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Spring 2014

## Summer 2014 Biomedical Engineering Newsletter

Department of Biomedical Engineering, Michigan Technological University

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# BIOMEDICAL ENGINEERING

SPRING 2014



New IEEE, AIMBE and SPIE fellows

Arteries on aisle 9

Implants with sensors that shake off infection

Mitch Kirby wins Whitaker International Fellowship

Skin patch warns when it's time to get out of the sun

## LETTER FROM THE CHAIR



Dear Friends and Colleagues,

RESEARCH. TEACHING. SERVICE. These are the foundations that academic departments build upon. And build we have. This edition of the Newsletter focuses on the funded—and sometimes unfunded—research successes of the past year. Research in the Department focuses on four major areas: tissue engineering and biomaterials; biosensors and biomedical instrumentation; biomedical optics and imaging; and cardiovascular engineering.

The recent past has been record setting for the Department, with nearly every single faculty member receiving at least some measure of federal funding to support her or his research program. We have also attracted research funding from the State of Michigan, and from industrial sponsors. I hope that you will find these brief articles about our research programs as interesting and as exciting as I do.

Research is not the only area of growth the Department has witnessed as of late. Student enrollment in all of our educational programs is up. Our undergraduate enrollment approaches 300 students working on their bachelor's degrees in biomedical engineering at Michigan Tech. The number of students working towards advanced degrees in biomedical engineering continues to climb as well.

This year, we hit an all-time high for enrollment in our MS and PhD programs, including our Accelerated MS program, which allows highly qualified and motivated students to earn their MS degree in a single year of study beyond their bachelor's degree. This swelling of our graduate (and to no small degree, our undergraduate) ranks is, of course, tied closely to our successes on the research front.

Since our last newsletter, we have added one new faculty member to our BME family. Dr. Xuan Liu brings considerable skills in coherent imaging to the Department, including optical coherence tomography and other optical imaging and sensing technologies. The high-tech approaches she brings to our research programs greatly expand the opportunities for our students to become involved in cutting-edge research.

All of these developments in the Department are aimed at achieving our singular vision of being a high-quality, research-driven biomedical engineering department with excellence in both undergraduate and graduate education. This vision is now our reality.

Best Wishes,

Sean J. Kirkpatrick, PhD  
Professor & Chair  
Department of Biomedical Engineering

**On the cover: Jingfeng Jiang's computer model predicts lung motion during radiation therapy for precise dose delivery.**

## BIOMEDICAL ENGINEERING FACULTY

### ABOUT THE DEPARTMENT

The Department of Biomedical Engineering at Michigan Tech is among the world's leaders in providing quality education and research. We have ten faculty, several adjunct faculty, two staff members, thirty graduate students, and close to 300 undergraduate students. We are housed in the Minerals and Materials Engineering Building at the center of Michigan Tech's campus in Houghton. We offer programs leading to Bachelor of Science, Master of Science, and Doctor of Philosophy (PhD) degrees in Biomedical Engineering.

### OUR MISSION

The Department of Biomedical Engineering serves the University, the community, and the biomedical engineering profession through education, research, and design activities. The department offers innovative educational programs that integrate biological sciences and engineering, and apply engineering tools, methods, and practices to solve problems in biology and medicine. Graduates of our programs are highly-skilled biomedical engineers who understand the ethical, social, and economic implications of their work.

**MEGAN C. FROST, PhD**  
University of Michigan  
*Nitric oxide-releasing polymers,  
implantable sensors*

**JEREMY GOLDMAN, PhD**  
Northwestern University  
*Lymphatic and blood  
vascular systems*

**JINGFENG JIANG, PhD**  
University of Kansas  
*Biomechanics and biomedical  
imaging*

**SEAN J. KIRKPATRICK, PhD**  
University of Miami  
*Biomedical optics, lasers,  
and imaging*

**BRUCE P. LEE, PhD**  
University of Wisconsin-Madison  
*Bioadhesives*

**XUAN LIU, PhD**  
The Johns Hopkins University  
*Optical coherence tomography*

**MICHAEL R. NEUMAN, MD, PhD**  
Case Institute of Technology  
*Biomedical sensors and  
instrumentation*

**KEAT GHEE ONG, PhD**  
University of Kentucky  
*Biosensors, passive implantable  
sensors*

**RUPAK RAJACHAR, PhD**  
University of Michigan  
*Biomineralization in vascular  
and bone-related cell types  
and tissues*

**FENG ZHAO, PhD**  
Duke University  
*Tissue engineering*

Winter Carnival fireworks  
over Michigan Tech's Mont  
Ripley ski area





## NEW FACULTY



**X**uan Liu joins the faculty as an assistant professor. She comes to Michigan Tech from The Johns Hopkins University, where she earned her PhD in Electrical and Computer Engineering.

Before coming to Michigan Tech, Liu was a postdoctoral fellow at The Johns Hopkins University. She has been published in *Biomedical Optics Express*, *Optics Express*, and *IEEE Transactions on Biomedical Engineering*. She has conducted research in Fourier-Domain Optical Coherence Tomography (OCT) for vitreoretinal surgery. OCT provides high-resolution cross-sectional images of biological specimens in real time, and is used to diagnose various diseases in ophthalmology, cardiology and oncology. Liu is currently developing a manually-scanned OCT system with a miniature probe. She is also interested in the extraction of functional information from OCT images to characterize chemical and mechanical properties of biomedical specimens or synthetic biomedical materials.

Liu earned her MS in Physics and BS in Electronic Science and Technology from Tsinghua University in Beijing.

## MICHAEL R. NEUMAN NAMED IEEE FELLOW



**P**rofessor Michael R. Neuman was named a Fellow of IEEE for his contributions to the advancement of biomedical sensors and instrumentation with clinical applications.

Neuman is on the faculty of the Department of Biomedical Engineering, where he served as department chair from 2003 to 2010. His research interests lie in biomedical sensors and instrumentation, physiological measurements, perinatal medicine and clinical applications of biomedical instrumentation.

Neuman has served as editor of *IEEE Transactions on Biomedical Engineering* as well as the British journal *Physiological Measurement*. He is the former editor-in-chief of *IEEE Pulse*.

In 2004 Neuman received the IEEE Engineering in Medicine and Biology Society Career Achievement Award. He is also a Fellow of the Biomedical Engineering Society, the American Institute for Medical and Biological Engineering, the Institute of Physics (UK) and the Institute of Physics and Engineering in Medicine (UK). Neuman is the faculty co-advisor of the International Business Ventures Enterprise team at Michigan Tech.



