



2012 Materials Research Society Fall Meeting emphasizes sustainability, graphene, and other materials highlights

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The Materials Research Society boasted over 6400 participants attending 52 symposia at the largest ever Fall Meeting and Exhibit of the Society. The Meeting Chairs, **Chennupati Jagadish** (Australian National University), **Thomas Lippert** (Paul Scherrer Institut), **Amit Misra** (Los Alamos National Laboratory), **Eric Stach** (Brookhaven National Laboratory), and **Ting Xu** (University of California–Berkeley) convened the meeting on November 25–30, 2012 in Boston, Mass.

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The larger Meeting was also accompanied by broader coverage of the technical sessions and events. MRS OnDemand® features videos of all of the award and plenary talks (including Plenary speaker and Nobel laureate Dan Shechtman of the Technion), and selected talks from symposia on sustainability, graphene, science education, and biomimetics for biomedical applications. To complement this extensive coverage, MRS-TV was introduced, dedicated to news and views from the Fall Meeting, presented in venues throughout the Meeting. Access to the video coverage can be found at www.mrs.org/fall2012, as well as further in-depth coverage of the technical talks and other events through Meeting Scenes and the online proceedings.

This Fall Meeting particularly emphasized the Society's new accent on materials and sustainability as well as the rapidly progressing research field of graphene. With the launch of the *MRS Bulletin* expanded issue on graphene (December 2012 issue), the guest editors—John Boeckl and Weijie Lu of Wright-Patterson Air Force Base and

Patrick Soukiassian of Université de Paris-Sud, Orsay and CEA/Saclay—also coordinated a tutorial, special forum, and technical sessions within Symposium W on the topic. Making headlines in 2010, when André Geim and Konstantin Novoselov received the Nobel Prize in physics for their work on graphene, the field has since been in the spotlight. The Forum directed its two sessions on how research in graphene is being funded around the world and on industrial partners, including start-up companies looking for applications and ways to mass produce this material.

In addressing the question of commercializing large-area graphene, Mike Patterson of Graphene Frontiers said in his Symposium W presentation, “The days of the brilliant, reclusive, hide-in-the-lab inventors are really numbered, if not over altogether. You are not going to bring graphene technology to the market by yourself no matter how smart you are or how much work you put in.” Teamwork—including cooperative researchers, funding agencies, and investors—is the key to this challenge, Patterson said.

Rosie Hicks, CEO of the Australian National Fabrication Facility (ANFF), spoke about how cooperative research on carbon nanomaterials is being coordinated in Australia. The ANFF was founded in 2007, and now encompasses facilities from 19 universities across the country. To date, \$200 million has been spent on research projects, 60 ANFF staff members, and 500 “tools”—scientific instruments of all sorts—that researchers throughout Australia share to accomplish their goals. “We concentrated on putting together a collaborative facility with open access to infrastruc-

ture,” Hicks said. “We don’t want to duplicate tools at the expense of having significant capability gaps.” The ANFF also has international links to the London Center for Nanotechnology, Cornell University, and the US Air Force Research Labs, among others.

On the technical side of carbon nanomaterials and graphene in Symposium W, Rodney Ruoff of the University of Texas at Austin gave an excellent overview in which he outlined some “grand challenges” in carbon science. These included finding new allotropes of carbon (e.g., negative curvature carbon), new types of mechanochemistry, and new forms of known allotropes (e.g., diamond foils), among others. Negative curvature carbons were first postulated in 1985 by A. Mackay; the negative curvature arises from “the insertion of *n*-gons larger than hexagons,” Ruoff explained. Density functional theory (DFT) calculations by David Tománek’s group at Michigan State University have shown that the right choice of unit cells in such negative curvature carbons could lead to an all-carbon ferromagnet, Ruoff said. In terms of mechanochemistry, DFT has shown that the center atom of a kinked single-walled carbon nanotube has an energy 2 eV above the other atoms in the nanotube, making it a very reactive carbon atom, according to Ruoff. Synthesis of wrinkled graphene sheets could produce regular patterns of high curvature, with controlled placement of highly reactive carbon atoms. Diamond foils might be achieved by making graphene bilayers that are hydrogenated on each side. DFT calculations have revealed that this system naturally collapses by a very low energy pathway to form diamonds, with no need for high temperatures or pressures. As graphene with grain sizes on the order of millimeters gives rise to speculation that centimeter-sized grains could be produced, Ruoff believes “it is possible to contemplate that we might be able to form diamond sheets kilometers in length that will have remarkably large grain sizes—an ultrathin diamond.”

