January 2016

CNMS User Newsletter

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Important Dates:

- Call for Proposals: 2016B
  -Deadline: May 4
  to be announced in spring!
- CNMS User Meeting
  -August 10-12, 2016

Inside this issue:

Message from the User Executive Chair

Behind the Scenes at CNMS

Like you, I am a user of CNMS. I know first hand how time at a user facility can enhance the productivity of a research program and focused interaction with CNMS staff can offer new perspectives. I also know that CNMS will need to continue to evolve and update its expertise to meet the dynamic needs within our materials science community as we strive to solve 21st century challenges. This strategic vision for what CNMS should be will come from the CNMS leadership, advisory committee and most importantly—you the users. Your voice is channeled through the CNMS User Executive Committee (UEC), an elected committee of users tasked with working on your behalf to continuously improve the experience of users, voice user concerns in equipment selection and strategic planning and ensure consistent and fair proposal review processes.

I am delighted to introduce the 2016 CNMS UEC. Returning to this committee: Nazanin Bassiri-Gharb (past Chair, Georgia Tech), Eric Formo (U. Georgia), Enrique Gomez (Penn State U.), Megan Robertson (U. Houston), and Rafael Verduzco (Rice U.). Five new members joined on January 1st including Alex Belianinov (ORNL/CNMS), Kathrin Dörr, (MLU Halle-Wittenberg), Lane Martin (U. California, Berkeley), Evgheni Strelcov (NIST), and Yang Zhang (U. Illinois). Two of these members were also elected to the leadership team: Lane Martin (2016 Vice-Chair) and Yang Zhang (2016 Secretary).

This year we will continue the efforts started by the 2015 Chair, Nazanin Bassari-Gharb, to increase user input in the center's strategic planning process. She was the driving force for the 2015 User Meeting theme "*Planning the Second Decade*" and ensured that the output from the meeting was formally presented to CNMS management for incorporation into the 2015 revision of the CNMS Strategic Plan. Approximately 230 researchers attended the 2015 meeting; a 20% increase in over the prior year. The organizers initiated a topical roundtable format to ensure dialog regarding plans for new user capabilities at CNMS, with some sessions being standing-room only. The roundtables culminated with the annual user Town Hall Meeting with over 100 people in attendance.

On behalf of the UEC, I am also excited to announce that the dates for the 2016 CNMS User meeting are finalized (August 10-12, 2016). Please mark your calendars!!

Marian (Molly) Kennedy
Clemson University, Clemson, SC

News from CNMS

CNMS User Meeting a Success!

Approximately 230 researchers attended the 2015 CNMS User Meeting held on September 1-2, 2015. The attendance was a new record for the user meeting. The opening poster session on Tuesday afternoon featured 62 posters, another CNMS record, and the posters remained well-attended throughout the meeting. Thirty-two posters were presented by students competing for **Best Student Poster** with six prizes awarded on Wednesday! The new topical roundtable format was extremely successful for generating lively dialog regarding plans for new user capabilities at CNMS, with some sessions being standing-room only. The roundtables culminated in the best-attended user Town Hall Meeting we've ever had (over 100 in attendance!), during which each roundtable delivered a one-slide summary of their recommendations.

Results of 2016A Proposal Call

For the 2016A Proposal Call, there were 160 proposals submitted and 124 were approved. Extensions for eligible 2015A projects are underway.

*** It is important to use the latest version of the **CNMS Proposal Form** because the equipment offered is subject to change and only the latest form contains the up-to-date list.***

Staff Updates

Alex Belianinov, Ph.D.

