UCSD Jacobs | School of Engineering

FALL 2010

MATERIALS NEWS

UCSD Materials Science and Engineering

NRC Ranks UC San Diego's MSE Program #14 in U.S.

IN THIS ISSUE

UC San Diego's Materials Science & Engineering (MSE) Program was recently ranked 14th in its field nationwide by the National Research Council (NRC) Data-Based Assessment of Research-Doctorate Programs in the United States. The prestigious study consists of an assessment of more than 5000 doctoral programs in 62 fields at 212 U.S. research institutions. The study served as the basis for two illustrative ranges of program rankings of overall quality: regression-based (R) rankings and survey-based (S) rankings. The MSE program received an R-ranking of 14, which incorporates objective data for quality assessment; the program S-ranking was 23, in which perception-based data is emphasized (gathered from faculty surveys). The data-based rankings are determined based on 20 program characteristics including faculty publications, grants and awards; student GRE scores, financial support, and employment outcomes; and program size, time to degree, and faculty composition. In addition, the NRC study ranked UC San Diego as 2nd in the nation amongst all major public universities, behind UC Berkeley.

For additional information on the ranking of various disciplines within UC San Diego, please visit:
http://ucsdnews.ucsd.edu/newsrel/awards/09-28DoctoralPrograms.asp

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FROM THE DIRECTOR

This is the sixth newsletter describing the UC San Diego's Materials Science & Engineering (MSE) Program, and I hope you enjoy reading about education and research activities in our program.

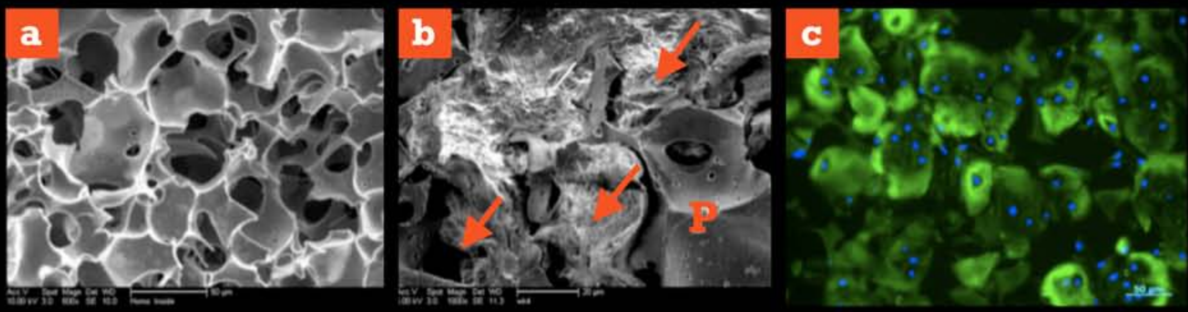
The MSE Program at UC San Diego is a university-wide, highly interdisciplinary program with close to 75 participating faculty members. The professors and students in our program come from various divisions of UC San Diego, including the School of Engineering (departments of electrical engineering, mechanical engineering, structural engineering, bioengineering, and nanoengineering), Division of Physical Sciences (department of physics, department of chemistry and biochemistry), Division of Biological Sciences, the School of Medicine, and the School of Pharmacy.

The strength of our MSE faculty members (which include 7 National Academy of Engineering, 5 National Academy of Sciences, 3 Institute of Medicine members, and recent recipient of the National Medal of Science, our chancellor Marye Anne Fox), combined with one of the highest per-faculty research grants in the nation provides a stimulating environment for our graduate students working toward their Ph.D. degrees. The total number of graduate students in our MSE Program is now approaching 100. UC San Diego's Materials Science & Engineering Program was recently ranked 14th among all Materials Science doctoral programs in the United States by the prestigious National Research Council (NRC) data-based assessment.

To cover more exciting subjects in energy, medical/bio and nanoscale materials in a timely manner, new courses have been added to our curriculum in recent years to rapidly upgrade the education of the students and prepare them well in the changing job market. The latest courses being taught include the "Energy Materials and Applications" class covering materials issues related to solar energy, fuel cells, hydrogen storage, biofuels, batteries, and nuclear energy, and the "Medical Device and Bio Materials" class which covers fundamentals of implant-live cell interfaces, design and fabrication of medical materials and biomaterials essential for functioning and reliability of devices and implants such as coronary stents, catheters, and drug delivery vehicles.

I am always proud of faculty and graduate students in our MSE Program and their accomplishments. With future newsletters, we will continue to share the latest information on academic, research, and career progress of our faculty, students, postdocs, and alumni from our MSE Program.

