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DAY 3
WEDNESDAY, APRIL 15

Day 3 of the 2009 Materials Research Society (MRS) Spring Meeting contained a full slate of technical sessions, a number of events and activities in the Exhibit Hall, the Plenary Session, and more.

Much of the day's activities centered around a theme -- "**Materials for the Developing World: Promising Solutions to Developing-World Challenges**". The Symposium X talks as well as the Plenary address illuminated the special needs and opportunities for materials-related activities in underdeveloped areas of the globe.

Teri Odom receives the MRS Outstanding Young Investigator award from MRS president Shef Baker

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WEDNESDAY SPOTLIGHT -- MATERIALS FOR THE DEVELOPING WORLD

Promising Solutions to Developing-World Challenges

The Wednesday Spotlight was created to illuminate the special needs and opportunities for materials-related activities in underdeveloped areas. Highlights included:

Product Showcase

A special section within the MRS Exhibit showcased products and activities -- bamboo bicycle frames, sustainable approaches to water purification, and a unique high-throughput recycling business aimed at reducing landfill size -- that offer promising solutions to developing world challenges.

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Symposium X: Richard LeSar

Richard LeSar
Iowa State University
Teaching Appropriate Technology in the Developing World: Educating Engineers in 21st Century Challenges

Over one sixth of the 6.7 billion people in the world today live in extreme poverty, with incomes less than a dollar a day. By 2050, the world will contain about nine billion people. As part of the Wednesday spotlight, Materials for the Developing World, Richard LeSar in his Symposium X presentation, asked how can engineering help lead to a world with equitable and profitable economies by 2050?

LeSar with Mark Bryden at Iowa State University have found one way—educating engineering students about appropriate technology and sustainable engineering in developing countries. In 2006, Bryden traveled to Mali—a country in western Africa—and saw a need for lighting systems and stoves. This initial contact led first to a graduate research program, but quickly evolved into a study-abroad opportunity, MatE/ME 389, which is open to all undergraduate students at ISU. Project based, the program has four main goals: (1) to introduce students to appropriate technology; (2) to provide the students with challenging engineering problems that are constrained by available resources; (3) to create an unbrokered educational experience; and (4) to make a difference in the lives of rural Malians. An overarching goal of the class is to have students think differently about engineering and themselves as engineers.

As one example, Malians typically cook over a three-stone open fire, using biomass for fuel, which is inefficient, smoky, and dangerous in their homes.

The students worked with villagers to assess their needs, limitations, and available resources. Together they designed stoves out of straw and clay. Straw and mud bricks provided the structure and insulating properties, and clay from termite mounds served as the facing material, which has a fine structure controlled by what termites can carry to the mound. They optimized parameters such as the spacing between stove and pot, and holes for the fuel, creating a more efficient stove, reducing fuel needs and emissions. While Villagers did not want the stoves at first, soon there was a waiting list.

A focus of the class is to avoid "drive-by" engineering, in which technologies are introduced into a developing country without a plan to sustain them. Rather, the class focuses on continued involvement for each project. To that end, technologies are developed in classes at ISU, taken and implemented in Africa, after which an assessment is made, which may lead to further development.

Symposium X: Scott M. Lacy

Scott M. Lacy
Emory University
Cross-Cultural Engineering: Science, Hybridity, and the Human Experience

"One finger cannot lift a stone." - Malian saying

Scott M. Lacy is an anthropologist at Emory University who has spent a lot of time in a village named Dissan in Mali. Complementing the first symposium X talk, Lacy presented a different perspective on his experience as well as what he believes cross-cultural engineering will bring to scientists. Lacy first moved to Dissan as a Peace Corps volunteer. Subsequently, several years ago, he started working with leaders from UC Santa Barbara's Engineer's Without Borders. He conducted interactive workshops with student engineers preparing for an international service project. As he began to understand the immediate,

high-impact potential that engineering brings to the "developing" world, he began to see his engineering collaborators as long-lost cousins of his Mali blacksmith friends...among others.

When an Engineers Without Borders team proposed a collaborative project with his Malian host community and his non-profit organization

(www.africansky.org), he embraced the opportunity to unite a group of young engineers and their mentor with their improbable counterparts in Dissan. In an anthropologist's dream, he found himself betwixt a host of high priests (a.k.a. experts) divided by their indoctrination into one of two rather exclusive and powerful, traditional knowledge systems: science and what Malian blacksmiths and hunters call knowledge-of-the-trees.

