MRS/MRS-Mexico Inaugural Joint Meeting Held in August 2009

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The **XVIII International Materials Research Congress (IMRC)** was held in Cancun, Mexico, on August 16–20, 2009, with six symposia organized jointly by the Materials Research Society and the Sociedad Mexicana de Materiales (MRS-Mexico) to complement the 17 IMRC symposia organized by MRS-Mexico. The president of MRS-Mexico **Luis Enrique Sansores Cuevas** of the Universidad Nacional Autónoma de Mexico (UNAM), Mexico, and former MRS president **Alan J. Hurd** of Los Alamos National Laboratory, USA, chaired the Meeting. In the welcoming ceremony, Sansores Cuevas welcomed the attendees and noted the growth of the IMRC with the present Meeting including 1625 presentations from researchers representing 44 countries. Hurd said that the close ties between the two Societies bodes well for materials research, not just for North America, but globally.

The opening ceremony featured Jose Antonio de la Pena, Deputy Director for Science at the National Council for Science and Technology (CONACyT), Mexico, as the special guest of honor. CONACyT is a major research funding organization in Mexico. He said that in Latin America, Mexico is second only to Brazil in scientific research by most measures. He described special programs sponsored and encouraged by CONACyT including various thematic networks and the Mexicans Abroad Network. The latter encourages the integration of Mexican researchers working abroad with Mexican universities. He also described the latest initiatives including the call for new topics for thematic networks, a new call for proposals for 10 new laboratories, and the Collaboration in the Americas in Materials (CIAM).

During the opening ceremony of the **XVIII International Materials Research Congress (IMRC)** held in Cancun, Mexico, in August 2009, **Pedro Hugo Hernández Tejeda** (right) of the conference organizing committee presents a special award of appreciation to **Alan J. Hurd** (former president of MRS and co-chair of IMRC), with MRS-Mexico president and conference co-chair **Luis Enrique Sansores Cuevas** in the foreground.

Special Forums

MRS and MRS-Mexico, both concerned with energy and water, co-organized forums to address each topic. Among the many issues discussed in the Energy Forum was the role of nanomaterials in energy conversion and storage. While many solid-state materials are capable of storing hydrogen, in many cases, this storage is not reversible within the required range of temperatures and pressures for commercial applications. Nanomaterials may aid this barrier by increased storage kinetics, capacity, and reversibility, as well as enabling rapid heat transfer involved in phase transitions. Free-standing nanostructured films are strong candidates for controlled storage materials. S. Mao of the University of California, Berkeley, USA, spoke about his group's work on developing composite nanomaterials for storage of hydrogen based on ultralow density physisorption network structures. Whereas traditional thin-film technology has complications due to the effects of substrates, free-standing sandwiched nanostructures provide more reliable hydrogen sorption properties, reduce oxidation, support loose agglomerates, and eliminate the possibility of substrate-induced nucleation as an origin of phase change. To make these types of structures, Mao deposits metal by vapor deposition onto glass substrates, and then delaminates the film by heating. Mao finds that the H sorption capability of the film increases with temperature, H sorption kinetics are increased, and that a free-standing film absorbs 20% more H than typical ball-milled powders, and does so at temperatures more amenable to commercial applications.

The Water Forum was developed to help define the major materials issues facing emerging water supply, treatment, and purification practices in both developed and developing regions of the world, but with an emphasis on Mexico. S.E. Garrido Hoyos of the Instituto Mexicano de Tecnologia del Agua said that significant problems in Mexican water resources are water quality and the inability to harvest a greater percentage of its precipitation and distribute it as drinking water. The removal of arsenic from Mexican drinking water is a top concern. The technologies currently used to remove arsenic have the drawback of generating arsenic waste sludge. Newer, more promising treatments include capacitive deionization, sand filtration, and absorption of arsenic onto goethite. In a separate presentation, B. Marinas of the University of Illinois, Urbana-Champaign, USA, addressed research being conducted to disinfect drinking water from viral pathogens.

Meeting attendees converse during breaks between technical sessions.

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(Above) The evening poster sessions generate much enthusiasm.

(Right) Attendees visit close to 20 exhibitors.