Sungho Jin
Director, UC San Diego Materials Science & Engineering Program
Distinguished Professor of Materials Science



(a) SEM image of internal fracture surface of cryogel (scale bar = 50μm)

(b) Chondrocytes seeded on PEG cryogels after 4 weeks of in vitro cultivation ("P" represents a polymer network and arrows indicate ECM; scale bar = 20μm)

c) Collagen type II immunofluorescent staining of cell-laden hydrogels after 4 weeks of culture (scale bar = 50μm)

Promising Scaffolds for Cartilage Tissue Engineering

Synthesis and characterization of interconnected macroporous poly(ethylene glycol) cryogels as a cell scaffold for tissue engineering

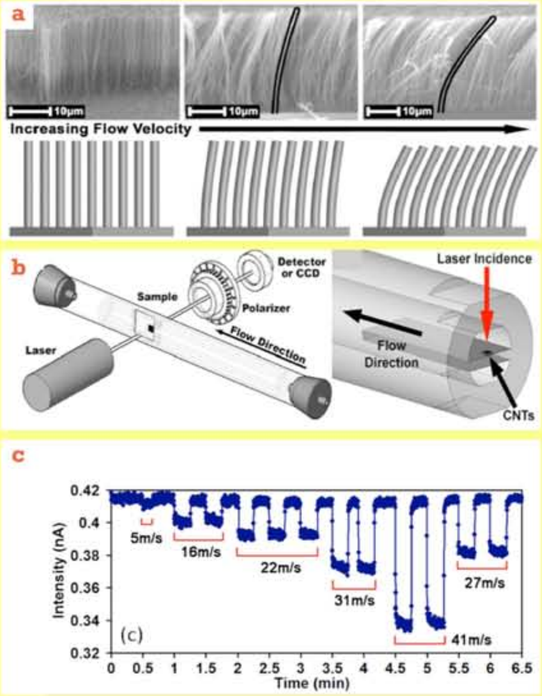
Progressive joint degeneration is a debilitating disease that in past years has affected approximately 50% of adults 65 years or older in the U.S. (Data Source: 2003-2005 NHIS). In spite of much advancement in medicine and total joint replacement, the current treatments for repair of cartilage damage are often less than satisfactory, and seldom restore full function to the tissue. The field of tissue engineering holds great promise for overcoming this problem, and exciting progress has been made by bioengineering and materials science engineering professor Shyni Varghese and graduate student Yongsung Hwang. The group of engineers have synthesized **macroporous networks** of poly(ethylene glycol) (PEG) with interconnected pores having similar chemical composition but distinctly different internal microstructures via cryogelation techniques. Manipulation of polymerization kinetics allows for tuning of their structural and mechanical properties, swelling behavior favoring enhanced mass transport within the network.

Graduate student Yongsung Hwang and his co-authors evaluated the potential application of the networks as a scaffold for cartilage tissue engineering. They demonstrated that PEG cryogels can successfully **support cell attachment and proliferation** over 4 weeks of in vitro culture. The seeded chondrocytes maintained chondrocyte phenotype and secreted cartilage-specific extracellular matrix (ECM), such as glycosaminoglycan (GAG) and collagen, showing their promising application as **scaffolds for cartilage tissue engineering**.

For more information on this research, please see the published articles by Yongsung Hwang, Chao Zhang, and Shyni Varghese, **J. Mater. Chem.** *20, 345 (2010), and by Yongsung Hwang, Nivedita Sangaj, and Shyni Varghese,* **Tissue Engineering Part A**, *16(10), 3033 (2010).*

Modeling the Response of Carbon Nanotube Ensembles to Laminar and Turbulent Fluid Flow

First successful derivation of drag coefficients and bending profiles of CNTs published



(a) The in situ shearing of CNT ensembles, as observed through scanning electron microscopy imaging, was modeled as through the deflection of a cantilever (as depicted in the outline) - (from Battiato et al, Physical Review Letters, 2010)

(b) Schematic of experimental setup for the observation of CNT deflections, due to fluid flow, by monitoring the transmitted laser intensity variations

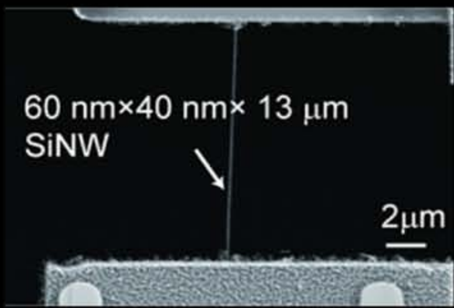
(c) The variations in the transmitted laser intensity, through the CNT ensembles exposed to varying fluid velocities (i.e., 5m/s, 16 m/s, 22 m/s, 31 m/s, 41 m/s, and 27 m/s), as a function of time (from Ni et al, J. Applied Physics, 106, 074304, 2009). The robustness of the measurements is revealed in the digital response to various fluid velocities and return to a reference value when the flow is removed.

