We encourage feedback and suggestions for the content of future newsletters. We are especially interested in receiving research highlights from CNMS users that may be featured in future issues of this newsletter. Please email us any time you have an important paper that is accepted for publication.

Message from the UEC Chair

Welcome to the April 2014 CNMS Newsletter!

Save the dates of September 15-19th for the 2014 CNMS User Meeting with two Workshops: Electrochemical Strain Microscopy organized by Sergei Kalinin and Art Baddorf and Advanced Electron Microscopy: Recent Developments for In Situ Microscopy and Imaging/Spectroscopy organized by Ray Unocic and Juan Carlos Idrobo. The User Meeting will include Plenary and Invited User speakers in addition to contributed talks and posters. Details on how to submit your abstracts will be posted shortly at the CNMS website.

In case you missed it, the ShaRE microscopy facilities were included in the last CNMS User Proposal call and accounted for nearly 1/3 of approved CNMS projects. We look forward to continued success and excellent proposals from our expanding user community. You may learn more about the capabilities brought by the merge with ShaRE at the workshop and on page 3 of this newsletter.

The UEC is here to voice your questions and comments and we value your input. Feel free to contact any UEC members directly or anonymously via the feedback button on the CNMS homepage.

Many thanks go to Viviane Schwartz for all her efforts in putting together these newsletters.

Vivek Prabhu
National Institute of Standards and Technology
Gaithersburg, Maryland
The CNMS continues to be extremely proud of its vibrant and successful User Program. Maintaining a robust environmental, safety, and health (ESH) envelope at CNMS is a primary focus at our facility and ensuring that Users work safely and remain ESH compliant is our number one goal. The continued success of our ESH program is a total team effort including but not limited to the division director, research group leaders, researchers, administrative staff, Operations, and last but most assuredly not least, our User community. The effectiveness of CNMS is highly dependent on working safely and the excellent efforts put forth by Users and CNMS staff continues to provide a strong framework for state-of-the-art nanoscale materials research. CNMS Users are always encouraged to visit our CNMS/ESH webpage and ask questions and/or seek advice with a very important premise being that there are no stupid or silly questions. For any ESH concerns, in addition to your technical contact, users should feel free to contact me: I am located at the ground floor, room J-G56, and my email is hollenbecksm@ornl.gov.

Thanks to all our Users for making CNMS a success!!!

Scott Hollenbeck
CNMS Operations Manager

News from CNMS

OPEN! CNMS Call for User Proposals: High-Impact Nanoscience Research

Deadline for submission: Wednesday, April 30, 2014

The Center for Nanophase Materials Sciences (CNMS) at Oak Ridge National Laboratory (ORNL) is soliciting proposals for user-initiated nanoscience research that will make effective use of CNMS facilities and staff expertise. The CNMS nanoscience research program provides users with access to a broad range of capabilities for nanomaterials design, synthesis, characterization, and theory/modeling/simulation in order to carry out studies that will significantly advance our understanding of nanoscale phenomena and develop functional nanomaterials systems. Access is provided at no cost to users for research that is in the public domain and intended for publication in the open literature.

The CNMS website provides detailed descriptions of specific CNMS Research Capabilities that are offered to users. Prospective users are invited and strongly encouraged to contact CNMS staff members in the respective research areas to discuss their proposal ideas and learn more about the specific capabilities of interest to them.

Thank a Staff Member

The CNMS User Executive Committee recently requested a new channel to allow users to show their appreciation and let CNMS Management know about staff members that had provided exceptional assistance during the execution of a user project. Visit the User Group page of the CNMS website to find our “Thank a CNMS Staff Member” button! CNMS management will review submissions periodically and award special recognition for staff who have provided user support “above and beyond” the routine.