**Michael R. Neuman**  
is a regional editor  
and former editor-in-  
chief of *IEEE Pulse*.

## SEAN J. KIRKPATRICK NAMED AIMBE FELLOW, SPIE FELLOW

Sean Kirkpatrick, chair of the Department of Biomedical Engineering, was named to the College of Fellows of the American Institute of Medical and Biological Engineering (AIMBE) in January 2014. AIMBE is an advocacy organization recognizing excellence in, and advancing the fields of, medical and biological engineering, as well as providing the collective expertise of biomedical engineers to federal policy makers. The organization's College of Fellows comprises 1,500 outstanding bio-engineers in academia, industry and government.

"We are proud that the professional community has recognized the talents of Dr. Kirkpatrick with this appointment," said Wayne Pennington, dean of the College of Engineering. "The College of Fellows is limited to the top 2 percent and represents an elite group, indeed."

In March 2013 Kirkpatrick was named a Fellow of SPIE, the international society for optics and photonics. According to SPIE, "Kirkpatrick has made valuable contributions to



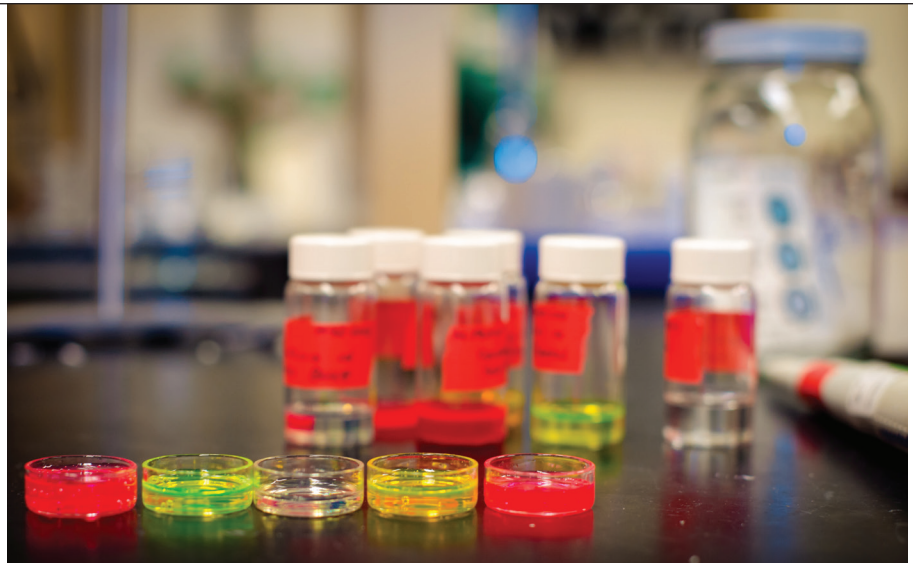
research on the interface between the fields of continuum mechanics, tissue mechanics and optics. His primary accomplishments have been in developing both the theoretical basis and practical applications of laser speckle techniques for biomedical imaging and diagnostics. He pioneered the use of laser speckle for understanding soft tissue mechanics and was one of the founders of the field of optical elastography."

Kirkpatrick has developed, patented and published on unique and highly sensitive methods for quantifying the micro- and macro-mechanical behavior of hard tissue, vascular tissue, skin, and ligamentous tissue, among other tissue types. Kirkpatrick has also developed light scattering methods for assessing the mechanical properties of synthetic biomaterials and the curing behavior of biopolymers.

## KEAT GHEE ONG NAMED DIRECTOR OF MICHIGAN TECH BIOTECHNOLOGY RESEARCH CENTER



Associate Professor Keat Ghee Ong was elected as director of the Michigan Tech Biotechnology Research Center (BRC). The BRC currently houses approximately 35 projects. Most are funded through major federal agencies, including the Department of Energy, the National Institutes of Health, the National Science Foundation and the Department of Agriculture. BRC's research expenditures average more than \$2.3 million annually. More info at [www.biotech.mtu.edu](http://www.biotech.mtu.edu)



## ARTERIES ON AISLE 9

**F**eng Zhao dreams of the day when replacement blood vessels will be as easy to buy as garden hoses.

In the United States alone, hundreds of thousands of people a year undergo surgery to bypass a blocked artery and restore blood flow. Typically, surgeons first cut a vein from the patient's leg or chest. Then they use it to create a detour around a blockage in the artery, restoring circulation.

The technique works well—if the patient has a good vein and suffers no complications. However, many thousands of patients do not have healthy veins available. They must settle for grafts made from synthetic materials, which are prone to clots and blockages, or veins taken from animals, which can provoke a dangerous immune response.

New research is leading to the development of bioengineered vessels grown from human stem cells, but so far, the vessels have been on the large side. Some cardiac bypasses require smaller grafts, with an interior diameter of six millimeters or less. Scientists are growing smaller blood vessels on a scaffold, but the materials in that scaffold can set off the body's immune system.

"There's not a perfect solution on the market," says Zhao, an assistant professor of biomedical engineering. "So we're trying to make a completely biological vessel. We use just the stem cells. We let them do all the work."

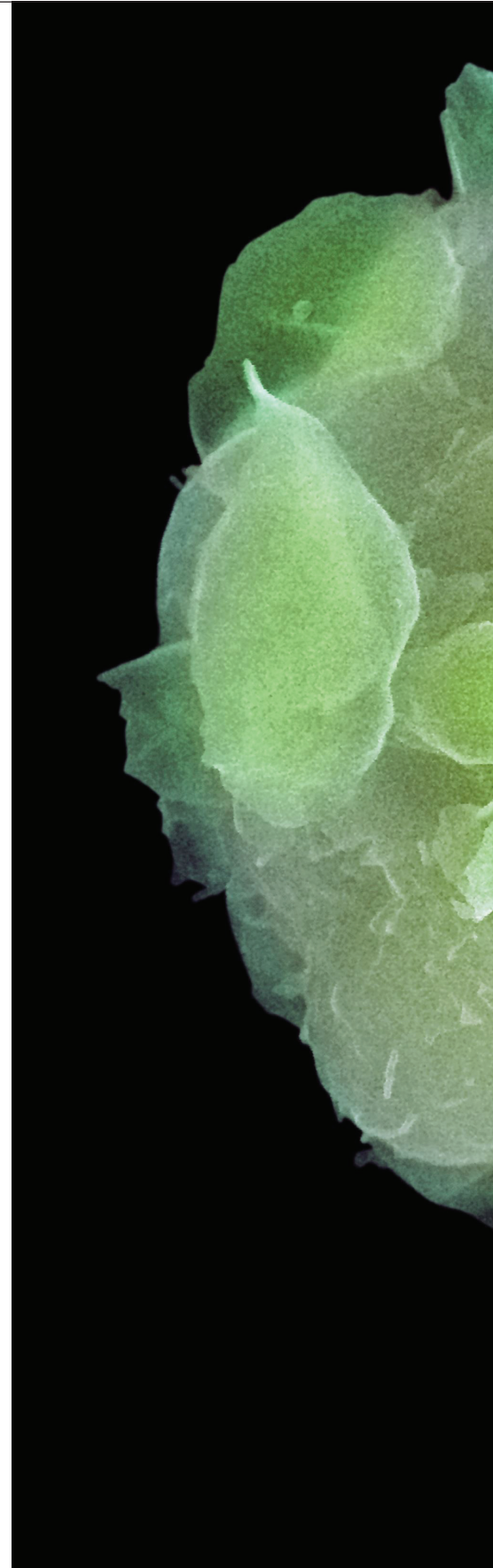
The stem cells used in her research are harvested from bone marrow and fatty tissue. Like all stem cells, they have a unique advantage. They can be extracted from a donor and then transplanted into someone else without triggering an immune response. If all goes well in their new host, they become naturalized citizens, differentiating into a specific cell type and blending in with the natives.

