Tuesday Afternoon, October 20, 2015

Manufacturing Science and Technology
Room: 114 - Session MS-TuA

Working with National Labs and User Facilities
Moderator: Charles Eddy, Jr., U.S. Naval Research Laboratory, Bridget Rogers, Vanderbilt University

2:40pm **MS-TuA2 Research Opportunities at the Cornell Nanoscale Science and Technology Facility, a member of the National Nanotechnology Coordinated Infrastructure.**, ***Michael Skvarla***, *D. Ralph*, Cornell NanoScale Science and Technology Facility

The Cornell Nanoscale Science and Technology Facility (CNF) is one of a network of open-access shared facilities partially subsidized by the US National Science Foundation to provide researchers with rapid, affordable, shared access to advanced nanofabrication tools and associated expertise. Projects can be accomplished either hands-on or remotely. Hundreds of engineers and scientists nationwide, from academia, industry, and government, utilize CNF to make structures and systems from the nanometer to the centimeter scale. CNF offers unique capabilities in world-leading electron-beam lithography, advanced stepper photolithography, soft lithography, and rapid prototype development, along with the ability to deposit, grow, and etch a very wide variety of materials. CNF's technical staff are dedicated full-time to user support, providing one-on-one help with process development, training, and troubleshooting. They can offer expertise for a wide range of fabrication projects, including not just electronics but also nanophotonics, magnetics, MEMS, thermal and energy systems, electrochemical devices, fluidics, and the life sciences. More than 30% of CNF's users come from biology/bioengineering fields. All users are welcome; no experience in nanofabrication is necessary and a central part of CNF's mission is to assist users from "non-traditional" fields seeking nanofabrication techniques for the first time. CNF's user program is designed to provide the most rapid possible access (typically 2 weeks from first contact) with the lowest possible barriers to entry (users retain full control of their IP, with no entanglement by CNF or Cornell University). More than 85% of CNF's external academic users come from institutions with their own local cleanroom facilities, but still they utilize CNF for advanced capabilities, staff expertise, or tool reliability not available locally.

This talk will explore the tools, services and advice available to CNF users, and show examples of ongoing work. We will also provide the latest details on the National Nanotechnology Coordinated Infrastructure (NNCI) program, a new NSF-sponsored network of shared facilities similar to CNF that is in the process of being organized at abstract submission.

We invite you to explore the CNF and NNCI and discuss ways we can help bring your research visions to fruition. CNF's User Program Managers will at no cost provide detailed processing advice and cost estimates for potential new projects. The CNF technical staff also meets every Wednesday afternoon for conference calls where we welcome questions about any topic related to nanofabrication. Visit cnf.cornell.edu to contact us and get started.

3:00pm **MS-TuA3 The CNST NanoFab at NIST is Open for Business**, ***Vincent Luciani***, NIST Center for Nanoscale Science and Technology

The NIST Center for Nanoscale Science and Technology (CNST) supports the U.S. nanotechnology enterprise from discovery to production. As part of the CNST, the shared-use NanoFab provides its users rapid access to a comprehensive suite of tools and processes for nanoscale fabrication and measurement. The CNST NanoFab at NIST is part of the Department of Commerce and therefore puts a high priority on operating a business friendly, easily accessible facility. The same rates are applied to all users, whether from industry, academia or a CNST colleague down the hall. Applications are accepted at any time and are reviewed and processed every week. Also, NIST does not claim any inherent rights to inventions made in the course of a NanoFab project. The NanoFab features a large, dedicated facility, with tools operated within a class 100, 8,000 square foot (750 m^2) cleanroom or in adjacent laboratories that have superior air quality along with temperature humidity, and vibration control. Over 80 major process tools are available, including but not limited to e-beam lithography, 5x reduction stepper photolithography, nano-imprint lithography, laser writing for mask generation, scanning and transmission electron microscopy, metal deposition, plasma etching, chemical vapor deposition, atomic layer deposition, deep silicon etching and ion beam etching. The NanoFab staff consists of scientists, engineers and technicians that specialize in all areas of nanofabrication and provide training and ongoing technical assistance to users. Our goal is to be a catalyst to our user's success and to help nurture nanotechnology commerce in the Unites States. Project applications and instructions are easily available on the web. Users inside NIST and from all around the country are provided on-line access to tool schedules and the tool reservation system. From physicists, engineers and biologists to medical researchers, users find common ground at the nanoscale in the CNST NanoFab.