Marinas presented results that showed the adenovirus was more resistant to UV disinfection, and the coxsackievirus was more resistant to free chlorine. The UV light and chlorine inactivation mechanism is believed to work by inhibiting E1A protein and DNA synthesis which stops the virus replication cycle. Marinas concluded that future materials research should include viral biosensors that will provide an early alert to the presence of infectious agents in the water supply.

Women in Science Luncheon

During the Women in Science Luncheon, speaker Gabriela Diaz Guerrero (UNAM) said that science has no gender and that there is no science "for women." A good idea in science should be respected, regardless of its origin. Despite these ideals, she said, some discrimination against women and scientists from developing countries persists. In Mexico, Diaz said, women comprise 33% of the Research National System (2007), 20% of the Mexican Academy of Science, and 33% of scientific research at the UNAM. Participation of women in science is growing though. Diaz is currently serving on an evaluating committee at Centro de Nanociencias y Nanotecnologia, UNAM where, for the first time, there is an even number of women and men on the committee. In a survey, the National Association of Universities in Mexico found that when comparing the number of men and women involved in graduate work across a variety of disciplines, there are an even number in natural science and health sciences, more women in humanities and education, and more men in engineering and technology. While Diaz has enjoyed a dynamic science career, accepting, in 1985, an invitation from the director of the Instituto de Fisica to create a catalysis group there and being the first woman with a PhD degree to occupy a high level position at CONACyT (1991), she described some continuing problems facing scientists: She said that challenges facing the Mexican female scientist include male-dominated evaluation committees and difficulties associated with publication when all authors have Latin surnames. Diaz said, "What is important is to put passion in your work, no matter what your gender."

Technical Highlights

MRS and MRS-Mexico co-organized symposia on various topics, including photovoltaics, solar energy materials, thin films and ion beams. Other technical symposia included composites and hybrid materials as well as semiconducting materials.

"This is the time for photovoltaics," B. Kippelen (Georgia Institute of Technology, USA) began, summarizing the excitement and promise of the field. The photovoltaic (PV) field is currently dominated by silicon, CdTe, and other inorganic materials. Yet, organic materials represent significant advantages, especially due to economies of scale. Organic power conversion efficiencies currently stand around 6–7%. One way to improve the power conversion efficiency is to optimize device length scales with the diffusion length scales of the carriers: organic PVs operate by dissociation of excitons, which are generated at the interfaces between donor and acceptor materials, Kippelen said. These materials must be thin, as the excitonic diffusion length is limited; but they must also be sufficiently thick for efficient light absorption. Donor–acceptor heterojunctions have been achieved in multilayer thin-film and interpenetrating bulk geometries. Kippelen's group focused on pentacene/C_{60} solar cells. Pentacene is a common hole-transport material and C_{60} an electron-transport material, both with high charge mobilities. Large external quantum efficiencies of up to 70% are explained by a large exciton diffusion length in pentacene (70 nm), which was calculated by electron transport equations with the assumption that exciton dissociation occurs at the donor–acceptor interface.

In another presentation on thin films, J. Flores (Universidad Autónoma de Nuevo León) discussed ZnO, a wide, direct bandgap semiconductor and a promising candidate for optoelectronic applications, especially as a replacement to indium tin oxide (ITO) as a transparent electronic contact. Through atomic layer deposition, with a Si(100) substrate, Flores made polycrystalline ZnO films. He varied the substrate temperature to study the effect on film quality and determined that the substrate temperature has a profound effect on the crystalline orientation of the films. Furthermore, optical transmittance showed 73% transmittance of the visible range, similar to that of ITO. The room-temperature photoluminescence spectrum is dominated by near band-edge (NBE) emission at 390 nm, with blueshift from the bulk NBE due to the presence of point defects in the form of vacancies.