However, a blob of stem cells is no substitute for a working blood vessel. So Zhao's team has coaxed them into forming proto-blood vessels in the lab. She grows them in a nutrient-rich, low-oxygen fluid that mimics conditions inside the body. "They are like silk worms; they build a little house for themselves out of proteins and carbohydrates," she said.

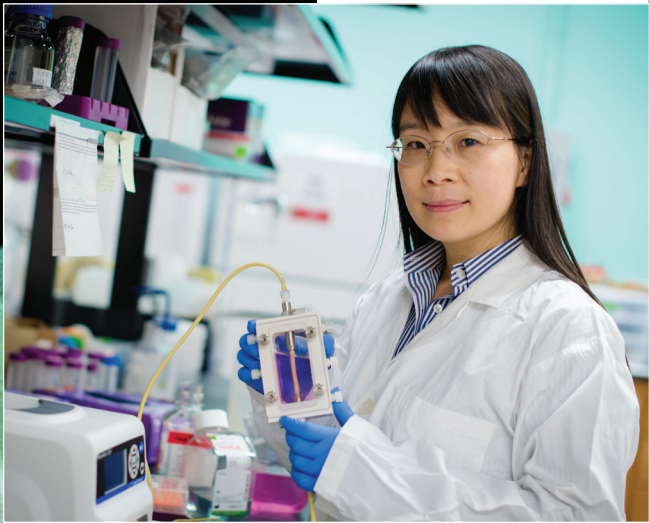
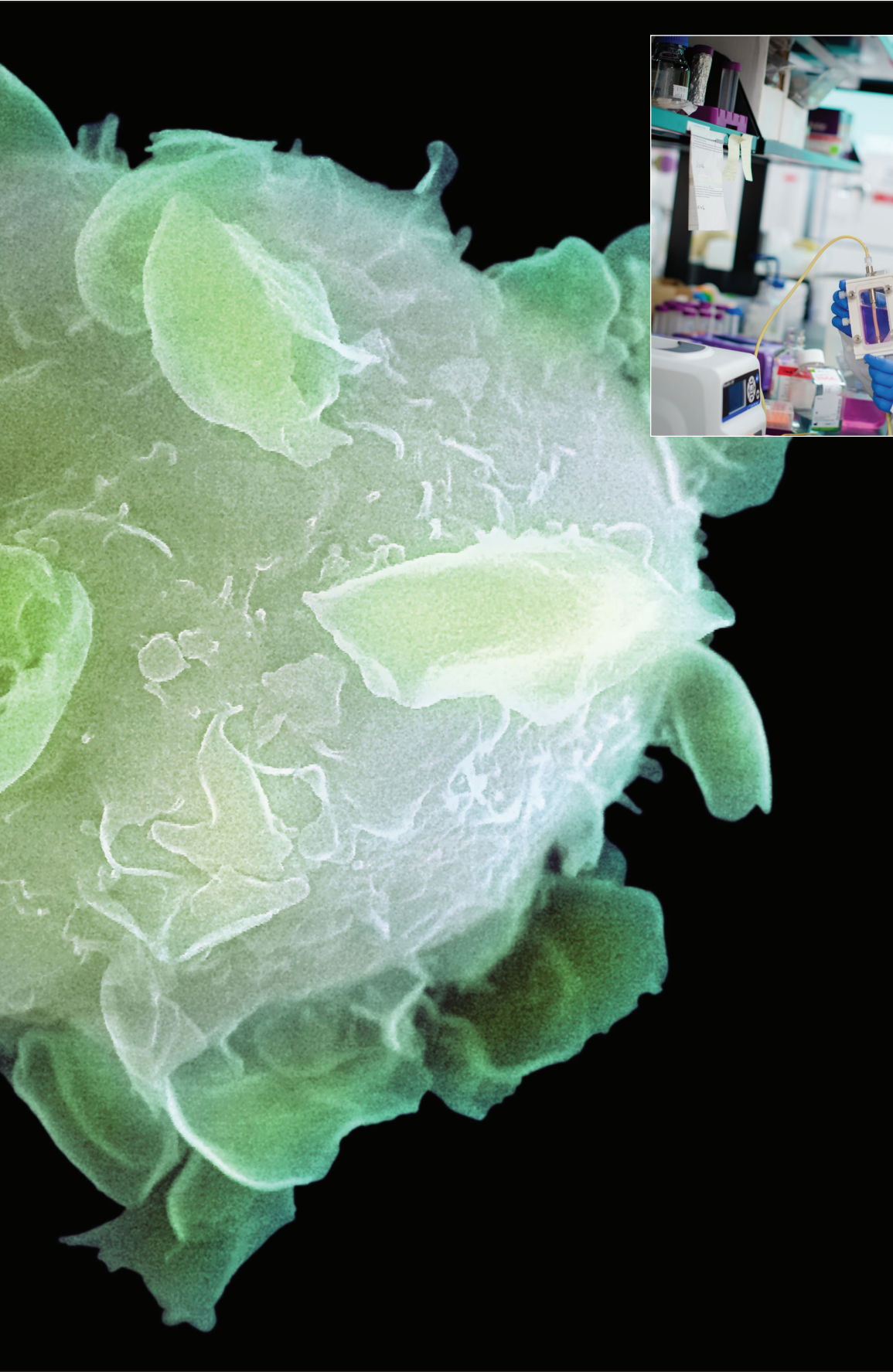
Initial tests show promise; she has successfully transplanted these stem cell tubes in rats. "After two weeks, they look pretty good," she said. "We see them differentiating into vascular cells and becoming denser and stronger."

In a similar vein, Zhao is also using stem cells to grow the tiniest blood vessels of all. Unlike their larger cousins, these sheets of capillaries would not be used to treat blockages. Instead, they would serve as the plumbing system for artificial tissue. "We pre-vascularize the tissue, so it can hook up to the patient's blood supply after it is implanted," she said.