Carbon nanotubes (CNTs) have been predicted to possess a remarkable combination of mechanical properties, incorporating high elastic moduli (*E*), reversible bending and buckling characteristics, and superplastic behavior at elevated temperatures. However, in experimental measurements of the properties, while the applied loads and strains can be relatively easily configured and determined, it is not always practical to measure accurately the nanotube cross-sectional area for the calculation of stresses or the moments of inertia (*I*). In this context, for the determination of the mechanical response of nanotubes of varying lengths, subject to different forces, a quantity of interest is the flexural rigidity, *EI*. As the independent determination of *E* and *I* for CNTs can be difficult, Professor Bandaru's group demonstrated a simple optical method to measure the *EI* product value. The flexural rigidity was determined through analyzing the CNT deflection – shown in Figure (a), which was measured as a function of fluid flow induced drag forces, through the blockage of a laser beam by monitoring the transmitted intensity using a photo-detector and CCD camera based image processing – shown in Figure (b). By fitting the experimental observations – shown in Figure (c), to deflections obtained using fluid flow simulations, the *EI* values were determined.

In collaboration with Prof. D. Tartakovsky and his student I. Battiato, Professor Bandaru published an article in *Physical Review Letters*, to yield a firm physical foundation for the obtained results. This paper sheds new light on CNT-fluid flow interactions by treating the CNT ensembles as a porous medium and deriving analytical solutions for a coupled system of the Navier-Stokes and Brinkman equations, which describe flow over and through the CNTs, respectively. In addition to confirming and predicting the CNT deflections and their mechanical properties, the paper was also successful in deriving for the first time, the corresponding drag coefficients and bending profiles of the CNTs.

The predictive and diagnostic capabilities of nanosensors and other nanostructure covered surfaces are often hampered by the relative lack of quantitative understanding of their response to hydro- or aerodynamic loading. By considering the elastic response of CNTs to ambient laminar and turbulent fluid flows, the principle of the published methods can be applied for tactile and shear force sensors, mechanical actuators, chemical filters, and fluid flow sensors.

For more information on this research, please see the published Ilenia Battiato, Prabhakar R. Bandaru, and Daniel M. Tartakovsky, **Physical Review Letters***, 105, 144504 (2010).*



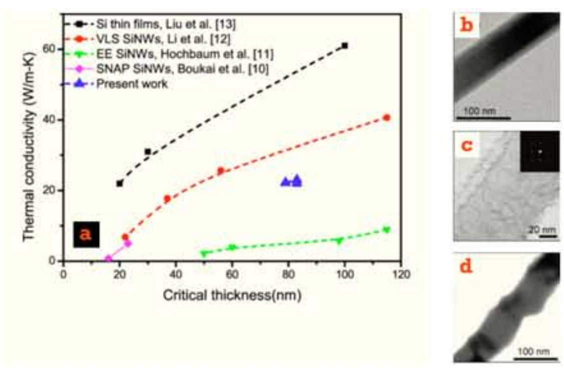
SEM image of a 60-nm-wide, 40-nm-thick and 13-µm-long silicon nanowire.

Converting Wasted Energy into Electricity Using Thermoelectrics

Microdevices with integrated nanowires for investigating low-dimensional phonon transport

Typical heat engines operate at 30 to 40 percent efficiency; the wasted energy is lost to the environment. There is significant interest in developing low-cost thermoelectric materials that can efficiently convert this waste heat into electricity. Phonon transport in nanostructures plays an important role in energy conversion such as thermoelectrics. When the nanostructure feature size is comparable to phonon wavelength, a new regime of heat conduction, coherent scattering of phonons at nanowire boundary, may arise. This may impact thermal energy transport and conversion. Traditional methods used to investigate phonon transport in one-dimensional structures suffer from uncertainty from contact resistance, defects, and limited control over sample dimensions. UC San Diego's new Assistant Professor Renkun Chen (Mechanical and Aerospace Engineering Dept and Materials Science & Engineering Program, formerly a postdoc at UC Berkeley) and co-workers developed a new batch-fabrication technique for suspended microdevices with integrated silicon nanowires (SiNW) from silicon-on-insulator (SOI) wafers by e-beam lithography (EBL). The nanowires are defect-free and have extremely high aspect ratios (length/diameter > 2000). The nanowires can be precisely controlled during fabrication. Using these novel devices, phonon transport in silicon nanowires is systematically investigated. This fabrication technique can also be used for thermal transport investigation in a wide-range of low-dimensional structures.