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In the development of radiation-resistant materials, B. Averback and co-workers at the University of Illinois, Urbana-Champaign, worked with a series of dilute immiscible Cu alloys, computer simulations, and ion irradiation experiments including x-ray diffraction and atom probe tomography. A material subjected to ion beam irradiation receives energy from the energetic ions. This energy is dissipated in the material, through nuclear collisions and electronic interactions, causing atomic displacements and creating point defects. In this process, there is a balance between the dynamics of the atomic displacements and the internal tendency of the atoms to revert to their equilibrium crystalline positions. This balance dictates the microstructural evolution in the material. Averback's group was able to adjust this balance to yield self-organization and compositional patterning on a nanometer length scale. One of the consequences of this nanoscale self-organization is that phase boundaries can act as sinks or traps for supersaturation of point defects, leading to radiation resistance.

Plenary Presentations Reflect Broad Range of Materials Topics

The XVIII International Materials Research Congress offered five plenary addresses covering gate oxides, self-assembled nanostructures in mixed III–V and group III–nitride materials, polymers for electronic applications, energy conversion and storage, and regenerative medicine.

Darrell G. Schlom of Cornell University, USA, presented the first plenary address of the Meeting on new gate oxide materials to replace SiO_2 in current microprocessors that have been the backbone of the current information technology revolution. The very latest microprocessors use hafnium oxide (HfO_2) as the gate oxide material. Schlom said that the future holds interesting possibilities, one of which is the use of III–V materials. Schlom has carried out a series of thermodynamic analyses for these materials in contact with various oxides. Varying the group III species was found to greatly affect the stability of the oxide on the semiconductor material. Schlom's group concluded that gate dielectrics that work for Si are also candidates for the III–V materials.

Semiconductor alloys allow for the tailoring of bandgaps and lattice constants to achieve a variety of optoelectronic applications. In a plenary presentation on mixed III–V and group III–nitride materials, **Subash Mahajan** of Arizona State University, USA, explored whether there is any pattern in the mixed-group sublattice, and what the implications of this are on device performance. He has found that phase separation occurs, to the detriment of some devices but also to the benefit of others, and that the microstructures resulting from the phase separation and ordering may be optimized for desired device performance. For example, Mahajan said, dislocations have been shown to act as nonradiative recombination centers, reducing device performance. However, a phase-separated microstructure will arrest dislocation glide and climb propagation that inevitably occurs as a result of energy from nonradiative recombination at the dislocations during carrier injection, resulting in a longer device lifetime.

In another plenary address, **Ullrich Scherf** (Bergische Universität Wuppertal, Germany) described the synthesis and processing of conjugated polymers, giving a specific example of nanostructured polymer blends based on semiconducting polymer nanoparticles, and the development of an organic light-emitting diode (OLED) based on semiconducting polymer nanoparticles. He also discussed his most recent work with all-conjugated amphiphilic rod-rod block copolymers, and the hierarchical self-assembly of micellar, vesicular, and lamellar nanoscale structures, a fertile research area of materials science.

Guozhong Cao (University of Washington, USA) focuses his research on the engineering of micro- and nanostructures through surface and interface chemistry to improve the performance of dye sensitized solar cells (DSC), lithium ion batteries, mesoporous carbon supercapacitors, and coherent hydrogen-storing nanocomposites. On the topic of DSCs, Cao said that engineering micron-scale particle aggregates and surface chemistries can enhance light scattering in DSCs to improve photon capture and carrier harvest. Toward this end, Cao investigated structures providing a direct pathway for electron transport by fabricating submicron-sized aggregates of ZnO and TiO_2 nanocrystallites and nanotubes. This hierarchical structure was shown to increase cell efficiency by 3.5% over a commercial sample. To ensure that improved efficiency is indeed due to light scattering, Cao annealed the cell to reduce particle aggregation to form nanocrystallites and found that the current density was cut in half, proving his theory.

Buddy D. Ratner (University of Washington, USA) gave an enlightening look into the changing perspective on what it means for a material to be deemed "biocompatible." There is now a movement toward thinking of biomaterial properties in terms of precision cell control and tissue engineering. The material 6S, developed by Healionics, contains a precise pore structure that is uniform throughout the material. It is believed that the geometry of these pores incites macrophage cells to behave in a manner that stimulates tissue reconstruction. While the phenomena occurs without respect to polymer type (i.e., hydrophilic or hydrophobic), pore size does seem to play an important role. Pore sizes close to 35 μm can induce tissue regeneration, but pore sizes outside of that range tend to promote encapsulation.