3:20pm **MS-TuA4 The Molecular Foundry: A Knowledge-Based User Facility for Nanoscale Science**, ***Branden Brough***, The Molecular Foundry, Berkeley Lab

The Molecular Foundry, a nanoscience research center at Lawrence Berkeley National Laboratory provides communities of users with access to expert staff and leading-edge instrumentation to enable research on the nanoscale in a multidisciplinary, collaborative environment. Selected through an external peer-reviewed proposal process, users come from academic, industrial or national laboratories, both domestic and international, free of charge. Located in the Bay Area's active academic environment and near Silicon Valley, research is organized into seven closely coupled facilities: Inorganic, Organic, and Biological facilities for synthesis, preparation, and assembly; Nanofabrication, for processing and integration; the National Center for Electron Microscopy and Imaging and Manipulation, for characterization; and Theory, for understanding and predicting material properties. In summarizing the Foundry program, a selection of recent results will be highlighted such as those using automated high-throughput synthesis of nanocrystals, 2d materials, metal-organic frameworks, and sequence-specific polymers; aberration-corrected electron microscopy and electron tomography of individual proteins; 20 nm resolution optical spectroscopy; synthesis and simulations of nano-hybrid thermoelectrics and electrode-electrolyte interfaces; and interfaces between inorganic nanoscale building blocks with living cells.

The Molecular Foundry is supported by the Office of Science, Office of Basic Energy Sciences, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

4:40pm **MS-TuA8 User Opportunities at the Center for Nanoscale Materials: From Hybrid Nanomaterials to Tailoring Nanoscale Interactions**, ***Kathleen Carrado Gregar***, Center for Nanoscale Materials at Argonne National Laboratory

The mission of the Center for Nanoscale Materials (CNM) user facility at Argonne National Laboratory is to provide expertise, instrumentation, and infrastructure for interdisciplinary nanoscience and nanotechnology research by scientists and engineers from academia, industry, and government agencies. The Center's goal is to support and explore ways to create functional hybrid nanomaterials and to tailor nanoscale interactions for energy-related research and development programs. The CNM addresses grand challenges in energy and information conversion and transport, while furthering the Department of Energy (DOE) missions in energy generation, storage, and efficiency. Unique capabilities at CNM include a large clean room, expansive synthesis and nanofabrication resources, a hard x-ray nanoprobe at the Advanced Photon Source synchrotron, myriad scanning probes including low temperature, ultrahigh vacuum STMs, TEMs with in situ holders and chromatic aberration-correction, a 30 TFlop supercomputer, oxide MBE, and ultrafast optical probes. Another CNM asset includes outstanding staff with expertise in nanocrystal and nanoparticle synthesis, complex metal oxides, nanophotonics, plasmonics, scanning probe microscopy, nanofabrication, functional bio-inorganic hybrid nanomaterials, and theory, simulation and modeling. Core technological materials range from photocatalysts to graphene to nanocrystalline diamond. All of these capabilities and expertise are available to the international research community through peer-reviewed user proposals; access is free of charge for allocated non-proprietary research in the public domain. CNM is one of DOE's premier Nanoscale Science Research Centers serving as the basis for a national program encompassing new science, new tools, and new computing capabilities for research at the nanoscale (https://nsrcportal.sandia.gov). Recent staff and user research highlights will be presented, painting a picture of present and future nanoscience and nanotechnology at the CNM (www.anl.gov/cnm).

The Center for Nanoscale Materials, an Office of Science user facility, is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under contract no. DE-AC-02-06CH11357.