Her team has developed a technique for growing dense webs of the tiny vessels from stem cells, which can be layered on a sheet of artificial tissue. The tissue can then be rolled up, like a jellyroll, or stacked in alternating layers, like a club sandwich. In both cases, the capillaries assure that blood can reach the interior of a transplant of any size, providing life-giving nourishment throughout.







**Feng Zhao,  
Assistant Professor**

*“We’re trying to make a completely biological vessel. We use just the stem cells. We let them do all the work.”*

**Bone marrow stem cell, colored scanning electron micrograph (SEM).**



## IMPLANTS WITH SENSORS THAT SHAKE OFF INFECTION

**K**eat Ghee Ong envisions a new generation of implantable biosensors. Not only could they signal if all is well (or not) after surgery, they would do it without batteries or computer chips. Plus, they could fight infection.

For his insights, Ong was one of 24 Outstanding Young Investigators invited to present at the 2013 Frontiers in Bioengineering Workshop. The workshop, held at Georgia Tech Feb. 25-26, brought together leaders in bioengineering to discuss cutting-edge research in the field.

Here's what makes Ong's sensors radically different. Instead of being surgically inserted alongside a device such as an artificial knee, they would be part of the device itself. Ong is developing special coatings for surgical implants, like replacement hips and knees. These coatings could tell doctors how well a patient is healing.

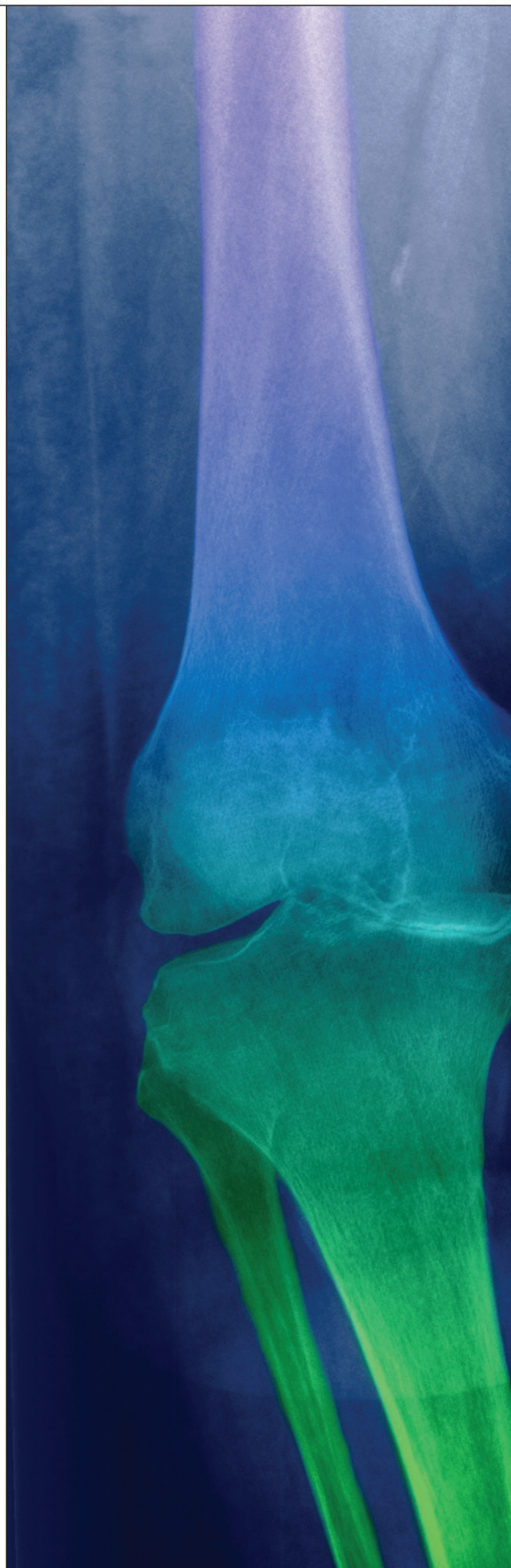
Made of magnetoelastic materials, the coatings' magnetic properties change under pressure. When scanned from outside the body, they could reveal if the patient's bone is healing properly with an implant—or if it isn't.