Several years have passed since he first witnessed the transformative power of cross-cultural engineering, and now he cannot imagine his research, his teaching, his life, or even Mali without it. Collaboration across cultural and technical boundaries has inspired Lacy to live and breathe within the nexus of science-based engineering and other "traditional" knowledge systems because he has seen this dynamic approach produce/generate sustainable, locally salient solutions to alleviate suffering and diminish inequality at home and abroad. He has become a bridge-maker for creative scientists and innovative local populations who are combating endemic poverty throughout the world.

He concluded by saying that his time and experience in Mali changed him, for the better. He urged scientists and engineers considering spending time in a place like Mali to do this not for the "developing world" but rather as being important for us and for the world.

Plenary Session and Plenary Talk

Walter Kohn
University of California Santa Barbara
The Power of the Sun

Plenary Session

The major event of the day was the plenary session in the evening. First, MRS president Shefford Baker welcomed everyone. He told the packed room that they had the privilege to be present at the largest MRS Spring Meeting ever, with over 5000 people in attendance. He also emphasized the strong quality of science represented at the Meeting.

MRS Past-president Cynthia Volkert recognized the Meeting Chairs, Paul Besser, Peter Fratzl, Nicola Spaldin and Terry Tritt, for their efforts in organizing this successful Meeting.

Shefford Baker then recognized the officers of the Society. He mentioned some recent MRS initiatives. He also mentioned the new Editor-in-Chief of the *Journal of Materials Research*, Gary Messing. He also mentioned the upcoming joint MRS-Mexican MRS conference in Cancun. Then, the 51st MRS student chapter at the California Institute of Technology was inducted. Also, the efforts of V.S. Arunachalam for the special *MRS Bulletin* issue on Energy were specially recognized. Baker also noted the new group of MRS Fellows.

MRS Secretary Linda Horton then listed all the graduate student award gold and silver winners, as the students received their awards from president Baker.

Finally, the 2009 MRS Outstanding Young Investigator award was presented to Teri Odom of Northwestern University.

Plenary Talk: Nobel Laureate Walter Kohn

The plenary talk continued with the theme of "Materials for the Developing World" on Wednesday. The plenary presentation by Prof. Walter Kohn, Nobel Laureate, of the University of California, Santa Barbara, at this Meeting was

different from previous meetings in that the major focus was a film, "The Power of the Sun" for which Kohn is the executive producer. Prof. Walter Kohn is the recipient of the 1998 Nobel Prize in Chemistry (along with John A. Pople) for developing density-functional theory. Kohn initially gave a few introductory remarks. He said that he was very pleased with the theme of materials for the developing world at this conference, though it should be noted that we are all in "the same place" in spite of the distinction between "developed" and "developing." The film was made in 2005 on a double anniversary, the 100th anniversary of Einstein's miracle year, when one of his significant papers proposed light quanta, and the 50th anniversary of the development of the solar cell at Bell Laboratories. The film was then shown to the packed room.

[View Excerpts | Film Website]

The film, focusing on solar energy and narrated by British actor John Cleese, presented the history of our understanding of light itself, from the initial wave hypothesis to the current wave-particle dual nature of light. It traced the history of the development of the solar cell beginning at Bell Labs. in the U.S. The latter half of the film focused on the present scenario and the ever expanding use of solar energy through the world. The film reiterated how solar energy is clean, sustainable and environmentally friendly. In addition to the widespread use of silicon technology, it also discussed other possibilities including organics. While challenges in large-scale adoption of the technology are large, the film showed the success of solar energy in Japan and Germany, as examples to emulate in other countries. One of the big advantages of solar energy is the possibility of electricity in developing countries and, particularly, remote locations within such countries which are entirely off the power grid. It is possible to bring inexpensive and easily generated power to such places allowing for improvements in the quality of life.

After the film was screened, lasting about an hour, Kohn presented a few additional remarks. He mentioned the peak of per capita oil production in the world as perhaps occurring in 2030 after which it is likely to drop very quickly. We must ensure alternate energy supplies for humans and develop the appropriate technologies before then. He said that he hopes energy will be dominated by wind and light, and that he hopes this group (of materials scientists and engineers gathered at the MRS Spring Meeting) will make it happen. One specific way might be a better understanding of interfaces and the capability to tailor them. Kohn then fielded questions from the audience.

