From the Director

I am pleased to present the current issue of Advances, a quarterly e-brief update of the Frederick Seitz Materials Research Laboratory (FSMRL) at the University of Illinois. This issue features important advances in the directed assembly of flexible, transparent, and lightweight solar cell arrays and of photoresponsive colloids. Several prominent awards received by my colleagues are also highlighted.

The primary mission of the FSMRL is to foster interdisciplinary research at the forefront of materials science. Our laboratory brings together world-class faculty, graduate students, and post-doctoral researchers with expertise in condensed matter physics, chemistry, and materials science. We house several multi-investigator programs in the broadly defined areas of quantum, nanoscale, computational, and soft materials. These programs derive great benefit from our central facilities for materials fabrication and characterization.

(Cont. on pg 2)

Ultrathin Silicon Solar Microcells for Flexible, Semitransparent Module Designs

An interdisciplinary team of FSMRL researchers, led by John Rogers (MatSE), has created silicon solar cells that are thin, semitransparent, lightweight, and flexible. Their module design uses one-tenth of the amount of silicon relative to conventional modules, yet have the potential to produce comparable power. These capabilities might not only make solar power more cost effective, but expand its use in applications, such as fabrics, windows of buildings, and sunroofs of automobiles. The team’s work establishes new design rules and fundamentally new approaches for photovoltaic devices that may underpin more efficient and lower-cost solar energy utilization.

The FSMRL research team, which also included Ralph Nuzzo (Chemistry) and Jennifer Lewis (MatSE), reported their findings in the featured cover article of the November 2008 issue of Nature Materials. Their strategy involves two parts: (i) the synthesis of large-scale collections of solar cells that are much thinner (down to ~100 nm) and smaller (down to a few microns) than those possible with conventional technologies and (ii) the integration of these microcells in modules with unusual designs. This work also suggests that silicon purity requirements are not as stringent as in conventional cells, and light-matter interactions can be optimized for increased performance.

To create this module design, individual microscale cells are first generated by anisotropic etching of a mono-crystalline silicon wafer. A rubber stamp then places, in a solid printing-like process, large-area arrays of these individual cells into desired configurations, for integration into working modules. The resulting systems offer high efficiency solar energy conversion, using less than one-tenth of the amount of silicon typically needed in current-generation solar panels, thereby creating the potential for significantly reduced costs. Even with simple designs composed of microcells with thicknesses of 15 microns, efficiencies of ~12% are achieved. The research team is now focused on fundamental theoretical and experimental studies of the electrical, mechanical, and optical characteristics of several types of modules that incorporate silicon solar microcells.

This research is supported by the DOE/BES Materials Sciences and Engineering Division through the FSMRL Materials Research Cluster (MRC) on Programming Function via Soft Materials.

Workshop on Programmable Functional Materials

The FSMRL will host a workshop on Programmable Functional Materials on May 19, 2009. This workshop brings together leaders in the fields of materials assembly, computation, and theory with an emphasis on soft functional materials. Invited presentations will be given by several FSMRL researchers, including Paul Braun, Ralph Nuzzo, John Rogers, and Ken Schweizer, as well as Sharon Glotzer (Michigan), Craig Hawker (UC Santa Barbara), David Norris (Minnesota), Francesco Sciortino (Univ Roma La Sapienza), Dave Weitz (Harvard), and George Whitesides (Harvard). The workshop is supported in part by Dow Chemical.

The FSMRL gratefully acknowledges financial support from the DOE/BES Division of Materials Sciences and Engineering.
acterization, which are widely recognized as amongst the finest mid-scale facilities in the nation.

Each quarter, Advances highlights the recent accomplishments of researchers involved in the FSMRL. Together, we are transforming fundamental scientific discoveries into technological advances in the areas of photonics, flexible electronics, superconductor devices, and energy materials (e.g., photovoltaics, catalysts, and fuel cells).

I hope that you enjoy learning more about the Frederick Seitz Materials Research Laboratory and our impact on the scientific community and society as a whole.

Jennifer A. Lewis
FSMRL Director

Direct Laser Patterning of Photo-Responsive Colloids

An FSMRL research team composed of Paul Braun (MatSE) and Jennifer Lewis (MatSE) along with their collaborator Nelson Bell (Sandia) have harnessed the power of multiphoton direct laser writing to locally define the interactions between photo-switchable colloidal microspheres suspended in an organic solvent. The team reported their findings in the featured cover article of the January 5, 2009 issue of Advanced Materials.

Using this novel approach, one can pattern 3D structures of near arbitrary geometry with controlled feature size, roughness, and porosity. As one example, Braun and his colleagues have created porous-walled 3D structures, including microscale rectangular cavities that exhibit size-selective permeability. These locally defined architectures may find potential application as functional elements (e.g., chaotic mixers and filters) in microfluidic devices. Given their photo-reversible nature, there is great potential for dynamic control of element geometry, permeability, and size selectivity via programmable assembly and disassembly of the colloidal building blocks or simply by photo-actuation of the polymer brush conformation. In addition, this approach allows one to construct model systems for studying the dynamics of confined colloidal fluids, flow through porous media, and colloidal gelation.

This research is supported by DOE/BES Materials Sciences and Engineering Division through the FSMRL Materials Research Cluster (MRC) on Programming Function via Soft Materials.

Granick awarded 2009 APS Polymer Physics Prize

Steve Granick (MatSE) has been recognized as the 2009 recipient of the Polymer Physics Prize of the American Physical Society, the highest honor in physical polymer science in the United States. The award citation reads: “For path-breaking and elegant experiments that elucidate the structure and dynamics of polymers and liquids confined by surfaces.” This marks the second year in a row that the prize has gone to an FSMRL researcher; the 2008 recipient was Kenneth Schweizer (MatSE).

Rogers selected as a National Security Science and Engineering Faculty Fellow

John A. Rogers (MatSE), the Lee J. Flory Founder Chair in Engineering Innovation at Illinois, has been selected as a National Security Science and Engineering Faculty Fellow (NSSEFF). Rogers is one of six distinguished university faculty scientists and engineers in the 2009 National Security Science and Engineering Faculty Fellows Program. This program provides substantial funding to conduct long-term, unclassified, basic research involving the most challenging technical issues facing the Department of Defense.

Petrov receives the Bunshah Award

Ivan Petrov, Director of the FSMRL Central Facilities, has received the R.F. Bunshah Award from the Advanced Surface Science Engineering Division (ASED) of the American Vacuum Society. This award acknowledges outstanding research or technological innovation in areas of interest to ASED with an emphasis on the fields of surface engineering, thin films, and related topics by a scientist or engineer.