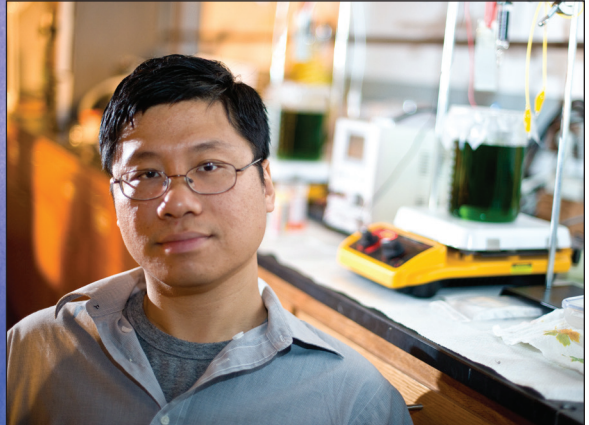
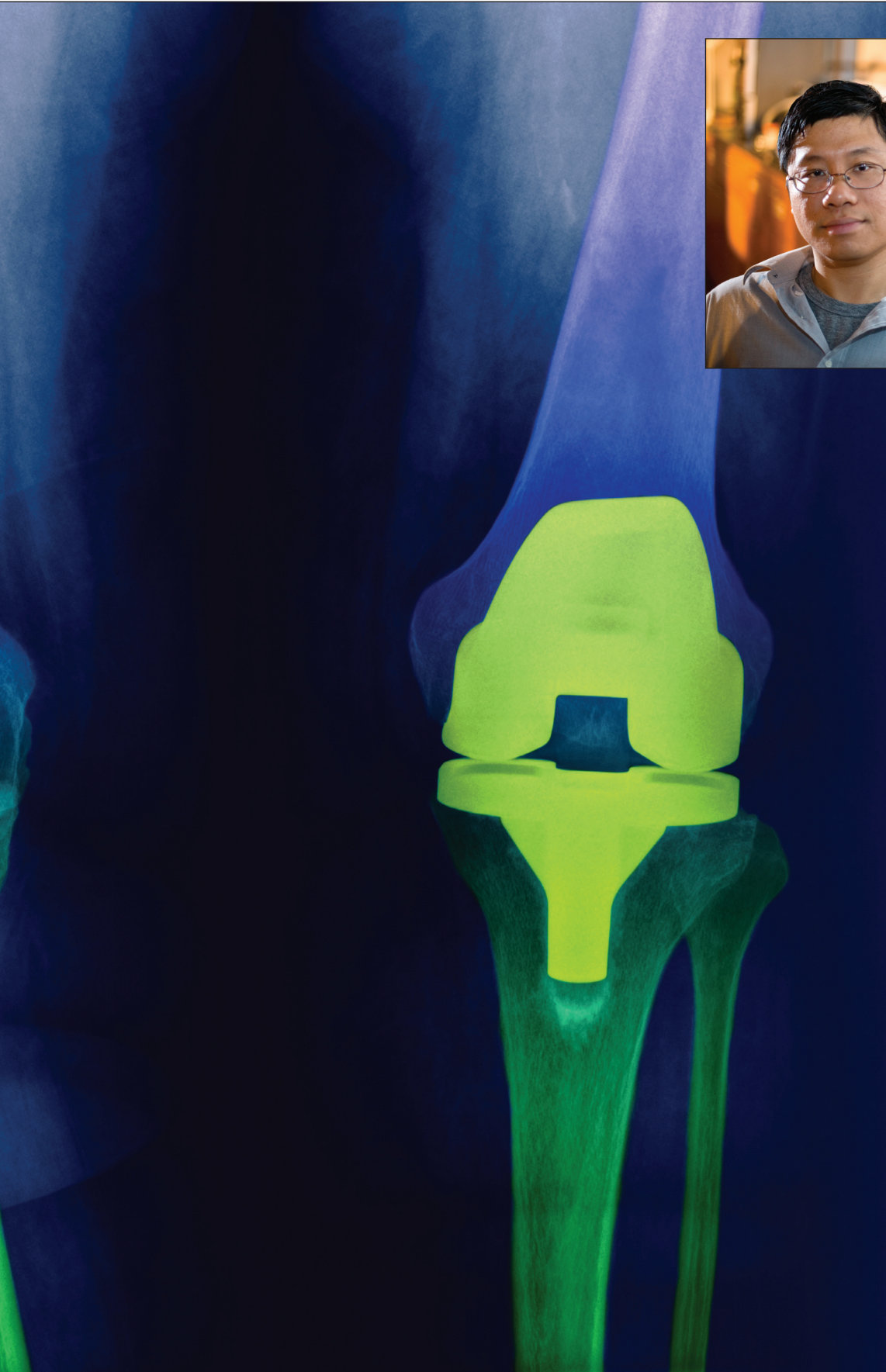
A magnetoelastic coating can even help battle infection. "It will vibrate in an AC magnetic field," says Ong. That can knock bacteria loose from the surface, and antibiotics and the body's own immune system can better launch an attack. This property could also help solve another problem with implants. "If a cell attaches too much, a small vibration on the magnetoelastic coating can loosen it and prevent cell growth," Ong says. "The vibration tells the cell, 'Don't stand there, go away,' in the gentlest way possible."

This property could also loosen internal scar tissue, which sometimes sticks to foreign objects in the body, reducing their effectiveness and shortening their lifespan.

Ong and his team have tested their magnetoelastic coatings on cells and in mice. It's a fascinating line of inquiry that's beginning to attract attention, says Ong. "We're looking at something completely different, using physical stimulation to improve the interface of medical implants," he says. "When you do something new, it always takes time to gain credibility, but after a few years, we're making headway."

Ong's recent work, which is partially funded by Rupak Rajachar's grant from the National Institutes of Health, is described in two articles: "Remotely Activated, Vibrational Magnetoelastic Array System for Controlling Cell Adhesion," in the *Journal of Biomedical Science and Engineering* and coauthored with Steven Trierweiler, Hallie Holmes, Brandon Pereles and Rupak Rajachar; and "Magnetoelastic Vibrational Biomaterials for Real-Time Monitoring and Modulation of the Host Response" in the *Journal of Materials Science: Materials in Medicine*, 2013, coauthored with Eli Vlaisavljevich, Hallie Holmes, E. L. Tan, Z. Qian, Steven Trierweiler and Rupak Rajachar.





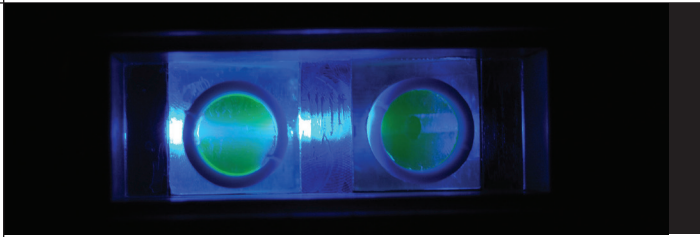
**Keat Ghee Ong,  
Associate Professor**

*“If a cell attaches too much, a small vibration on the magnetoelastic coating can loosen it and prevent cell growth.”*

**Total left knee  
replacement**



## FACULTY RESEARCH UPDATES



A 470 nm blue LED is used to illuminate a solid core waveguide device upon which cells can be cultured. The wells contain fluorescent dextran that glows yellow when excited by the 470 nm LED. Photoactive agents can be coated on the bottom of the wells to deliver drugs to cells under investigation by manipulating the light illuminating the waveguide.

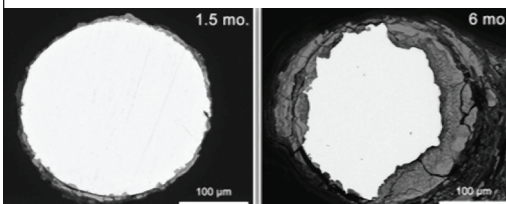
### MEGAN C. FROST

Frost's research group is currently focusing on NO-releasing film dressings for the inhibition of bacterial adhesion and prevention of infection. In a project funded by the Michigan Economic Development Corporation (MEDC), they are developing antimicrobial film dressing that will kill the bacteria that cause the most device-associated infections, including MRSA, without contributing to the development of antibiotic resistance. The polymers they are using to achieve this do not require refrigeration or special handling, making them potentially very useful for wilderness medicine and military/disaster relief applications.

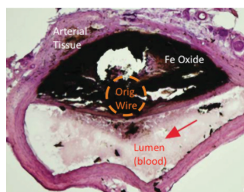
### JEREMY GOLDMAN

To mitigate the long-term side effects associated with corrosion-resistant stents, Goldman's research team is actively developing a new generation of bioabsorbable metal stents based upon metallic zinc. These new coronary stents can be absorbed in the artery after completing their task as vascular scaffolding. The team recently found that zinc corrodes at a near-ideal rate and that alloying zinc with other bioabsorbable elements improves the material's strength, making such alloys near-ideal candidates for fully-bioabsorbable metallic stents.