Materials Research with a Mexican Flavor

Mexico is, of course, well known for Tequila, its most popular alcoholic drink. J. Morales of Universidad Autónoma de Nuevo León and UNAM-Queretaro described an unusual use for Tequila—creating nanocrystalline diamond films. It so happens that Tequila has a carbon:oxygen:hydrogen ratio that lies within the diamond growth region of the C-H-O phase diagram. Tequila, which is made from the agave plant, has an alcohol content of ~38–43%. Morales and his co-workers used pulsed liquid injection chemical vapor deposition (PLICVD) to form the diamond films on silicon and stainless steel substrates. The liquid Tequila was heated to 280°C to transform it into a precursor gas. In a reaction chamber, the gas was heated to 800°C for the deposition, resulting in solid diamond crystallites of about 100–400 nm. As is to be expected, nucleation and growth were a function of the surface quality of the substrates. While the technique works, the question is, why use Tequila? The answer is low cost; even very cheap Tequila appears to work well and this could be an inexpensive method to produce diamond films.

Thevetia peruviana, a tropical plant native to Mexico, was the subject of an investigation conducted by C.M. López Domínguez (Universidad Autónoma de Yucatán) to evaluate *Thevetia* oil as an alternative feedstock for biodiesel production, and to characterize its physiochemical properties. The study began with the collecting, drying, and removal of *Thevetia* seeds. The oil was then manually extracted, with 33.4% oil recovery. The physicochemical properties examined were fatty acid composition, saponification value, specific gravity, and

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viscosity among others. Oil from the *Jatropha curcas* plant was used as a comparison. The results of the study revealed that the *Thevetia* oil had sufficient physiochemical properties for use as a biodiesel fuel and that if *Thevetia* seeds are to be used extensively in the future, first-generation seeds should be avoided, to maintain the food source.

What comes first, heritage or its conservation? This was the philosophical question posed by Luis Alejandro Torres Montes of UNAM, Mexico, one of the pioneers of archaeological conservation in Mexico. He reviewed the history of the conservation of archaeological artifacts of ancient Mexico during various periods, since epochs before the arrival of the Spaniards, finishing around the beginning of the 21st century. He divided time into various periods including prehispanic times, the conquest period of 1521–1555, the colonial era of 1555–1770, formation of the nation during 1770–1864, and on to more modern times. He said that conservation efforts in Mexico came into their own only in the 1950s and 1960s, with a few specific researchers including him who went abroad and attained the training needed, returned to Mexico, and then set up appropriate institutions. In fact, he said, other conservators from Latin America were able to come to Mexico and get their own training.

One of the symposia of the Meeting addressed technological innovation and its influence on materials processing. FRISA Aerospace (Santa Catarina N.L., Mexico), established in 2003, specializes in state-of-the-art rolling processes, and has employed students to test a new software to develop efficient experiments for the optimization of Ni-based alloys for oil and gas applications, as described by O. Covarrubias. The multi-step production of these Ni-based rings leaves many variables for optimization: raw materials are forged, rolled, pressed, fed into a ring-rolling machine, heat treated, and finally finished in the machine shop. Testing metrics included tensile properties, grain size, and hardness, obtained as a function of processing time and temperatures. Statistical tools, such as regression analysis, were used to determine the effects of process parameters on the properties of interest and ensure the validity of the findings. Processing steps were optimized using these methods.

For additional meeting highlights provided by the MRS Meeting Scenes, access Web site www.mrs.org/meetingscene.

MRS Elects Officer, Board of Directors for 2010

Members of the Materials Research Society have elected one officer and five directors to join the 2010 MRS Board of Directors. The board is composed of the officers and up to 18 directors. The officers of the Society are the president, the vice president (who is also the president-elect), the secretary, the treasurer (a position appointed by the Board of Directors), and the immediate past president. The annual election ended November 4, 2009.

The Board of Directors is organized into the following governing committees: Planning, Operational Oversight, External Relations, and Governance. The president, who serves as chair of the board, appoints each of the directors and officers to one of the first three governing committees, and designates the chairs of these committees.

Terms of office expire at the end of the year indicated in parentheses. The asterisk (*) designates those who are newly elected.

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