This Meeting’s activities on the topic of sustainability grew from efforts started at the 2012 MRS Spring Meeting. As



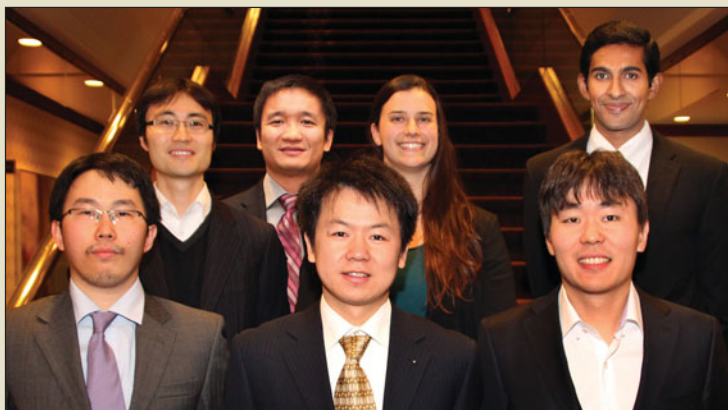
defined by the Brundtland Commission (United Nations, 1987), sustainable development entails fulfilling the needs of the present without compromising the ability of future generations to meet their own needs. Accordingly, many water, energy, and transportation technologies that currently impart key benefits to society cannot continue indefinitely and must be directed to a more sustainable path.

A large group of organizers divided their efforts on this topic, chairing two Forums (John R. Abelson, University of Illinois at Urbana-Champaign; Frank J. DiSalvo, Cornell University; Martin L. Green, National Institute of Standards and Technology; and Ashley A. White,

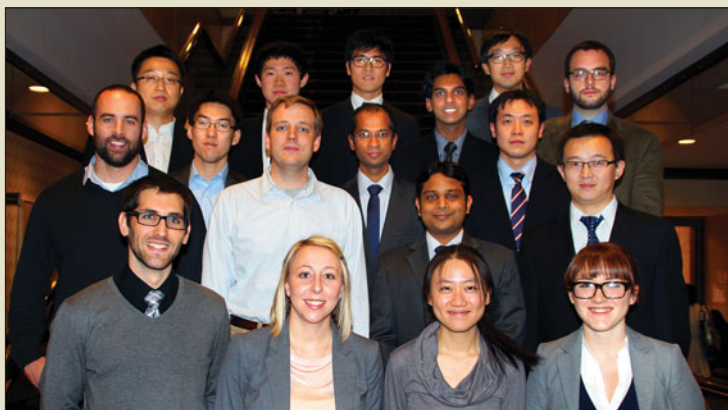
AAAS Science and Technology Policy Fellow, National Science Foundation) and a symposium (Laura Espinal, National Institute of Standards and Technology; Enrico Traversa, University of Rome Tor Vergata; Samuel S. Mao, Lawrence Berkeley National Laboratory; and Marie-Isabelle Baraton, Centre Européen de la Céramique). Not only did they concentrate on how “sustainability” reaches across all fields of materials research, but also how essential it is for the science community to meet with engineers, industrial ecologists, economists, and other practitioners in this diverse arena.