For more information on this research, please see the published article by Baoling Huang, Kedar Hippalgaonkar, Renkun Chen, Karma Sawyer, and Arun Majumdar in **Nano Letters**, *Article ASAP (2010).*



(a) Room temperature experimental data for confined silicon structures as a function of critical thickness

(b) TEM picture of smooth VLS SiNW

(c)TEM pictures of EE SiNW from 0.1 Ω-cm presented in Hochbaum et. al.11

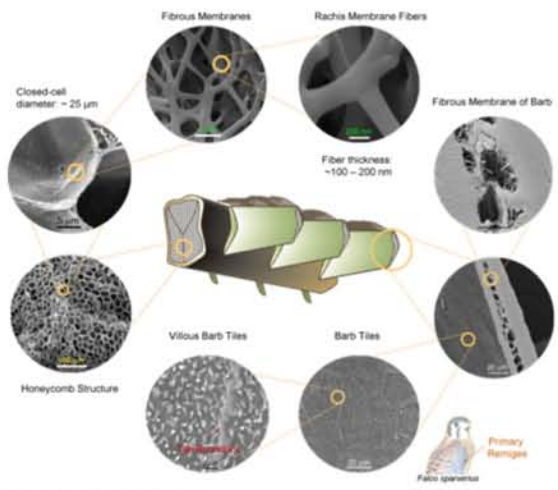
(d) STEM image taken at 30 kV of EBL-based integrated SiNW presented in this work

RESEARCH

Aviariomaterialia: Materials Science is for the Birds

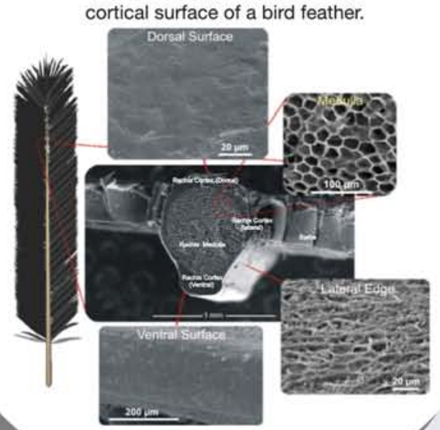
Advanced biomimetics research for an improved understanding of how bird feathers withstand the aeroelastic stresses of flight

Hierarchical structure of bird feathers.



Of the approximately 10,000 species of modern Aves, only about 40 are non-flying; therefore, for most birds the ecological and mechanical competency feathers and other integumentary structures must be balanced with low weight. This can be accomplished by structural and material adaptations. Materials Science & Engineering graduate student Sara Bodde, with her advisor Prof. Joanna McKittrick and collaborators Dr. Yasuaki Seki & James Kiang, has investigated these structural and material adaptations. The flight feathers are the wing and tail feathers, employed for, among other functions, generation of lift and thrust forces during flight. In understanding how something "light as a feather" endures the aeroelastic stresses of flight, the feather is revealed to be a paradigm for several materials science phenomena.

SEM micrographs depicting the structural differences in the cortical surface of a bird feather.



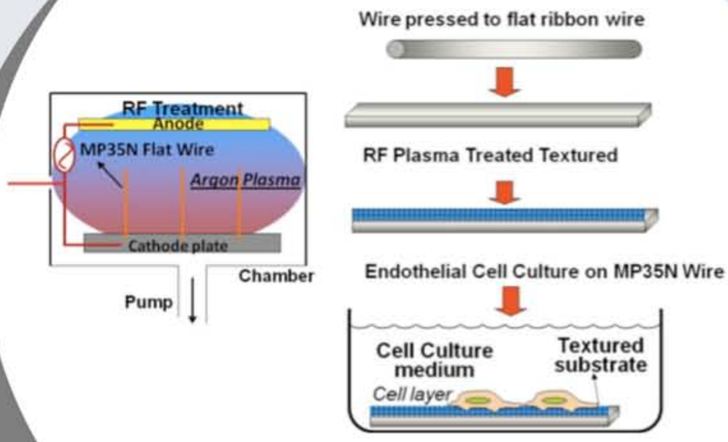
The most obvious attribute is the branching or **hierarchical structure** at macroscale to mesoscale. The primary shaft, or rachis, supports secondary barbs which include tertiary barbules. And these barbules are connected by quaternary hooklets which ensure continuity of the feather vane. The structural hierarchy allows for load at a point of connection, of barb to rachis, for example, to be dispersed throughout the area of the vane. Structural hierarchy implies that failure of the part, such as damage to barbules by ectoparasites, does not necessarily compromise the performance whole or, in this case, flight of the host. And the hierarchy continues into the nanoscale. The cortex of the rachis and barbs are comprised of bundles, measuring 6 – 9 μm in diameter, of supramolecular β-keratin fibers measuring 300 – 500 nm. The bundles are oriented longitudinally in the bulk of the cortex, as in a **fiber-reinforced composite**, and circumferentially at the surface.