GRADUATE STUDENT AWARD WINNERS

Below are the winners of the Gold and Silver Graduate Student Awards.

Gold Award Winners

(Left to right): Magnus Johssan, Bishnu Khamal, Ayse Asatekin Erik Garnett, Matthew Bierman

Silver Award Winners

FRONT: (Left to right): Xiaolong Luo, Kelly Burke, Candace Chan, Jian Shen
BACK: Darren Lipomi, Sinan Keten, Bahman Hekmatshoar, Purushottam Kumar

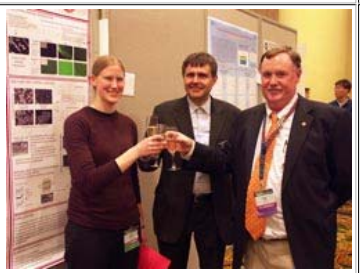
POSTER AWARDS

The following poster authors were presented with Outstanding Poster Awards at Wednesday night's poster session.

(Author unavailable for photo.)

M5.18
Enhanced Conversion Efficiency of GaAs Photovoltaics Utilizing Anti-Reflective Indium-Tin-Oxide Nano-Columns
Chia-Hua Chang1, Peichen Yu1, Min-Hsiang Hsu2, Ching-Hua Chiu1 and Hao-Chung Kuo1; 1National Chiao-Tung University, Hsinchu, Taiwan; 2National Tsing-Hua University, Hsinchu, Taiwan.

EE9.15
Modal Decomposition of Surface Plasmon Whispering Gallery Resonators
Ernst Jan R. Vesseur1, F. Javier Garcia de Abajo2 and Albert Polman1; 1Center for Nanophotonics, FOM Institute for Atomic and Molecular Physics (AMOLF), Amsterdam, Netherlands; 2Instituto de Óptica - CSIC, Madrid, Spain.



KK5.18
The Effect of Silk Fibroin Hydrogels, Peptides, and ß-chitin on Calcium Carbonate Crystallization: A Synthetic Model for Nacre Formation.
Ellen C Keene1, John S Evans2 and Lara A Estroff1; 1Material Science & Engineering, Cornell University, Ithaca, New York; 2Laboratory of Chemical Physics, New York University, New York City, New York.

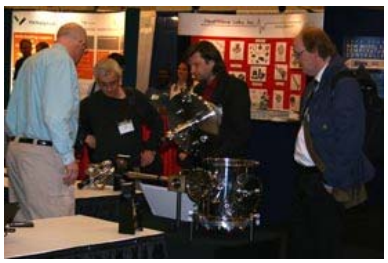
TECHNICAL SESSIONS

Symposium A: Amorphous and Polycrystalline Thin-Film Silicon Science and Technology

NeoSilicon Materials

NeoSilicon is a novel functional material consisting of an ensemble of nanocrystalline Si quantum dots with controlled dot size and inter-dot distance. In his talk in symposium A, Shunri Oda (Tokyo Institute of Technology, Japan) described the preparation of monodispersed Si nanocrystals quantum dots and their assembly, as well as the transport and optical properties of NeoSilicon. The bandgap of NeoSilicon can be controlled by dot size due to the quantum size effect, while the transport properties can be controlled by the inter-dot distance due to the tunneling effect. Spherically shaped Si nanocrystals were formed by plasma decomposition of silane gas in a plasma cell, extracted from the plasma cell through a small orifice due to the pressure difference and then deposited on a substrate at room temperature. These features are ideal for deposition of NeoSilicon onto large area, flexible substrates. The surface of each Si nanocrystal is readily covered by its natural oxide or nitride, which serves as an ideal potential barrier and tunneling barrier with very high quality interface. The thickness of the surface layer determines the transport properties. The NeoSilicon materials show unique characteristics including Coulomb blockade, visible luminescence, and high-efficiency electron emission. Oda concluded by suggesting

that surface modification plays a key role in assembly and electron transport. Also, Si nanodots appear to be very promising for TFTs and photovoltaics.



