**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 (MRL) at the University of Illinois. In this issue, we feature important advances in the fundamental understanding of complex oxides and the design and assembly of novel colloidal building blocks, as well as recent awards received by my colleagues.

The primary mission of the MRL 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, which are widely recognized

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**Observation of fractional vortex states in SRO**

A team led by MRL researcher Raffi Budakian (Physics) recently reported the first tantalizing glimpse of an exotic state of matter, known as the half-quantum vortex, in the unconventional superconductor, strontium ruthenium oxide (SRO). Their findings were published in the January 14 issue of *Science*. First proposed in the 1970s to exist in superfluid helium-3, but never directly observed, a half-quantum vortex can be thought of as a ‘texture’ that arises from the spin phase of the superconducting order parameter.

Budakian’s group investigated SRO, because it has been proposed as the solid-state analog of the A-phase of superfluid helium-3. Using state-of-the-art nanofabrication methods and highly sensitive cantilever-based magnetometry techniques developed by his group, the team has observed minute fluctuations in the magnetism of tiny rings of SRO. In their experiment, the researchers first fabricated a micron-sized ring of SRO by focused ion beam milling. The resulting structure, which looks like a microscopic donut, is then glued onto the sensitive silicon cantilever and then cooled to 0.4° above absolute zero.

Being able to make the SRO rings is crucial to the experiment, because the half-quantum vortex state is not expected to be stable in larger structures. After attachment to the cantilever, a static magnetic field is applied to change the ‘fluxoid’ state of the ring and detect the corresponding changes in the circulating current. In addition, time-dependent magnetic fields can be applied to generate a dynamic torque on the cantilever. By measuring the frequency change of the cantilever, the magnetic moment produced by the currents circulating the ring is determined. Specifically, the research team observed transitions between integer fluxoid states, as well as a regime characterized by ‘half-integer’ transitions, which could be explained by the existence of half-quantum vortices in SRO.

Not only does Budakian’s work provide a significant advance in fundamental scientific understanding, it may be an important step toward the realization of a so-called “topological” quantum computer, according to MRL researcher and Nobel Laureate, Tony Leggett (Physics).

This work was supported in part by the DOE/BES Materials Sciences and Engineering Division through the Quantum Materials at the Nanoscale Cluster in the Frederick Seitz Materials Research Laboratory, with use of the Advanced Photon Source at Argonne National Laboratory supported by DEAC02-06CH11357.

*Celia Elliott (UI Physics) contributed to this article.*
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as amongst the finest mid-scale facilities in the nation.

Each quarter, Advances introduces the researchers involved in the MRL and highlights their recent accomplishments. 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
MRL Director

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**Rogers elected to National Academy of Engineering**

John Rogers (Materials Science) has been elected a Member of the National Academy of Engineering for his seminal contributions in “novel electronic and optoelectronic devices and systems”. In addition to this distinguished honor, he has been awarded a MacArthur Fellowship and has been elected a fellow of the Institute for Electrical and Electronics Engineers, the American Physical Society, the Materials Research Society, and the American Association for the Advancement of Science.

Renowned for his pioneering work in flexible electronics, Rogers combines soft, stretchable materials with micro- and nanoscale electronic components to create classes of devices with a wide range of practical applications. His most recent work has produced devices from biocompatible sensor arrays to implantable LEDs to eye-inspired cameras to stretchable integrated circuits. To date, he has published more than 300 papers and holds more than 80 patents. His research is supported DOE/BES Materials Sciences and Engineering Division through the Programming Function via Soft Materials Cluster.

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**Lokesh wins outstanding poster at TMS 2011**

Research on “Nanoscale precipitation in Cu-TiB, thin films under ion irradiation” by Ph.D. student Rannesh Lokesh and his co-advisors, MRL researchers Pascal Bellon (Materials Science) and Robert Averback (Materials Science), was selected as the Outstanding Poster in the Microstructural Processes in Irradiated Materials (MPIM) symposium at the TMS 2011 Conference.

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**Triblock Janus Spheres Assemble into Complex Structures**

MRL researcher Steve Granick (Materials Science and Engineering, Chemistry, and Physics) and his group have developed a simple, generalizable technique to fabricate complex structures that assemble themselves. Their advance, published in the Jan. 20 issue of Nature, utilizes a new class of self-assembling materials that they developed. Granick’s group is well known for its work with Janus particles. Named after the dual-natured Roman god, Janus particles have two sides or segments of different surface chemistry. Having explored spheres with two different-natured halves, their group had the idea to make spheres with three “stripes” of reactivity, which they have dubbed triblock Janus spheres. These spheres are composed of a charged center band, while their poles are hydrophobic.

In a salt-water solution, the hydrophobic poles are drawn together, while the charged equators repel one another. As a result, the spheres form a complex lattice where only the poles are in contact with one another. The hydrophobic polar caps are large enough to come into contact with two other spheres. This causes the spheres to arrange into a formation like a six-pointed star, creating a sheet of delicate lace. Such porous sheets composed of chemically anisotropic particles may find potential application as specialized filters.

To date, much of the work in making complicated structures has been done through computer simulation of highly complex, “patchy” particles. These experimental observations are a big step forward in demonstrating how non-trivial, non-obvious structures can be assembled from simple, anisotropic building blocks.

Now, the team is applying their simple particle design strategy to fabricate other complex architectures. By adjusting the size of the spheres or the proportion of the bands, different lattice patterns and tunable pore sizes may be achieved.

This research is supported by the DOE/BES Materials Sciences and Engineering Division through the Programming Function via Soft Materials Cluster in the Frederick Seitz Materials Research Laboratory.

UI News Bureau Physical Sciences Editor Liz Ahlberg contributed to this article.