The tensile Young's modulus of rachis cortex increases along the length of the feather from the proximal to the distal end, suggesting that cortex is a **functionally graded material**.

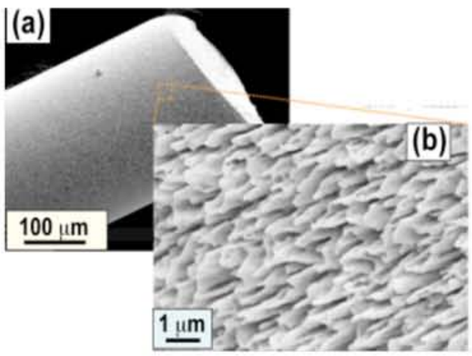
Furthermore, the flight feather is a **sandwich structured composite**. The thin quasi-brittle cortex of the rachis and barbules encloses a thick, low-density medullary core or **cellular solid**. In addition to thermally insulative function, this microstructure reinforces the long flight feathers against Euler buckling. The membranes of the closed-cell foam are fibrous networks, or a secondary cellular network in themselves, woven of the β-keratin fibers.

Cutting-Edge Materials Research: Nanopillar Polymer-"less" Stents

Plasma-induced nanopillars on bare-metal coronary stent surface for enhanced endothelialization



Schematic of the RF treatment chamber (left).
Schematic of experimental procedure (right).



Nanopillars on the stent wire surface

Polymeric drug-eluting stents benefit millions of patients with cardiovascular complications. However, due to the late-stent-thrombosis (blood clotting of the vessel) concerns and lack of endothelialization, or endothelial cell coverage, associated with drug-eluting stents, **bare metal stents** are receiving much attention in recent years. In light of these facts, Mariana Loya and Karla Brammer (MSE graduate students in Prof. Sungho Jin's lab), have been working on demonstrating how endothelial cells are positively influenced by the presence of nanoscale surface texturing of biocompatible metals (Ti) and most recently metal alloys (MP35N). "In the Jin lab, we have created radially emanating metallic nanopillar structures on the surface of MP35N (Co-Ni-Cr-Mo) stent alloy wires using an argon RF plasma processing technique". The plasma processing induced high aspect ratio, vertically aligned pillar type of nanostructure, which is shown to be very useful for favorably stimulating the endothelial cell response in vascular stent applications. Karla comments, "It is critical that the material surface elicit properties that enable full integration of the stent as a part of the vessel wall and facilitate structurally sound endothelialization." Their study shows that the superior endothelial cell growth is also combined with a well organized monolayer formation and improved endothelialization on the MP35N stent alloy nanopillar structure.

In addition, the nanopillar structure with deep grooves in between offers a much increased surface area and adds an important capability for trapping drugs and controlled slow release for therapeutics that minimize restenosis (narrowing of the blood vessel). With the demonstrated significant results, it is believed that these optimistic findings are likely to (i) contribute to new surface design concepts for bare metal stents utilizing nanotechnology, (ii) eventually lead to medical advances toward mitigating stent thrombosis (clotting) and restenosis, and (iii) eliminate the need for polymer modified stent surfaces which could cause unwanted long term health problems.