R&D Staff Researcher in Nanofabrication Research Laboratory Group

My research interests revolve around expanding imaging and spectroscopic capabilities in various microscopy platforms such as Scanning Probe, Electron and Helium Ion. These newly developed capabilities are then applied to study a broad range of material classes, interfaces, and functional devices. Notably, much of the development is focused on designing and implementing third party control and detection schemes, capable of collecting more data in a broader parameter space. What makes this wealth of data useful is integration of the experimental techniques with novel computational algorithms and capabilities. The hardware that handles data processing of these large, multidimensional data sets is identical to what is being utilized by theorists in their computational and simulation efforts. The goal of my research program is to unify experimental and theoretical efforts via an umbrella computational approach where data flow between the experiments to theory is seamless and real-time.

Alex received his Ph.D. in Analytical Chemistry from Iowa State University in 2012. Prior to joining CNMS as a staff member in 2015, he was a postdoctoral researcher at CNMS in the Scanning Probe Microscopy group working with Sergei Kalinin.

Olga Ovchinnikova, Ph.D.

R&D Staff Researcher in Nanofabrication Research Laboratory Group

My research focuses on investigating the relationships between physical structure and chemical functionality at the nanoscale through the development of multimodal imaging platforms, and co-registration of multidimensional data. Additionally, I work on engineering control in functional materials using helium and neon ion beams; investigating relationships between physical structure and chemical functionality through local tuning of material properties using a scanning helium ion microscope, probing the resultant material functionality using advanced scanning probe and optical spectroscopy; development of in-situ helium ion microscopy to understand influence of local structure on chemical dynamics and ion beam interactions.

Olga received her Ph.D. in 2011 from the University of Tennessee, Knoxville, in Chemical Physics. Following her Ph.D., she worked as a postdoctoral associate and research staff scientist in the Organic and Biological Mass Spectrometry Group in the Chemical Sciences Division at ORNL developing spatially resolved atmospheric pressure surface sampling/chemical imaging mass spectrometry approaches.

CNMS Users on LinkedIn

The UEC has started a LinkedIn group titled, **Center for Nanophase Materials Sciences (ORNL CNMS) – Present, Past and Future Users**, with the goal of connecting users in order to increase scientific discussions, interactions, and collaboration. Check out the group page and join at https://www.linkedin.com/groups/8448231.

About the UEC
-Contact information
-Web links

Research Highlights

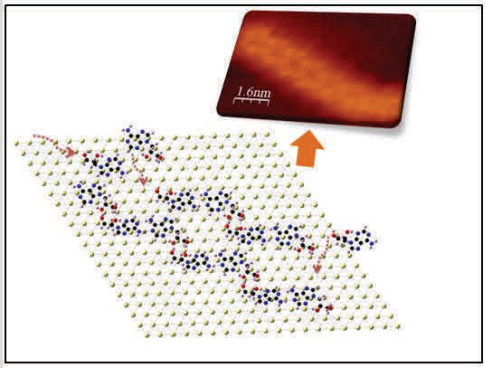
Miguel Fuentes-Cabrera
Research Scientist, Nanomaterials Theory Institute
Center for Nanophase Materials Sciences

"I am interested in self-organization at the nanoscale. I find it fascinating how systems can organize themselves into patterns and I want to predict what patterns they form and how they do it. I like to work with complex systems composed of molecules on metallic substrates, levitating droplets (Leidenfrost droplets) on a ratchet, and even nanorobots. I'm a theorist, so I use computers and a variety of theoretical techniques to delve into scientific questions. One particular technique that I'm very interested in is agent-based modeling. It has been used a lot in areas where complex phenomena leads to self-organization, areas such as microbiology and social sciences, but it has not been used very much in nanoscience; I think there is an opportunity there. Fortunately, CNMS offers a great environment to pursue these research opportunities. Here, a theorist can easily chase experimentalists down the hall until they agree to conduct an experiment to test your hypothesis. They also chase us from time to time, unrelentingly, if I may say! Come to think of it, perhaps that is one of the reasons why I enjoy going outdoors to exercise. We're blessed here with mountains, rivers and lakes; so I whitewater kayak, mountain bike, and most of all trail run. I even went skiing recently for the first time, but that's something I'd rather not talk about!"