#### Zinc—up to 6 months in arterial wall

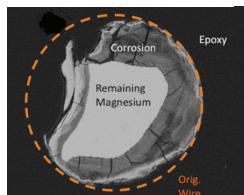


#### Iron—After 9 months in arterial wall



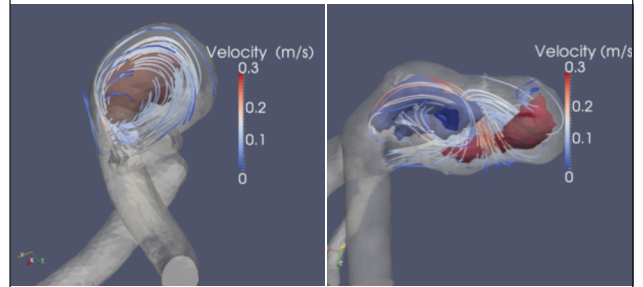
Fe corrosion product voluminous and harmful

#### Magnesium—After 32 days in arterial wall



Mg corrosion was too rapid

Zn corrosion rate was near-ideal and corrosion product was biocompatible with vascular cells and tissue



Aneurysmal hemodynamics plays an important role in the vascular remodeling of intracranial aneurysms. Plots of streamlines of cardiac-cycle average velocity vectors in two cerebral aneurysms based on phase-contrast MR angiography measurements from two patients.

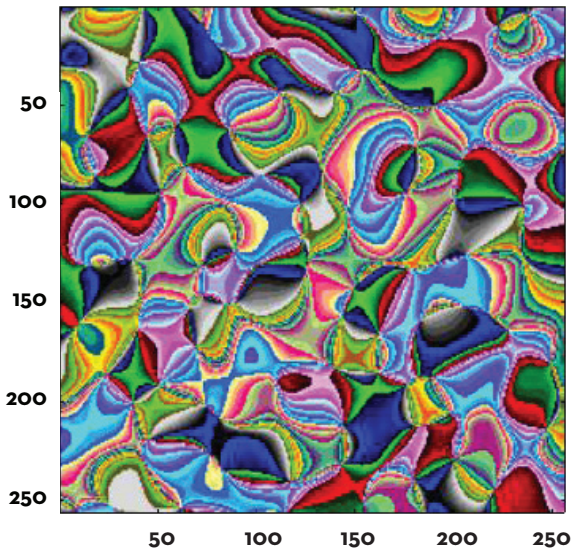
### JINGFENG JIANG

Jiang's Biocomplexity and Mechanics Lab is partnering with an interdisciplinary team at the University of Wisconsin-Madison to investigate real-time ultrasonic monitoring of thermal ablation therapy.

Leveraging the Michigan Tech High Performance Computing facilities, Jiang's lab will develop novel computer algorithms to monitor the tissue stiffness changes associated with thermal ablation—for example, "cooked" tissue becomes harder. These newly-developed algorithms will be used for (Phase I) clinical trials in human patients at the University of Wisconsin Hospitals and Comprehensive Cancer Center. This work is supported by an RO1 award from the National Institutes of Health/National Cancer Institute.

Additionally, the Radiological Society of North America (RSNA) is sponsoring Jiang's group to develop a shared resource in the public domain that researchers can use as a tool to perform "virtual prototyping" of shear wave imaging.

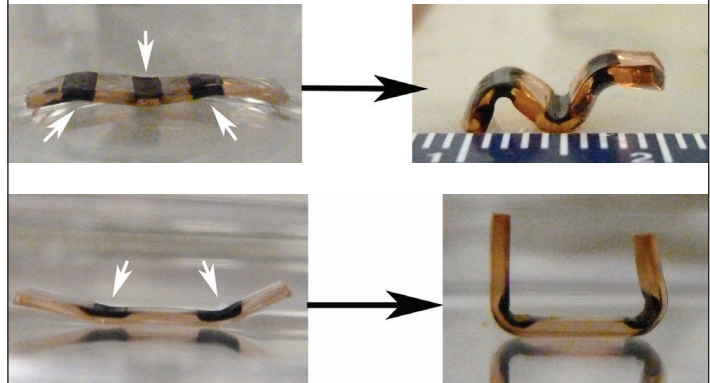
Specifically, they are investigating the modeling of shear waves in liver tissue. This project is a collaborative effort between Jiang's lab and researchers at Duke University and the University of Rochester. Jiang is also working closely with Siemens Healthcare to use computer models (see figure above) to predict hemodynamics in and around cerebral aneurysms.



False color representation of the phase of an optical field scattered by biological tissues.

**SEAN J. KIRKPATRICK**

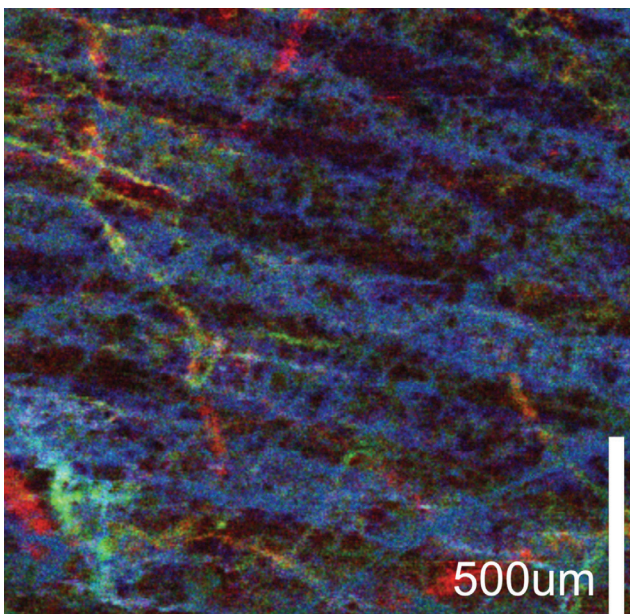
Kirkpatrick’s research team continues to explore the theory and application of laser speckle as applied to biomedical imaging and diagnostics. They have been taking a closer look at many of the outstanding issues in laser speckle contrast imaging, as well as beginning to exploit the behavior of phase singularities (optical vortices) in dynamic, scattered optical fields to assess the behavior (motion, flow, etc.) of biological media.



**Biomimetic hydrogel actuator inspired by marine mussel chemistry. Locally introduced biomimetic coordination bonds (white arrows) transformed flat hydrogel into 3-dimensional shapes in response to changes in pH.**

**BRUCE P. LEE**

Lee’s lab has received a three-year research grant entitled “Biomimetic Tissue Adhesive with Mechanically Tough Hydrogel Support” from the National Institutes of Health. The objectives of this project are 1) to functionalize mechanical tough hydrogel with marine adhesive moiety to develop a novel bioadhesive with elevated adhesive strength and tunable degradation rate and 2) to evaluate its biocompatibility in cell culture and subcutaneous implantation experiments. The long-term goal of this project is to develop tissue adhesives with strong adhesive strength and biomechanical properties matching those of native tissue to repair tissues that routinely experience large, repeated loads.



