resonance imaging, which doctors use to examine twisted knees, is revolutionizing the study of the brain.

MRI maps the inner structures of brains in living people. That's a distinct departure from even the recent past, when autopsies and guesswork were the order of the day. Compared to millimeter-level-resolution maps now possible with MRI, earlier approximations of a living person's brain structure were crude indeed.

A recent undertaking by **John Richards** and **Jane Roberts**, two psychology professors who are among 20 USC faculty members in USC's multidisciplinary Institute for Mind and Brain, illustrates the technology's promise, particularly for studying autism.

Richards, who for more than 35 years has studied attention in young children, has harnessed MRI technology to precisely track brain development in infants. He's now able to pinpoint areas of the brain that are changing and infer how they contribute to an infant's attention devoted to a face, object or sound.

Roberts is collecting information on infant behavior before the age at which an autism diagnosis can be reliably made.

Richards and Roberts are following brain and behavior changes in infants with older siblings diagnosed with autism. The younger siblings have an increased risk of a similar diagnosis later.

They are thus preparing a database of detailed, individualized maps of developing infant brains — some of which may eventually contribute to an autism diagnosis.

This basic research will help address the question of how brain structure might be associated with autism and related disorders. Depending on the results, their work holds promise for facilitating an earlier diagnosis or more targeted treatment.

And this project is just part of a wider spectrum of similar research. Highly detailed maps of brain structure in living individuals, recorded before and after injury, disease or aging, should reveal a lot about how the brain operates — and where to start when it needs to be repaired.

The Institute for Mind and Brain comprises 20 faculty members from across campus, all focused on the study of the human brain. A new facility at 1600 Gervais Street houses several faculty offices, laboratory space, and gathering areas for both organized and spontaneous discussions. The institute, directed by **John Henderson**, unifies the efforts of USC researchers addressing one of the most fundamental questions of human existence: how does the brain give rise to the mind?

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