Miguel was born in Tenerife, Canary Islands, Spain. He received his Ph.D. in Physics in 1998 from the University of La Laguna, although a large portion of the research was done at Arizona State University, ASU. He did a Fulbright postdoc at ASU, and a postdoc in biophysics at North Carolina State University. He has been a staff member at CNMS since 2009.

Here's a recent highlight from Dr. Fuentes-Cabrera's research at CNMS that was published in *Nature Scientific Reports.*

Extending Supramolecular Polymerization to New Lengths



Schematic representation of the polymerization process. Upper right-corner, high-resolution image of the chain-like structure.

Scientific Achievement

A molecule deposited on a metallic substrate was found to form a polymer encoding a sequence that remained intact for hundreds of nanometers (two orders of magnitude increase over prior accomplishments).

Significance and Impact

Polymerization on substrates is a promising approach for designing and creating polymers that store information that is readable and erasable with microscopy techniques.

Research Details

- A molecule with two parts, A and B, was deposited on Gold which guides the self-assembly of chain-like structures spanning a length 100X longer that previously made.
- Calculations and imaging techniques revealed that the chains encode the sequence A-A-B-B-A-A, etc.
- The sequence can be erased by applying voltage across a scanning tunneling microscope.

Work was performed at the Center for Nanophase Materials Sciences, the Tokyo Institute for Advances Study, and the Universidad Autónoma del Estado de Hidalgo, Mexico.

Wang, J. et al. *Nat. Sci. Rep.* (2015) DOI: 10.1038/srep18891.

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OAK RIDGE National Laboratory

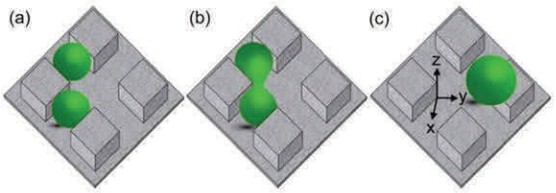
Chuan-Hua Chen
Associate Professor of Mechanical Engineering & Materials Sciences
Duke University

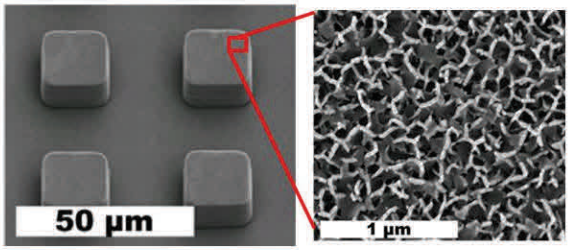
"I am interested in the self-propelled condensation process, in which condensate droplets jump away from superhydrophobic surfaces upon drop coalescence. My former Ph.D. student Jonathan Boreyko made the initial discovery and joined ORNL as a postdoc under the direction of Dr. Pat Collier. Prior to our joint user project, an open question in the field was whether or not the self-propelled motion can be combined with the sweeping removal of dropwise condensate. The sweeping process simultaneously removes a large number of condensate droplets and is essential for effective condensation, but is conventionally driven by gravity. Using the cleanroom facilities at CNMS, Jonathan was able to fabricate a microstructured condenser with nanoscale surface roughness, a design that enabled the self-propelled sweeping removal of the condensate droplets, in a manner that is completely independent of external forces including gravity. Aided by the world-class facilities at CNMS, the self-propelled sweeping removal is now demonstrated, opening up new possibilities to enhance self-sustained condensation."

Chuan-Hua Chen is an Associate Professor and Hunt Faculty Scholar in the Department of Mechanical Engineering and Materials Science at Duke University. Dr. Chen received his B.S. degree in Applied Mechanics from Peking University (1998) and Ph.D. degree in Mechanical Engineering from Stanford University (2004). Since joining Duke in 2007, Dr. Chen has received the NSF CAREER Award and the DARPA Young Faculty Award.

Following is a highlight from Professor Chen's user research in CNMS that was recently published in *Applied Physics Letters*.