**Microvasculature map of human skin obtained in vivo using optical coherence tomography with different colors indicating blood vessel at different depths.**

**XUAN LIU**

The Liu Lab, also known as the Biophotonics Imaging and Sensing Lab, continues to develop novel, advanced optical techniques for noninvasive and minimally invasive biological imaging and sensing. Their focus is on the development of advanced optical coherence tomography (OCT) techniques, but they employ and develop a wide variety of optical microscopy techniques to assess tissue health. One area of focus is advancing OCT-based optical elastography techniques.

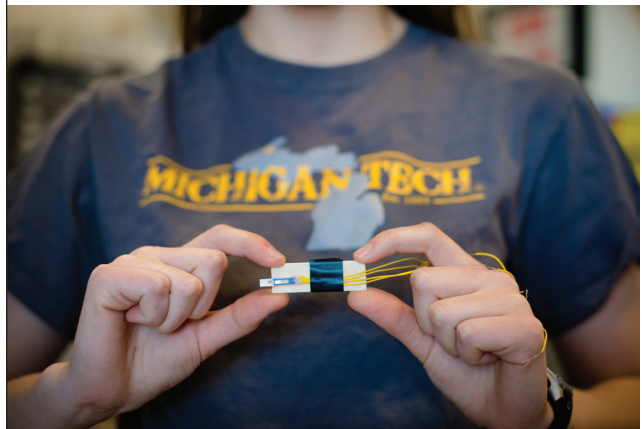


## FACULTY RESEARCH UPDATES

### MICHAEL R. NEUMAN

The National Institutes of Health and the Indian Department of Biotechnology are jointly funding the development of an infant cardiac annunciator, a small electronic device that announces each infant heartbeat with a “beep” and a flash of light to help caregivers establish that a newborn infant is alive and to encourage resuscitation. Collaborating neonatologists in the US and India have demonstrated that with elementary training, birth attendants can improve the survival rate of infants, but need a way to determine which non-responsive infants are indeed alive at birth. Neuman’s team has received a grant from the National Collegiate Inventors and Innovators Alliance (NCIIA) to continue development of a version of the infant cardiac annunciator that they have been working on for the past four years. They plan on taking the design to Ghana for evaluation in the summer of 2014.

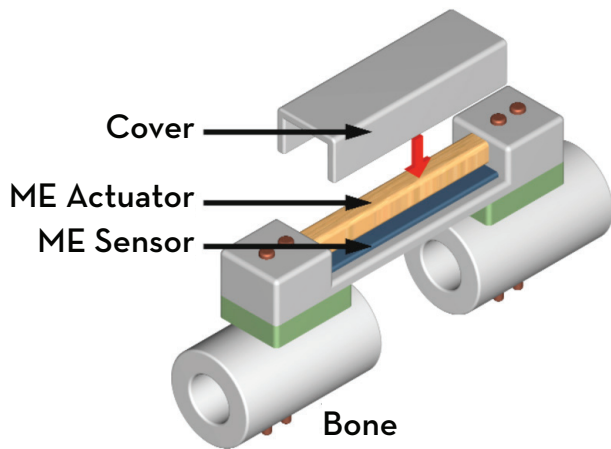
Additionally, a small biomedical device business has contracted the team to independently evaluate a new type of electroencephalographic (EEG) electrode that they have developed under NIH Phase 1 and 2 grants. The evaluation consists of electric characterization of the electrodes in the laboratory and signal quality evaluation in human subjects.



**Michael R. Neuman is advising undergraduate researcher Elizabeth Wohlford in the development of a real-time urinalysis instrument/catheter for critical care patients. The device measures electrical conductivity of urine at the bedside as it is produced.**



**The infant cardiac heart annunciator**

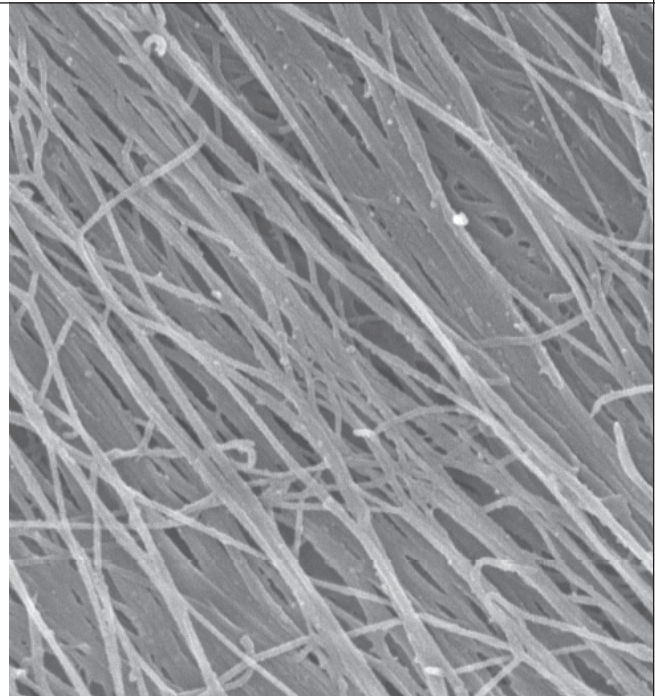


**ABOVE** Illustration of the bone fixation plate.  
**BELOW** A prototype of the bone fixation plate



**KEAT GHEE ONG**

Among the 7.9 million bone fractures that occur in the US annually, 5-10% develop into delayed or nonunion fractures that may require bone fixation plates to assist the healing process. Ong's latest research seeks to develop an adaptive bone fixation plate that has the potential to reduce the number of surgical interventions, decrease healing time, and resolve fractures that could otherwise burden patients for a lifetime. The new bone plate contains the magnetoelastic material that can generate a small, localized mechanical strain when activated by a magnetic field. This type of mechanical strain has been shown to accelerate bone healing and improve successful healing rates. Furthermore, the magnetoelastic material can measure and wirelessly relay the force loading on the plate as a secondary magnetic field, allowing the user to adjust the mechanical stimulation based on real-time feedback.



**Highly aligned nanofibers created by fibroblasts form a biological scaffold which could prove an ideal foundation for engineered tissues. Stem cells placed on the scaffold thrived and had the added advantage of provoking a minimal immune response.**

**FENG ZHAO**

The Zhao lab is currently focused on developing completely biological small-diameter blood vessels using human stem cells. In a project sponsored by the National Institutes of Health/National Heart Lung and Blood Institute, they aim to develop an off-the-shelf, small vascular graft to meet the urgent needs of patients requiring coronary artery substitutes.

## WHITAKER INTERNATIONAL STUDENT FELLOWSHIP IN NEW ZEALAND

**M**itch Kirby, a sophomore majoring in biomedical engineering, was the recipient of a Whitaker International Student Fellowship. Kirby worked in New Zealand at the University of Otago in Dunedin, New Zealand last summer researching biomedical optics.