Additionally, users have an opportunity to suggest to CNMS management ideas for new equipment or scientific expertise that they would like to see at CNMS – use the Suggestion Box for that!
New Equipment/Capabilities

Liquid cell microscopy is an emerging in situ S/TEM based characterization technique that allows for the direct imaging and analysis of liquid phase phenomena at high spatial and temporal resolution. This method utilizes microfabricated silicon microchip devices to encapsulate thin layers of liquids between electron transparent viewing membranes to probe nanoscale chemical and electrochemical processes. The system is part of a unique suite of specialized in situ TEM holders in the CNMS electron microscopy group. A recent application (ORNL microscopy system delivers real-time view of battery electrochemistry) appears in an article published in Chemical Communications and highlighted under CNMS in the News below. Prospective users that are interested in learning more about this new CNMS capability are encouraged to contact Dr. Raymond Unocic at unocicrr@ornl.gov.

Career Opportunities at the CNMS

Currently, there are 11 positions open. The most recent postings include: R&D Staff Scientist-Polymer Program, Senior Polymer Scientist, Postdoctoral Research Associate-Microfluidics. Visit the website for more information and links to view open positions as well as other opportunities at ORNL.

NUFO Newsletter

The National User Facility Organization (NUFO) is now publishing a newsletter available online. Founded in 1990, NUFO represents the interests of all users who conduct research at U.S. National Scientific User Facilities, as well as scientists from U.S. universities, laboratories, and industry who use similar facilities outside the United States. The NUFO Newsletter keeps us informed about news and events that are of interest to the user community. Please, visit their website to find out about the latest updates!

CNMS in the News

ORNL microscopy system delivers real-time view of battery electrochemistry

Using a new microscopy method, scientists at ORNL can image and measure electrochemical processes in batteries in real time and at nanoscale resolution. They used a miniature electrochemical liquid cell that is placed in a transmission electron microscope to study an enigmatic phenomenon in lithium-ion batteries called the solid electrolyte interphase, or SEI, as described in a study published in Chemical Communications and highlighted at Science Daily and ClimateWire.
Researchers grow carbon nanofibers using ambient air, without toxic ammonia

Materials science researchers from North Carolina State University (NCSU) and CNMS have demonstrated that vertically aligned carbon nanofibers can be manufactured using ambient air, making the manufacturing process safer and less expensive. Vertically aligned carbon nanofibers hold promise for use in gene-delivery tools, sensors, batteries and other technologies.

“This discovery makes VACNF manufacture safer and cheaper, because you don’t need to account for the risks and costs associated with ammonia gas,” says Dr. Anatoli Melechko, Associate Professor, Department of Materials Science and Engineering at NCSU and lead scientist in the paper published at Nanomaterials and Nanotechnology and highlighted in Science Daily. “This also raises the possibility of growing VACNFs on a much larger scale.”

Research Highlights

User Spotlight

Zhigang Jiang – Associate Professor in the School of Physics at Georgia Institute of Technology

“Probing energy, symmetry and dispersion of low-lying excitations and studying many-body effects in novel electronic materials via spectroscopy techniques are longstanding goals of my research program. At CNMS, I am currently collaborating with Dr. An-Ping Li in studying the ballistic transport in epitaxial graphene nanoribbons using four-probe scanning tunneling microscope, and with Dr. Petro Maksymovych in probing the topological surface states of the Kondo insulator, samarium hexaboride, using low-temperature scanning tunneling spectroscopy. These measurements would not be possible without the state-of-the-art user facilities in the Imaging and Nanoscale Characterization Group, as well as the dedicated technical support from both Dr. Li’s and Dr. Maksymovych’s groups.”

Dr. Jiang joined the School of Physics at Georgia Tech in 2008, where he is currently an Associate Professor. Before joining Georgia Tech, he was a Postdoctoral Fellow at the National High Magnetic Field Laboratory, co-sponsored by Columbia University and Princeton University. He received his Ph.D. in Experimental Condensed Matter Physics in 2005 from Northwestern University and his B.S. in Physics in 1999 from Beijing University, China.