Nanotextured Micropillars Accelerate Ice/Water Removal from Surfaces for Heat Exchangers





Two-tier roughness consisting of silicon micropillars coated with aluminum nanostructures facilitate sweeping removal of water drops in-plane by inducing coalescence between neighboring drops at micropillar edges.

Work was performed as User Project at the Center for Nanophase Materials Sciences , at Duke University, and at the University of British Columbia.

Scientific Achievement

Superhydrophobic surfaces consisting of nanotextured micropillars induce sideways jumping of water droplets, which can rapidly remove water condensate from the surface in a "chain reaction".

Significance and Impact

Rapid removal of liquid drops due to coalescence – induced drop jumping can increase heat transfer rates by up to a factor of ten, leading to enhanced performance in refrigeration, heating and power generation applications.

Research Details

- Nano/micro roughness needed to induce lateral droplet motion was realized by coating silicon micropillars with nanoroughened aluminum.
- In contrast to previous reports where drop motion was perpendicular to the surface, drops coalesce at micropillar corners, resulting in a lateral sweeping removal of liquid across the surface resulting from subsequent coalescence of neighboring drops.

X. Qu, et al. *App. Phys. Lett.* 106, 221601 (2015) DOI: 10.1063/1.4921923

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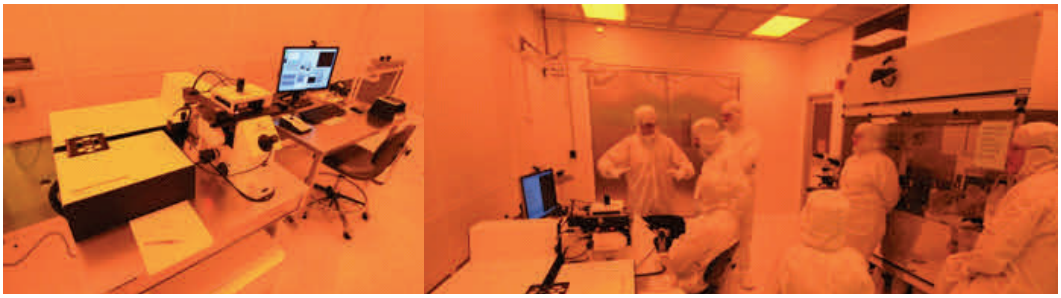
Duke UNIVERSITY
OAK RIDGE National Laboratory

New Equipment

Installation of the new 3D lithography tool (NanoScribe Pro GT) tool is now complete! The tool is located in the CNMS cleanroom in the bay previously known as "e-beam resist area." This new capability enables deterministic sculpting of arbitrarily shaped nano- and micro- structures in 3D with spatial resolution as high as 200nm along each axis within up to a few cubic millimeters of total volume. The NRL staff plans to add the tool as a standard capability in the next proposal call.



CNMS Honors and Awards

Thomas Maier has been named a Fellow of APS. Maier was cited by the APS's Division of Condensed Matter Physics for "numerical and phenomenological calculations that have provided insight into cuprate and iron-pnictide superconductors."

Sergei Kalinin has been named a Fellow of APS. Kalinin was cited by the APS's Division of Materials Physics for "foundational contribution to nanoscale electromechanics and revolutionary studies of defect-mediated phase transitions, energy conversion and electrochemical reactivity at the nanometer and atomic scales enabled by advanced scanning probe microscopy techniques."

UT- Battelle Award Night Winners were recently announced and the CNMS has several reasons to celebrate! **Miaofang Chi** was awarded an Early Career Research Award, **Ray Unocic** was awarded a Team Research Accomplishment Award, **Rama Vasudevan** was awarded a Postdoctoral Researcher Award, and **Scott Hollenbeck** was awarded an individual award in Mission Support.

CONGRATULATIONS !!

Career Opportunities at CNMS

Visit the website for more information and links to view open positions as well as other opportunities at ORNL.

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.