2017 MRS Spring Meeting features issues and developments across disciplines

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The Materials Research Society (MRS) held its Spring Meeting in Phoenix, Ariz., on April 17–21, and featured several opportunities for professional development, extending research, practicing scientific writing, and networking. The Meeting Chairs, **Christopher J. Bettinger** (Carnegie Mellon University), **Stefan A. Maier** (Imperial College London), **Alfonso H.W. Ngan** (The University of Hong Kong), **W. Jud Ready** (Georgia Institute of Technology), and **Eli A. Sutter** (University of Nebraska–Lincoln) put together 53 symposia that comprised the technical core of the Meeting. They were grouped into five topical clusters: Characterization, Theory, and Modeling; Electronic Devices and Materials; Energy Storage and Conversion; Nanomaterials; and Soft Materials and Biomaterials.

Symposium presentations

Lithium-ion batteries (LIBs) represent one of the most successful cell chemistries. **Mark Verbrugge**, General Motors R&D Center, discussed the "Needs and Challenges Associated with High Energy Batteries with an Emphasis on Thermodynamic Underpinnings" in his symposium presentation. The spread of LIBs in the commercial market is due, in part, to lucrative energy/power-to-size scaling, close to 100% reversibility, and a reasonable cycle life. Storage of electrochemical energy in electrode materials takes place via intercalation, which in itself is considerably different and far more complex than traditional solution-phase electrochemistry. This makes the fundamental understanding of LIB materials challenging as well as interesting. Verbrugge has been working on a "thermodynamically consistent" description of intercalation in electrodes that ties together experimental material behavior with a minimal set of functional relations.

Takeshi Morikawa, Toyota Central R&D Labs, presented a talk on "Solar CO_2 Reduction Coupled with Water Oxidation" that focused on CO_2 as one of the key contributors to the greenhouse effect, hence a growing effort to convert CO_2 into fuel. After earlier success in CO_2 reduction using a semiconductor electrode (nitrogen-doped tantalum oxide) along with a metal complex electrocatalyst, Morikawa and his team at Toyota have been progressively improving their system to realize objectives for an industrial scale production, such as the use of cheaper materials. The research team has developed a new system that couples a titanium oxide-based photoanode for water reduction and a cathode to reduce CO_2 without explicit use of an electron donor for reduction at the cathode. With a silicon-germanium junction as a light absorber, they reported solar conversion efficiency as high as 4.6%.

Lab-on-chip devices are a revolutionary concept that operate at the interface of biology and fluid mechanics. **Anna Balazs**, in her talk "Surface-Bound Enzymatic Reactions Organize Microcapsules and Protocells in Solution," discussed how the principles of microfluidics can be leveraged to transport desired molecules to particular locations. Thus, specificity of location and selectivity of particles are key design objectives of such systems. Of late, there is growing interest in prototyping mechanisms that do not require external inputs, thus making them more portable and automated. Balazs and her group at the University of Pittsburgh have been actively pursuing physics-based solutions to this challenge. They identify feasible routes to this problem with a strong emphasis on theoretical understanding.

Recognitions

Joost W.M. Frenken (Advanced Research Center for Nanolithography) received the Innovation in Materials Characterization Award, **Nicola Spaldin** (Swiss Federal Institute of Technology, Zürich) received the Mid-Career Researcher Award, **Jennifer A. Dionne** (Stanford University) and **James M. Rondinelli** (Northwestern University) received the Outstanding Young Investigator Award, **Lynnette D. Madsen** (National Science Foundation) received the inaugural MRS Impact Award, and **Andrew J. Gayle** and **Robert F. Cook** (National Institute of Standards and Technology) won the 2016 *Journal of Materials Research* Paper of the Year for their article, "Mapping viscoelastic and plastic properties of polymers and polymer-nanotube composites using instrumented indentation."

The 2017 MRS Fellows

Standing (left to right): Joseph Mantese, Orlin Velev, Robert Carpick, Sergei Kalinin, Ju Li, and Mariappan Parans Paranthaman. Absent: Manish Chhowalla, Sharon Glotzer, Arunava Gupta, Yu Huang, George Malliaras, Catherine Jones Murphy, John Reynolds, Luisa Torsi, Chongmin Wang, and Gwo-Ching Wang.