Symposium I: Engineered Multiferroics -- Magnetoelectric Interactions, Sensors, and Devices
Magnetoelectric Multilayer Capacitors

N.D. Mathur (University of Cambridge, UK) described the development of inexpensive multilayered capacitors, which has been labeled "the one-cent capacitor." The speaker's group recently showed that industrially manufactured multilayer capacitors (MLCs) based on $BaTiO_3$ display strain-mediated magnetoelectric effects because their electrodes nowadays contain nickel as it is cheaper than the Ag-Pd alloy it replaces. The focus there was on the electrical response to a magnetic field. In addition, Mathur described the magnetic and elastic response of these capacitors to an electric field. He also reported on a.c. magnetoelectric effects in MLCs. An interesting aspect of this work is the development of an undergraduate practical based on the magnetoelectric sensor, which can be used to explore ferroelectricity, ferromagnetism, magnetostriction, magnetoelectric coupling, piezoelectricity, and pyroelectricity by just using a mounted MLC, a multimeter, and a magnet.

Symposium Q: Materials Science of Water Purification
Iron Oxide Nanostructured Materials in Water Treatment

Maria M. Fidalgo de Cortalezzi (Buenos Aires Institute of Technology, Argentina) described the use of nanostructured iron oxide in water treatment. Iron oxides are low cost and well-studied materials that have been applied extensively in traditional water treatment processes such as coagulation. Now, the availability of these materials in the nanoscale has made them interesting for a wider array of applications. In recent years, the speaker's work has focused on the investigation of iron oxide nanoparticles as base materials for the fabrication of new devices and processes for drinking water treatment. Iron oxide nanoparticles were used as the precursor for high specific surface area ceramics. Their adsorption properties for arsenic and other heavy metals were studied in a variety of conditions and water matrixes, and the material was characterized extensively. Based on this, the researchers have developed a low cost arsenic adsorbent device tailored for application in rural and remote areas with minimum requirements. A membrane-adsorbent reactor was also designed to more efficiently use the material for applications of high water demand such as municipalities.

Water samples from naturally arsenic contaminated groundwater in the Buenos Aires province in Argentina were used to perform field tests of the systems. The study showed that the good performance observed in artificial arsenic solutions was maintained for the natural samples and allowed for a preliminary cost assessment of the technology. The iron oxide ceramics were also investigated as ultrafiltration membranes. Retention and fouling potential of different organic macromolecules were measured. Work in this area focused on the evaluation of new cleaning methods for the ceramics through degradation of the adsorbed foulants by Fenton type reactions. Cleaning of the fouled membrane with Fenton reagent recovered 100% of the initial membrane permeability, with no detectable membrane material loss.

Symposium BB: Material Systems and Processes for Three-Dimensional Micro- and Nano-Scale Fabrication and Lithography
Dynamic patternable hydrogel composites

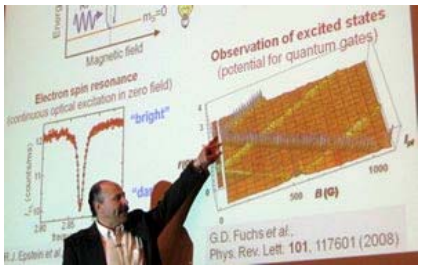
While many elegant technologies have been developed for creating three-dimensional (3D) patterns with soft materials for tissue engineering, most of these methods produce structures that cannot evolve with the changing requirements of biological systems. To address this limitation, Prof. Sarah Heilshorn and her group at Stanford University have developed a dynamic-hydrogel 3D patterning approach based on layered

spatial deposition of chemically cross-linked, biodegradable polymers. By arranging polymers with widely differing and controllably tuned degradation rates within a single composite, patterns can be triggered to emerge over time in response to biologically relevant enzymes. When the degradation fragments are smaller than the hydrogel pore size, internal voids evolve within a well-sealed hydrogel with both spatial and temporal resolution. Material released during pattern formation was additionally modified to serve as drug delivery vehicles. These scaffolds could also provide a means to enable "two-way" communication between cells and engineered biomaterials, or provide cells with a dynamic environment that can respond to fluctuations in cell and tissue biochemistry.

Symposium FF: Novel Materials and Devices for Spintronics
Manipulating Single Spins and Coherence in Semiconductors

"Semiconductors are like people. It's the defects that make them interesting!"