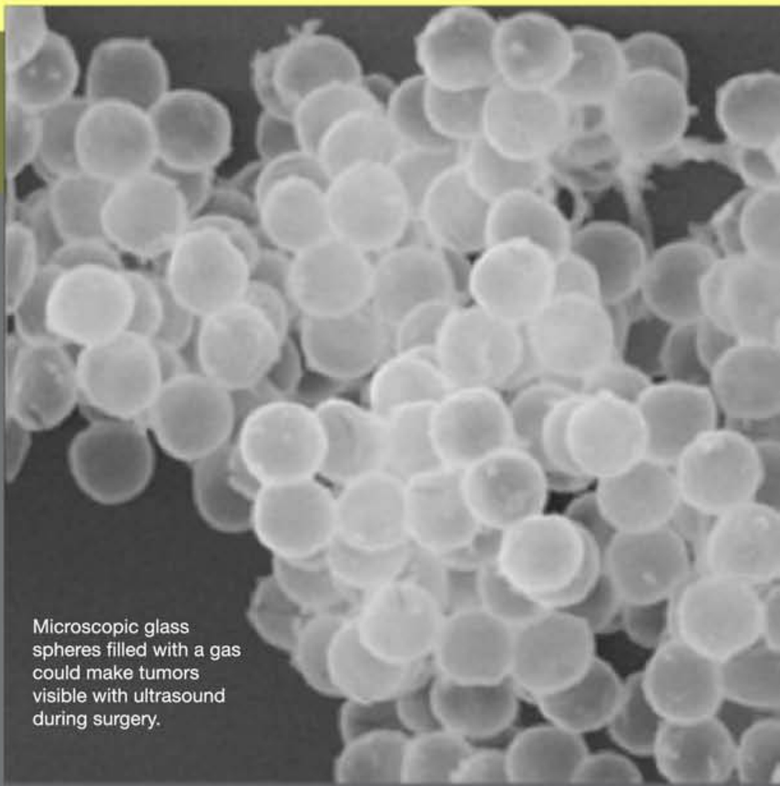
For more information on this research, please see the published article by Mariana Loya, Karla Brammer, Chulmin Choi, Li-Han Chen, and Sungho Jin in **Acta Biomaterialia***, 2010 (In Press).*

Enhanced Ultrasound Imaging Using Gas-Filled Microbubbles

Hard shell gas-filled contrast enhancement particles for colour Doppler ultrasound imaging of tumors

A new material could help surgeons more accurately locate breast cancer by ultrasound imaging. Microscopic gas-filled spheres of silica, a porous glass, can mark the location of early-stage tumors to show their position using ultrasound imaging in the operating room. Chemists Bill Trogler and Andy Kummel, of UC San Diego's Division of Physical Sciences, and radiologist Robert Mattrey (all are also participating faculty members in the MSE Program at UC San Diego), and surgeon Sarah Blair of the Moores UC San Diego Cancer Center led the project, with additional authors.

The X-rays used to make mammograms reveal calcium deposits associated with breast cancer even in tumors too small to be felt. But surgeons can't use X-rays while operating. Instead, radiologists place guide wires into tumors hours or even the day before surgery. The wires don't mark depth well and can shift. Patients find them both uncomfortable and unsettling. As an alternative, the researchers created gas-filled microbubbles made of silica and filled them with perfluoropentane, a gas that has been used before in short-lived contrast materials for medical imaging. Radiologists would be able to inject the durable material days before surgery, and ultrasound scans would reveal the position of the bubbles in three dimensions on the operating table.



Microscopic glass spheres filled with a gas could make tumors visible with ultrasound during surgery.

For more information on this research, please see the published article by H. Paul Martinez, Yuko Kono, Sarah L. Blair, Sergio Sandoval, Jessica Wang-Rodriguez, Robert F. Mattrey, Andrew C. Kummel and William C. Trogler, in **Med. Chem. Comm.** *1, 266 (2010).*

Ford Foundation Predoctoral Fellowship

Maria Isabel Lopez Fierro, a second year Ph.D. student in the MSE program from Prof. Marc Meyer's group, received the Ford Foundation Predoctoral Fellowship administered by the National Research Council of the National Academies. Through their fellowship program, the Ford Foundation aims to increase the diversity of the nation's college and university faculties by encouraging a more diverse population of predoctoral individuals who have shown academic excellence and commitment to careers in teaching and research. Maria Isabel's research is currently focused on understanding the biomineralization and development of the abalone shell and biomimetic research.

More Information: sites.nationalacademies.org/pga/fordfellowships

2009 2010 MSE STUDENT AWARDS

NSF Graduate Research Fellowship and National Defense Science & Engineering Graduate Fellowship

This past year, a MSE student **Laura Connelly** was awarded the prestigious National Science Foundation Graduate Research Fellowship (NSF GRFP) and the National Defense Science & Engineering Graduate Fellowship (NDSEG). Both fellowships are considered among the most selective and sought after funding opportunities for graduate students in the fields of science and technology. Laura, now starting her third year as a graduate student, was selected by the Navy within the Department of Defense (DoD) from over 2,600 applicants for the NDSEG. The DoD is "committed to increasing the number and quality of our nation's scientists and engineers," and is "a highly competitive, portable fellowship that is awarded to U.S. citizens and nationals who intend to pursue a doctoral degree in one of fifteen supported disciplines" in science and technology. Similarly the NSF GRFP aims to "ensure the vitality of the human resource base of science and engineering," and "recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based matters and doctoral degrees at accredited United States institutions." Her research focus is on biological materials and bio-AFM (jointly supervised by Professors Eduardo Macagno, Ratnesh Lal and Sungho Jin). More Information: ndseg.asee.org and www.nsfgrfp.org