Plenary Session featuring The Fred Kavli Distinguished Lectureship in Materials Science and Symposium X presentations

At Tuesday's plenary session, **Joseph M. DeSimone** of The University of North Carolina at Chapel Hill, described a new advance in additive manufacturing that is rapid, continuous, and no longer layer-by-layer, which promises to advance industry beyond basic prototyping to three-dimensional (3D) manufacturing.

Despite the increasing popularity of 3D printing, also known as additive manufacturing, the technique has not developed beyond the realm of rapid prototyping. The new continuous liquid production technology harnesses light and oxygen to continuously grow objects from a pool of resin instead of printing them layer-by-layer.

For the Symposium X: Frontiers of Materials Research presentations on Tuesday, **Julia R. Greer**, California Institute of Technology, discussed the creation of extremely strong, ultralight materials that can be achieved by capitalizing on the hierarchical design of 3D nano-architectures. Such structural metamaterials exhibit superior thermal, photonic, electrochemical, and mechanical properties at extremely low mass densities, rendering them ideal for many scientific and technological applications.

On Wednesday, **David A. Weitz**, Harvard University, discussed microfluidic devices that can be used to produce highly uniform, structured materials based on the production of drops of one fluid in a second. This talk described applications of this technology to create new materials and for very high-throughput screening, which is valued in biotechnology.

On Thursday, **Kazutomo Suenaga**, National Institute of Advanced Industrial Science and Technology, discussed properties of low-dimensional material that are largely influenced by structural imperfections, such as defects, impurities, edges, or boundaries. Analytical techniques at the single-atom level are becoming crucial to understand their physical and chemical performance.

Meeting Highlights

Sharon C. Glotzer, University of Michigan, presented the *MRS Communications* Lecture on the "Rational Design of Nanomaterials from Assembly and Reconfigurability of Polymer-Tethered Nanoparticles."

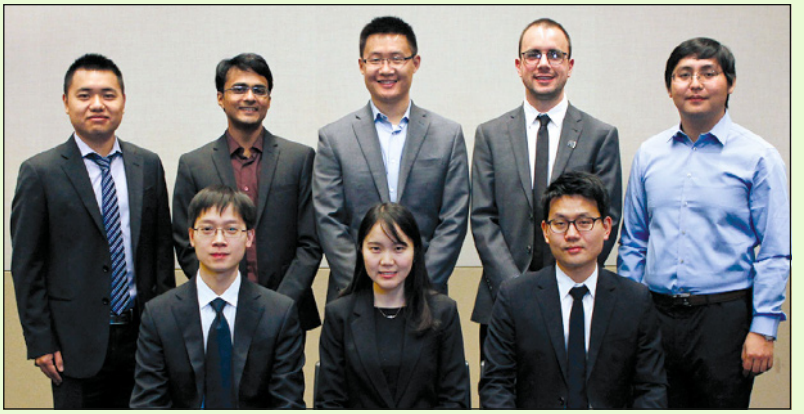
Polymer-based nanomaterials have captured increasing interest over the past decades for their promising use in a wide variety of applications, including photovoltaics, catalysis, optics, and energy storage. This lecture recognizes excellence in the field of materials research through work published in *MRS Communications*.

The National Academies of Sciences, Engineering, and Medicine held a Town Hall Meeting on Wednesday, April 19, to seek input for a study on the future of materials research. *Frontiers of Materials Research: A Decadal Survey* is looking at defining the frontiers of materials research ranging from traditional materials science and engineering to condensed-matter physics. Topics focused on progress, achievements and principal changes in the R&D landscape over the past decade; identification of key materials research areas that have major scientific gaps or offer promising investment opportunities from 2020 to 2030; and the challenges that materials research may face over the next decade and how those challenges might be addressed.

A panel on the Materials Needs for Energy Sustainability by 2050 was held to discuss our ability to achieve an energy-efficient, low-emissions future by achieving significant materials advances over the coming decades. The event was co-organized by *MRS Energy & Sustainability* and the MRS Focus on Sustainability Subcommittee. Top experts discussed the goals identified in the COP21 Paris Agreement, fundamental materials R&D necessary to achieve such goals, and the geopolitical and international supply-chain implications of the necessary R&D pathway.