Following is a recent highlight from Prof. Jiang’s work at CNMS.
Exceptional Ballistic Transport in Epitaxial Graphene Nanoribbons

Scientific Achievement

We show electrical resistance in nanoribbons of epitaxial graphene changes in discrete steps, allowing electrons to flow smoothly along the ribbon without scattering on greater than 10 μm length scale, similarly to metallic carbon nanotubes.

Significance and Impact

This work unambiguously shows graphene ribbons are metallic and transport is one-dimensional, involving a single quantum conductance channel, in contrast to general belief of graphene ribbons as semiconductors.

Research Details

— Graphene ribbons are produced by thermally annealing either natural or etched steps on a SiC substrate.

— The structural and electronic properties are studied by atomic force microscopy (AFM), scanning tunneling microscopy (STM), 4-probe STM, and a cryogenic transport measurement system.

J. Baringham, M. Ruan, F. Edler, A. Tejeda, M. Sicot, A. Taleb-Ibrahimi, A.-P. Li, Z. Jiang, E. Conrad, C. Berger, C. Tegenkamp, and W. A. de Heer,

CNMS Staff Spotlight

Kai Xiao – Staff Member in the CNMS Nanomaterials Synthesis and Functional Assembly Group

“I’m interested in understanding and controlling the synthesis and processing of thin films and nanostructured materials for optoelectronic devices (see recent example below). Specifically, my first research interest is in developing and using organic semiconducting materials in organic thin film devices (including photovoltaics, field-effect transistors, and memories) for fundamental understanding of their electronic properties, to discover new physical phenomena, and to contribute to the development of new practical electronic applications. Another recent focus area is on rational design and controlled synthesis, characterization, processing and applications of novel 2D layered materials (organic, inorganic and their hybrid) and fundamental investigation of their new chemical, optical, electronic and magnetic properties. My research at CNMS includes thin film and nanoscale device fabrication integrating new materials, developing new technological processes and physical characterization. Establishing a relationship between molecular organization and physical properties is fundamental towards nano-engineering devices. It is very exciting to work at CNMS.
and collaborate with staff scientists and users from different backgrounds because my research is highly interdisciplinary and combines organic/inorganic nanomaterial synthesis and processing, optoelectronic devices and physical aspects. CNMS has excellent complementary expertise from chemists, physics, materials scientist and engineers, theorists and they are open to new challenges coming regularly from users.”

Dr. Kai Xiao is a staff scientist in the CNMS Nanomaterials Synthesis and Functional Assembly Group and a joint faculty at Department of Computer Science and Electrical Engineering at University of Tennessee at Knoxville. He received his M.S. in Materials in 2001 from Institute of Metal Research, Chinese Academy of Sciences and his Ph.D. in Physic Chemistry in 2004 from Institute of Chemistry, Chinese Academy of Sciences. He worked as a Postdoctoral Associate at CNMS and became a Staff Scientist in 2008. He has published approximately 70 papers, 3 book chapters and has several patents.

### Isotopic effects of deuteration on the optoelectronic properties of conducting polymers

#### Scientific Achievement

We show that selective substitutions of deuterium (D) on the backbone or side-chains of conducting polymer poly(3-hexylthiophene)s (P3HT) significantly change their optoelectronic response in P3HT/PCBM ([6,6]-phenyl-C61-butyric acid methyl ester) photovoltaics.

#### Significance and Impact

Our work shows that isotopic substitution, once thought to be a benign modification, provides a new means to tune the optoelectronic properties of conducting polymers used for solar cells by affecting their intra- and inter-polymer chain interactions.

#### Research Details

- Developed a series of P3HT isotopes by selectively substituting deuterium on the backbone (MD-P3HT) or alkyl group (SD-P3HT).
- Integrated approaches including neutron/x-ray scattering, TEM and theoretical modeling to understand the origins of the large effects of D on the optoelectronic and structural properties.


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### Staff Honors

Congratulations to **Nina Balke**! She has just been elected a vice-chair for the next Gordon Research Conference on Batteries: Advances in Characterization, Analysis, Theory and Modeling of Basic Processes in 2016.