Siebel Scholars Award

Karla Brammer, a fifth year Ph.D. student in the MSE Program under Prof. Sungho Jin, is among this year's recipients of the prestigious Siebel Scholars award, which recognizes the most talented students at the world's leading graduate schools of business, computer science, and bioengineering in their final year of studies. She earned her award with her exploratory biomaterial research focusing on how to influence cell behavior and cell responses via nanostructured substrates and nanoscale biomaterials. "My most rewarding work has been in the investigation of novel approaches for improving surface features on orthopedic implants made of titanium in order to rapidly form bone at the surface in order to get patients 'back on their feet' as soon as possible." Her academic performance, stellar research capabilities, and leadership in the biomaterials field have given her the opportunity to join in the Siebel Scholars lively community, a community that actively works to find solutions to society's most pressing problems. "It is truly an honor to be named a Siebel Scholar. This award helps me to enable the acceleration of scientific exploration, driving to discover and develop improvements to the human condition and the world around us." More Information: www.siebelscholars.com

Global Research Collaboration Graduate Fellowship

Wilhelm Melitz, a fourth year Ph.D. student in the MSE program from Prof. Andrew Kummel's group, recently received a Global Research Collaboration (GRC) Graduate Fellowship towards a Ph.D., with Applied Materials, Inc. as a company sponsor. The Graduate Fellowship Program (GFP) addresses the issuesof improving educational opportunities at the doctoral level and supplying a relevantly educated workforce for the semiconductor industry. The objectives of the program are: 1) to encourage academically gifted U.S./permanent resident students to pursue doctoral degrees in research areas consistent with SRC program goals, and 2) to develop a cadre of the highest quality doctoral graduates for member companies and U.S. universities. Wilhelm's research focuses on semiconductor surface and interfaces for alternative materials to silicon, part of the efforts of the Global Research Collaboration (GRC). The GRC involves both industry and academics research efforts for both basic research and product development. Wilhelm Melitz's research includes process development for growth of High-k dielectrics on high mobility substrates with the goal of improved performance scaled MOSFETS. More Information: www.src.org

2009 Abe Hurlich Award

Sara G. Bodde, a Ph.D. candidate in the MSE program of Prof. Joanna McKittrick's group, received the 2009 Abe Hurlich Award at the recommendation of Prof. Marc Meyers. The Abe Hurlich award, which includes a $1200 scholarship and a one-year ASM membership, is presented to a local chapter student of materials science for research, leadership, and service in the memory of a past local chairman and presi-dent of ASM International after whom the award is named. She was presented the award and certificate by Hussam Jarmakani (left), ASM San Diego Chapter Chair 2010 and UC San Diego MSE alumnus. At the reception, Sara presented an overview of her work on mechanical and structural properties of avian appendages at the ASM San Diego meeting in May. MSE Prof. Prabhakar Bandaru, who was the invited speaker, also delivered an engaging talk on thermoelectric materials at the event.

More Information: www.databack.com/sandiego

MSE ALUMNI & NEW STUDENTS

MSE Alumnus Turned Archaeologist National Geographic's 2009 Adventurer of the Year

Upon graduation from the MSE program in 2008, Dr. Albert Yu-Min Lin embarked on a unique journey as research scientist of the "Valley of the Khans Project" at UC San Diego's California Institute for Telecommunications and Information Technology (Calit2), an endeavor which utilizes cutting-edge tools and materials analysis techniques to search for the tomb of Emperor Genghis Khan. As Principle Investigator of the project, Lin has led multiple high-tech expeditions into remote areas of northern Mongolia. What makes Lin's archaeological quest unique is that his entire search is performed without ever breaking ground – out of respect for the Mongolian people who believe that disturbing a tomb will trigger the end of the world. Consequently, the researchers analyze the ground using tools such as satellite imagery, ground penetrating radar, magnetometers, electromagnetic inductors, and remote sensors, which enable them to make archaeological discoveries without disrupting the environment.

When asked how his doctoral degree in materials science and engineering studying structural and functional biomaterials, in particular abalone nacre and abalone foot adhesion, led to a position as leading investigator on an archaeological hunt, Lin replied, "What I learned in materials science, which I have applied here, is that you can't always touch what you are trying to study. You have to find ways to gain information, visualize the information, and come up with theories about that information without actually physically being able to touch it. In our case it is the same thing. We aren't able to dig for what we're looking for, so we are trying to find non-invasive ways to do this survey." He likened the tools which their researchers use to scan through the earth (i.e. ground penetrating radar) to tools which are common to materials scientists, such as the scanning electron microscope and atomic force microscope. In both cases, the tools make use of the interaction of energy with a material (whether it be radar with the matrix of the earth or electrons with carbon nanotubes) in order to gain information about the material and map it into something that we can interpret. The essential detail which makes the two fields and their tools unique is the scale of the material being analyzed – in materials science it is often on the nanometer scale, whereas in Lin's case it is on the scale of meters. The direction that Lin's research has taken is a key example of the interdisciplinary characteristics of the field of materials science. He is an inspiration to current MSE graduate students, proving that the knowledge and skills of a materials scientist can be applied in the widest variety of fields, even one as unexpected as archaeology.