Some professional development opportunities included an ABET Information and Evaluator Retraining Session, workshops on the Essentials of Getting Your Work Published, How to Qualify for a Green Card, Science Writing, and Networking for Nerds. Many presentations from the 2017 MRS Spring Meeting are available through MRS OnDemand® video capture as well as news coverage of the Meeting on Meeting Scene® and MRS TV. **Further information can be accessed at www.mrs.org/spring2017.**

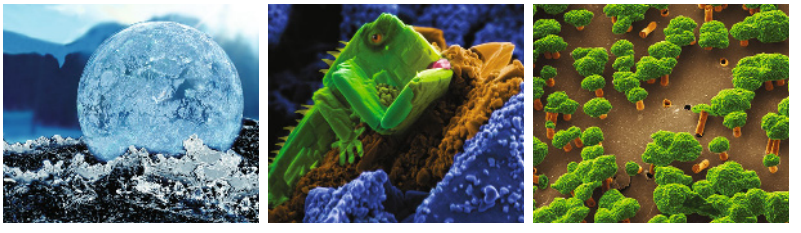
Graduate Student Award Recipients



Gold GSA Recipients: (First row) Pengcheng Chen, Northwestern University; Ye Zhang, Fudan University; Won-Kyu Lee, Northwestern University. (Second row) Ye Shi, The University of Texas at Austin; Aditya Sood, Stanford University; Fudong Han, University of Maryland, College Park; Gerald Brady, University of Wisconsin–Madison; Qiyang Lu, Massachusetts Institute of Technology.

Silver GSA Recipients: (First row) Jie Zhao, Stanford University; Zichao Ye, University of Illinois at Urbana-Champaign; Arko Graf, Universität Heidelberg; Yude Su, University of California, Berkeley; Achim Woessner, ICFO-The Institute of Photonic Sciences; Won Jun Jo, Massachusetts Institute of Technology. (Second row) YunHui Lin, Princeton University; Siying Peng, California Institute of Technology; Katalin Szendrei, Max Planck Institute for Solid State Research, Ludwig-Maximilians-Universität München; Shuozhi Xu, Georgia Institute of Technology; Swetha Barkam, University of Central Florida; Jinxing Li, University of California, San Diego; Lixin Sun, Massachusetts Institute of Technology. (Third row) Zhengshan Yu, Arizona State University; Michael Christiansen, Massachusetts Institute of Technology; Yanxi Li, Virginia Polytechnic Institute and State University; Nigel Becknell, University of California, Berkeley; Sujay Desai, University of California, Berkeley; Tyler Schon, University of Toronto.

Science as Art Winners



Congratulations to the Science as Art competition first place winners: Mostafa Yourdkhani, University of Illinois at Urbana-Champaign, for "Polynuclear Microcapsule"; Babak Anasori, Drexel University, for "Graphene-Anatase Iguana"; and Fernando Soto, University of California, San Diego, for "Jungle after the Storm."

2017 MRS Spring Meeting Poster Award Winners

Tuesday Poster Awards

Macromolecular Chemical Doping for Stable Graphene Electrode
Sung-Joo Kwon, Pohang University of Science and Technology

Avalanche Atomic Switching in Strain Engineered Sb_2Te_3– Ge Te Interfacial Phase-Change Memory Cells
Xilin Zhou, Singapore University of Technology and Design

Hydrated WO_3 for High-Power, High-Volumetric Capacitance Energy Storage
James Brooks Mitchell, North Carolina State University

Wednesday Poster Awards

Critical Current by Design through Large-Scale Simulations
Andreas Glatz, Argonne National Laboratory

Single Spins in Silicon Carbide Coherent Control Charge State Manipulation and Photonic Structures
Matthias Widmann, 3rd Institute of Physics and Center of Photonic Engineering

Photoelectric Nitrogen-Vacancy Electron Spin Magnetrometry
Michal Gulka, Czech Technical University in Prague

Thursday Poster Awards

Electronic Structure of Perovskite Single Crystals by Photoluminescence and Surface Potential
Hye Ri Jung, Ewha Womans University

Ge Incorporated CZTSe Thin-Film Solar Cell with a Conversion Efficiency of 12.3%
Hitoshi Tampo, National Institute of Advanced Industrial Science and Technology

Durable PEDOT-Based Medical Coating for Recording and Stimulating Electrodes
Nandita Bhagwat, Biotectix

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