5:00pm **MS-TuA9 Using EMSL Capabilities to Advance Your Research**, ***Donald Baer***, *M. Engelhard*, Pacific Northwest National Laboratory

EMSL, the Environmental Molecular Sciences Laboratory, is a Department of Energy user facility. EMSL's vision is to pioneer discoveries and effectively mobilize the scientific community to provide the molecular

science foundation for the DOE Office of Biological and Environmental Research research priorities and our nation's critical biological, environmental and energy challenges. To accomplish this vision, EMSL science is focused in four areas: biosystem dynamics and design, atmospheric aerosol systems, terrestrial and subsurface ecosystems and energy materials and processes. Processes that occur at surfaces and interfaces are critical in each of these areas and EMSL provides a wide range of unique and state-of-the-art spectroscopy, microscopy, magnetic resonance and computational capabilities to advance the relevant sciences (www.emsl.pnnl.gov).

Scientific discovery and technological innovation in environmental molecular sciences are facilitate by EMSL's integrated set of experimental and computational resources. Researchers are invited to apply for the opportunity to collaborate with recognized experts and use state-of-the-art instruments and facilities. Researchers use resources at EMSL for little or not cost if results are shared in open literature. The primary mode for obtaining access to EMSL is through an annual call for proposals oriented around specific topics identified with each science theme. This call appears in late December, Four-page proposals are due in March. As a multi-capability facility, we seek proposal that combine scientific innovation through instrument integration combining computational and experimental approaches for discovery. Increasingly we are developing and using capabilities that enable real-time *in situ* measurements in a variety of environments.

5:20pm **MS-TuA10 From Neutron Nanoscience to Direct-write Nanofabrication at the Center for Nanophase Materials Sciences**, ***Olga Ovchinnikova***, Oak Ridge National Laboratory

The Center for Nanophase Materials Sciences (CNMS) at Oak Ridge National Laboratory (ORNL) is a multidisciplinary user facility that provides the research community with access to expertise and equipment to address the most challenging issues in nanoscience. Industrial, government and academic researchers from around the world may access capabilities in functional imaging, atom-precise synthesis, and nanofabrication. The CNMS is a leader in a range of advanced nanofabrication techniques including electron beam assisted deposition on the sub-10 nm level using both gas and liquid precursors as feedstock material, 3D fabrication and atomically precise material sculpting, as well as direct matter manipulation on the atomic level by electron beams to induce material functionality. Spatially resolved quantitative measurements of physical and chemical properties of materials are available to users through unique measurement capabilities of band excitation scanning probe microscopy, scanning transmission electron microscopy, helium ion microscopy, and atom probe tomography. Furthermore, theoretical and computational approaches are available to CNMS users, as frameworks for deep-data analytics methods for imaging, and computational prediction of functional and physical properties in nanostructures, benefiting from the broad ORNL computational capabilities. Located adjacent to the Spallation Neutron Source at ORNL, CNMS acts as a gateway for the nanoscience community to ORNL’s world-class neutron science facilities, by providing diverse complementary capabilities such as selective deuteration, sample environments for multi-modal measurements, fabrication of templates for neutron reflectivity experiments, and many other materials science capabilities to complement neutron results. As one of the five Department of Energy Nanoscale Science Research Centers (see nsrcportal.sandia.gov), CNMS makes all of these capabilities, and the staff expertise to fully benefit from them, available free of charge to users who intend to publish the results, or at-cost for proprietary research, as described at cnms.ornl.gov. [The CNMS at Oak Ridge National Laboratory is a DOE Office of Science User Facility.]

Authors Index

Bold page numbers indicate the presenter

— B —

Baer, D.R.: MS-TuA9, **1**
Brough, B.: MS-TuA4, **1**

— E —

Engelhard, M.: MS-TuA9, 1

— G —

Gregar, K.C.: MS-TuA8, **1**

— L —

Luciani, V.K.: MS-TuA3, **1**

— O —

Ovchinnikova, O.S.: MS-TuA10, **2**

— R —

Ralph, D.: MS-TuA2, 1

— S —

Skvarla, M.: MS-TuA2, **1**