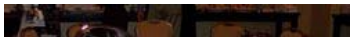
Recently, diamond-based materials have recently emerged as a unique platform for quantum science and engineering. Spins of single nitrogen-vacancy (NV) color centers in diamond can be imaged, initialized and read-out optically at room temperature, and measurements show remarkably long room temperature electron spin coherence times well into the microsecond regime. In his talk in symposium FF, D. D. Awschalom (University of California, Santa Barbara) described the coherent control and coupling of single spins in diamond. He said that while the value of a (gem) diamond was based on the four Cs (color, clarity, carat, and cut), the value of diamond for spintronics was based on coherence, control, communication, and coupling.



Using magneto-optical imaging and electron spin resonance (ESR) measurements, single NV center spins that are coupled to electron spins of nearby nitrogen (N) defects were investigated. Some of the NV centers are strongly coupled to only one single N spin, allowing the controlled polarization and readout of this single `dark' N spin with remarkably long lifetimes. Also, room temperature coherent control of the NV center spin using optical detection of pulsed ESR and spin echo techniques was shown. Diamond was also used to study the coherent dynamics of a single central spin coupled to an adjustable bath of spins. These experiments revealed that both the internal interactions of the bath and the coupling between the central spin and the bath can be tuned in situ with an applied magnetic field, allowing access to regimes with surprisingly different behavior. Combining these elements with precise implanting techniques paves the way toward future devices based on the quantum coherent control of multiple coupled spins in diamond.

WOMEN IN MATERIALS SCIENCE AND ENGINEERING BREAKFAST

Wednesday morning opened with the Women in Materials Science and Engineering Breakfast, featuring speaker Gregg A. Zank, who is Vice President, Chief Technology Officer, and Executive Director of Science and Technology at Dow Corning Corporation. Basing his presentation on Dow Corning's success, Zank talked about the many ways materials enable various industries, including the electronics industry and the photovoltaic industry. Both provide "huge materials challenges with exciting opportunities at the same time," he said. These challenges lead to career paths that require new collaborations and the ability to bridge across multiple disciplines. Zank ended his presentation with some advice on career advancement: Find what you like doing, then figure out how to get paid for it, he said. Balance management and technology as well as balance work and home-life. While some may be tempted to focus on what they can "do better" than their boss, Zank said he has focused on and learned from what his boss could do better. And timing is everything, he said: Typically, when companies offer an employee a new opportunity, they are investing in the employee for a broader goal. He has heard one CEO say that, during the course of his career, the only opportunity he turned down was one he has already done.




The Women in MS&E Breakfast is organized by the MRS Public Outreach Committee and sponsored by Aldrich Materials Science.

GOVERNMENT FUNDING SEMINARS

MATERIALS SUPPORT AT THE NATIONAL SCIENCE FOUNDATION
NSF Division of Materials Research Races Forward

From the Division of Materials Research (DMR) within the National Science Foundation, Zakya H. Kafafi's motif is that "we cannot afford to 'move' [forward], we need to race." With an additional $3 billion going to NSF from the recently passed American Recovery and Reinvestment Act (ARRA), on top of the FY2009 appropriations of $6 billion, NSF now has a substantial amount of funding to race out the door in FY2009. Kafafi, who directs DMR, itemized the Foundation's priorities. She said that $2.5 billion will go to Research and Related Activities and $100 million to Education and Human Resources. The Academic Research Infrastructure Program, which has been dormant since 1996, will now receive $200 million. Major Research Equipment and Facilities will receive $400 million to accelerate construction of major research facilities with unique capabilities at the cutting edge of science. A new program, called the Professional Masters Science Program, will receive $15 million.

Emphasis is being given to fund individuals in early career, and Partnerships for Research and Education in Materials (PREM) will expand to institutions primarily serving women and individuals with disabilities. DMR also has an international focus. The next "MRSECs" will expand activities to the international arena and the cyber infrastructure will be developed between research and education centers. DMR is continuing its Materials World Network. Among the many research topics supported by DMR, Kafafi described the SOLAR initiative and plans to support site-independent Coherent Light Sources.

ABOUT THE MEETING SCENE

The Meeting Scene e-mails are edited by Dr. Gopal Rao, Web Science Editor, and compiled by Bob Braughler, Web Manager, MRS.

Contributions by Gopal Rao, Bob Braughler, Betsy Fleischer and Judy Meiksin of MRS, and Anne Stockdale of Iowa State University

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