“We want to look at the environment, the economy, and society, and discuss

Graduate Students Receive Gold and Silver Awards



Gold Graduate Student Awards (front row, left to right): Xingchen Ye, Jiayan Luo, Seung Sae Hong; (back row, left to right): Seunghyun Lee, Yingchao Yu, Katharine Jensen, Manu Sebastian Mannoor



Silver Graduate Student Awards (front row, left to right): Eric Appel, Kaylie Young, Jennifer Choy, Kristy Jost; (second row, left to right): Andrew Thron, Timothy Miller, Rijju Singhal, Yuerui Lu; (third row, left to right): Jian Cui, Karthik Jambunathan, Changhyun Pang; (fourth row, left to right): Wenzhuo Wu, Xueyi Zhang, Oh Seok Kwon, Jimmy John, Minu Kim, John Thomas

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Award & Plenary Talks

- Plenary Address: 2011 Nobel Prize Winner Danny Shechtman, “Quasicrystals: Discovery, Structure, Properties and Uses”
- Von Hippel Award: Stuart Parkin, “The Spin on Electronics!”
- Turnbull Lecture: Robert Sinclair, “*In Situ* High-Resolution Transmission Electron Microscopy of Material Reactions”
- MRS Medal: Jennifer A. Lewis, “Printing Functional Materials”
- MRS Medal: Miquel B. Salmeron, “Physics and Chemistry of Material Surfaces under Ambient Conditions of Gases and Liquids—What’s New?”
- Materials Theory Award: John P. Perdew, “Climbing the Ladder of Density Functional Approximations”

Selected talks from the following technical symposia:

- Symposium G: Materials as Tools for Sustainability
- Symposium L: Biomimetic Nanoscale Platforms, Particles, and Scaffolds for Biomedical Applications
- Symposium W: Carbon Nanomaterials
- Symposium ZZ: Communicating Social Relevancy in Materials Science and Engineering Education

Selected Tutorial Sessions

- Tutorial VV: Neutron and X-rays—Sources, Instrumentation, and Scattering
- Tutorial AAA: Developing Successful Business Plans for Science and Technology Ventures

Special Events

- Sustainability Forum—Building Teams to Tackle Complex Problems
- Fred Kavli Distinguished Lectureship in Nanoscience: Sir John Pendry, “Emphasizing the Negative”

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how these factors interact for sustainable development,” White said.

Ernest J. Moniz of the Massachusetts Institute of Technology pointed to the current energy system as one example of an area that needs to be changed into a more sustainable system. He noted, for example, that the shale gas industry has proven to be a tremendous game-changer in the United States. This energy source shift has made the country more competitive and has changed the geography of the global energy market. Nevertheless, four critical issues affect the rate at which shale gas expands in the energy market: environmental concerns about fracking; export of natural gas; the displacement of enthusiasm for other renewable energy sources; and the adequacy of shale gas research, development, demonstration, and deployment and innovation. Moniz said that in this path toward a new energy future, society must remember that any type of energy system change relies on cooperation and communication between many systems, from legislators, to engineers, to construction workers, to communities.

During a panel discussion, two student groups presented conflicting experiences in working across disciplines to address sustainability. Mohammad Adnan Khan, representing students at King Abdullah University of Science and Technology (KAUST) in Saudi Arabia, cited lack of motivation, lack of trust between interdisciplinary groups, and conflict of interest in academic–government–industry partnerships as challenges to be met. “The true essence of working in an interdisciplinary environment is that experts do their own work while sharing their knowledge instead of training,” he said.

Ivana Aguiar, representing the student group at the University of the Republic, Uruguay, stated that energy is already an interdisciplinary and cross disciplinary topic in their country. “We always work with people from related areas, like physics,” she said. “We’re starting to reach out to researchers in the social areas.” Challenges include lack of training in how to work in interdisciplinary ways, and the need for both broad and specific

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knowledge in such a venture, she said.

From Boeing, panelist Linda Cadwell Stancin, speaking on behalf of Forum participants focused on industry, emphasized how little time is left to develop a sustainable model for industry and the environment. Her group said that an open culture was necessary in a company to make employees comfortable with talking to people from a different background. “Most industry teams are cross disciplinary from the outset,” she said. Boeing trains newly hired engineers in economics to cut across disciplines and give the engineers the proper

business perspective, Stancin said.

Other technical areas covered in the Fall Meeting include soft and biomaterials; functional materials and nanomaterials; structural and advanced materials; and synthesis, characterization, and modeling methods. Special events included the MRS Award Ceremony, an Acta Materialia Materials and Society Award forum honoring Mildred Dresselhaus of the Massachusetts Institute of Technology, professional development opportunities and funding information sessions, as well as an equipment exhibit.