**Q: Why did you decide to go to New Zealand?**

Initially I had been interested in New Zealand because of the natural beauty and easy access to both snowboarding and surfing. That, and the fly fishing. The University of Otago offered a few of the math courses I needed, so Dr. Kirkpatrick informed me of the Biophotonics and Biomedical Imaging Research Group there. I looked into their current projects and was interested in trying to work with a group on non-invasive brain imaging. As I learned more about New Zealand everything sort of seemed to line up.

**Q: What was your main project?**

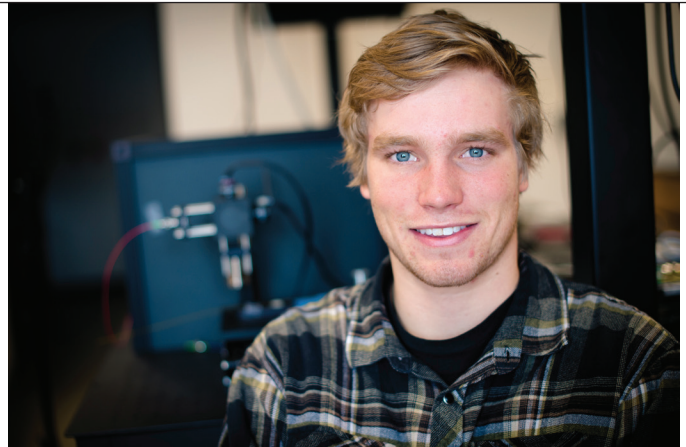
I ended up working on a project involving light/tissue interaction, with Dr. Igor Meglinski. As light propagates through biological tissue, the light waves exhibit different behavior based on the internal characteristics of the tissue. The goal was to gather enough experimental data on the different light/tissue interactions so that down the road it would be possible to use a light-emitting device to make medical diagnoses non-invasively. While the project was in the early stages, most of my time in the lab was spent lining up the different lenses and filters for the experiments with elliptically polarized light. Later we began writing code on MATLAB and analyzing light behavior.

**Q: How different was the culture and society?**

The culture was pretty similar to the states. British influence is pretty prominent. I lived close to the ocean, so it was cool to see how many New Zealanders still make a living from fishing. The fish and chips shops were awesome! Rugby was really the only sport down there.

**Q: How has studying abroad impacted or changed your outlook?**

Spending time overseas has definitely opened my eyes to the ability of a college education to take you places. Traveling and living abroad while studying and working in



the lab have shown me it is possible to mix work and play so that each day is an enjoyable one. I also enjoyed the excitement of working on a research project that could potentially change the way many medical diagnoses are made. Working with people in the lab from different backgrounds was a high point, as well-everyone had something unique to bring to the table, particularly because we all came from different countries and cultures.

**Q: What did you do for fun?**

Everyday life involved getting up very early, completing schoolwork and attending classes. After spending a few hours in the lab I would finish up for the day around 3 pm. If the waves were good, we would surf. If not, we would explore the countryside. During the weekends I traveled with a small group of friends to different locations throughout New Zealand. Trips usually involved snowboarding, backpacking, and just general adventuring.

**Q: Are you doing any research at Michigan Tech that relates to the work you did at the University of Otago?**

I am currently working in an optics lab with Dr. Xuan Liu, researching Optical Coherence Tomography. In the future I hope to continue to work on developing new technologies through academic research.





## SKIN PATCH WARNS WHEN IT'S TIME TO GET OUT OF THE SUN

By the time most of us realize we've been out in the sun too long, it's too late. It can take up to 24 hours after exposure before you realize you have a sunburn.

Now, a Michigan Tech senior design team has devised a sensor that tells you when it's time to seek shelter, long before your skin gets red and tender.

The biomedical engineering seniors developed a skin patch imprinted with a graphic—in this case, a happy face design. The nickel-size patch gradually darkens under ultraviolet light, the type of light that causes sunburn and skin cancer. When you can't see the happy face anymore, it's time to get out of the sun.



Not everyone burns at the same rate, and the team took that into account. "We calibrated it based on skin type," said team member Anne François. Their prototypes were made

for the three skin types that are most susceptible to sunburn.

The patch is made with UV-sensitive film bonded to a special tape with medical-grade adhesive that can withstand plenty of trips into the swimming pool. Because it measures total UV exposure, it "knows" when a user applies sunscreen or goes in the shade and darkens more slowly.

The team has filed a provisional patent on their invention and received Best Overall Award in the Invention Disclosure Competition at Michigan Tech's 2013 Undergraduate Expo. If it makes it to market, it would be inexpensive: the prototypes cost only 13 cents apiece in materials.

The UV monitors would be ideal for those wanting to avoid a sunburn and reduce their skin cancer risk while still enjoying outdoor activities, say the students. In addition, parents could use them to monitor their children's UV exposure. The patches could be especially useful in protecting babies' tender skin. They might even have some therapeutic applications for jaundiced babies, who need some sunlight—but not too much.



"There are other personal UV monitors out there, but what makes this one unique is that it's extremely simple and inexpensive," said the team's co-advisor, Megan Frost, an associate professor of biomedical engineering. "It's not a timer. They quantitatively calibrated it to the energy the device absorbs, and it's very robust."

The project has been rewarding, says team member Caroline D'Ambrosio: "It's great to actually make a working product." Other members of the Senior Design team were co-advisor Sean Kirkpatrick, Marie D'Ambrosio and Kelsey Sherman.

## BME EARNS TOP HONORS AT UNDERGRADUATE EXPO

### ENTERPRISE

#### First Place

#### International Business Ventures Enterprise

Team Leaders Evan Beckner, Operations and Systems Management, and Katy Hickey, Biomedical Engineering; Advisors Robert Warrington, Institute for Leadership and Innovation, and Michael Neuman, Biomedical Engineering. The team focuses on three main projects: an infant heart annunciator, a pandemic ventilator, and a mobile health clinic that was transported to Ghana to provide aid to remote villages.

### INVENTION DISCLOSURE COMPETITION

#### Best Overall

#### Ultraviolet radiation, skin-type specific indicator adhesive patch of one minimal erythemal dose

Submitted by Anne Francois, Caroline D'Ambrosio, Marie D'Ambrosio and Kelsey Sherman, Biomedical Engineering; Advisors Megan Frost and Sean Kirkpatrick; Sponsored by the Department of Biomedical Engineering

### SENIOR DESIGN

#### Third Place

#### Attachment and Release Mechanism for Catheter Delivery Device

Team Members Hal Holmes, Jon Juszkievicz, Alex Keim, Michael Lancina, Uziel Mendez, Kyle Mentink, and Will Paces, Biomedical Engineering; Advisor Rupak Rajachar; Sponsored by Medtronic



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