This research project recently earned Lin the 2009 National Geographic Readers' Choice Adventurer of the Year.

For more information please visit exploration.nationalgeographic.com/mongolia.

WELCOME 30 NEW GRADUATE STUDENTS

Andersen, Laura Michelle (Univ. of Washington)

Chen, Yi-che (National Chiao Tung Univ.)

Cho, Hyung Man (Pusan National Univ.)

Chowdhury, Sarah (UC Los Angeles)

Chu, Yinghao (Hong Kong Univ. of Science and Technology)

Garton, Kyle (UC Berkeley)

Harkema, Renee Andrea (North Carolina State Univ.)

Hsu, Felix (Duke Univ., Boston Univ.)

Jang, Sooyoung (Korea Univ.)

Kent, Tyler James (UC Santa Barbara)

Kim, Sanghoon (Konkuk Univ.)

Kuru, Cihan (Balikesir Univ.)

2010 Graduate Student

Meet & Greet

At the annual MSE Meet & Greet on September 22, new and continuing graduate students gathered with professors for a casual info session, food, and team building exercise. Some photos from the event, courtesy Irene Chen, show students' efforts to build the tallest structure holding a penny on top, using straws and a limited amount of scotch tape. The new graduate students of the winning group received last year's MSE T-shirt.

Kwok, Jeanie (UC San Diego)

Li, Sarah Yun-yun (Calif. Institute Tech)

Liberman, Alexander (UC San Diego)

Liu, Yu-hsin (Tsing Hua Univ.)

Lutz, Oliver Tim (Cornell Univ.)

Marquez, Andrew ((UC Irvine)

Mcgilvray, Thomas (Univ. of Florida)

Menon, Naveen Gopakumar (Princeton Univ.)

Mo, Alexander (Stanford Univ., Johns Hopkins Univ.)

Nguyen, Phi-khanh (Rutgers Univ., Univ. of Manchester)

Park, Jun Hong (Hanyang Univ.)

Stout, Samantha (Imperial College London, Cornell Univ.)

Su, Alvin W. (Chief Resident Orthopedics, Taipei Veterans General Hospital)

Sukrittanon, Supanee (Chulalongkorn Univ.)

Um, Kimoon (Seoul National Univ.)

Uychaco, Liakatrina (UC Berkeley, UC San Diego)

Villwock, Diana Maria Edith (Johannes Gutenberg Univ., UC Los Angeles)

Zhao, Chao (Beijing Univ. of Aeronautics and Astronautics)

New MSE FACULTY





From left to right:
Renkun Chen (Department of Mechanical & Aerospace Engineering)
Thermal transport, fundamental heat transfer science and engineering at the micro and nano scale, and thermoelectric materials and devices for energy conversion, storage and management.

Shaochen Chen (Department of NanoEngineering)
Biomaterials, biofabrication, nano-regenerative medicine, laser nano-manufacturing, nanophotonics, plasmonics, metamaterials, and bio and nano mechanics.

Ratnesh Lal (Department of Mechanical & Aerospace Engineering, Bioengineering)
Nanobiotechnology, multidimensional biological AFM imaging, ion channel biophysics and nanomedicine.

Dan Sievenpiper (Department of Electrical & Computer Engineering)
Electromagnetics, metamaterials, conformal and steerable antennas, nano-engineered artificial materials.

Oleg Shpyrko (Department of Physics)
Condensed matter physics, coherent X-ray scattering, behavior of materials in nanoscale confinement, physics of liquid surfaces, and magnetic domains.

We would love to hear the achievements and milestones from the UC San Diego Materials family that comprises students, alumni, faculty, visiting scientists and staff for inclusion in our next newsletter.

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ABOUT THE COVER IMAGES
THE IMAGES ON THE COVERS ARE SCANNING ELECTRON MICROGRAPHS OF THE NANOPILLAR TEXTURED STENT WIRE FROM THE ARTICLE ON PAGE 7 AND THE MACROPOROUS PEG CRYOGEL SCAFFOLD FROM THE ARTICLE ON PAGE 3.

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