January 2015

CNMS User Newsletter

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Important Dates:

CNMS User Meeting
Tentative Dates:
Aug. 31—Sept. 4, 2015

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Message from the UEC Chair

On behalf of the CNMS User Executive Committee (UEC), welcome to the first CNMS Newsletter of 2015! I would like to welcome two new members of the UEC, Dr. Eric Formo from University of Georgia and Prof. Enrique Gomez from Penn State, as well as the re-elected members, Profs. Rafael Verduzco (Rice University) and Megan Robertson (University of Houston). A big welcome back also to Prof. Molly Kennedy of Clemson University who returns as the new Vice Chair after finishing her term as an At-Large member.

Last year, the UEC and CNMS leadership interacted in many ways with the user community. In parallel with the UEC election, you voted for three amendments to the UEC By-Laws and all were approved. The updated By-Laws can be found on the CNMS website. A survey was sent out to over 1500 users and non-users to gauge interest with respect to possible capital equipment acquisitions by CNMS. The interest level was relatively uniform for all proposed equipment. The CNMS and ORNL leadership are currently evaluating the possible impact of these new capabilities and we are expecting a report back with a decision for acquisition of one or more of these equipment.

Of course, our biggest yearly interaction with the user base was the annual user meeting. In 2014, the CNMS User Meeting was accompanied by two workshops on advanced electron microscopy and probing nanoscale electromechanical response of functional materials, which were extremely well attended. Our very first Student Poster Competition showcased more than 50 posters and was also very well attended. We have tentatively scheduled the 2015 CNMS User Meeting for the week of August 31 through September 4. Please mark it on your calendar, or let the UEC know as soon as possible if there is any major conflict with technical conferences or workshops. We hope to see many of you on-site during the Annual Meeting and are planning to repeat the great experience of the Student Poster Competition.

In September, we also had our User Satisfaction Survey. The results were overwhelmingly positive with more than 90% satisfied or very satisfied with their experience at the CNMS. A CNMS subcommittee, headed by Dr. Robertson, compiled a list of the responses and suggestions and created a report that has been submitted to the CNMS leadership with four recommendations for further improvement of the communications with the user base. I would like to remind you that the UEC members are always here to listen to the users: You can contact me or any other UEC member at any time with your suggestions and comments. Similarly, the CNMS website allows you to submit anonymously your comments and suggestions directly to the CNMS leadership and program management team. Last but not least, considering the amount of positive response with respect to the interaction with CNMS staff, you can also "Thank a CNMS Staff" by using the appropriate link provided on the CNMS website.

2014 closed on a very sad note for the CNMS community, with the tragic passing of staff member, Dr. Michael Biegalski. We will all miss Mike as a great member of our community. My condolences, on behalf of the whole UEC and the users group, go to his family and the CNMS staff. Please see the In Memoriam piece at the end of the Newsletter for information on the memorial fund for the education of his daughters and the online guestbook.

The UEC had many accomplishments in 2014 and the biggest thank you goes out to our exiting UEC Chair, Dr. Vivek Prabhu of NIST. He will continue to serve on the UEC as an ex-officio member and Past-President. A big thank you also to Prof. Tony Hmelo, our past-president from University of Tennessee, and Dr. Nina Balke of CNMS. Many thanks to the CNMS User Program Manager, Tony Haynes, and the CNMS Director, Hans Christen that have worked tirelessly with the UEC to make CNMS even better over the past year. I am looking forward to work with them, the UEC and all the CNMS users this year.

Nazanin Bassiri-Gharb
Georgia Institute of Technology, Atlanta, GA, USA

About the UEC
-Contact information
-Web links

News from CNMS

User Executive Committee (UEC) Election

Users voted online during October to elect a Vice Chair and four At-Large members to serve on the 2015 UEC. Eleven candidates offered their services and appeared on the ballot. Molly Kennedy of Clemson University was elected as Vice Chair. The winners of the At-Large seats included two new members, Eric Formo (University of Georgia) and Enrique Gomez (Penn State), along with two re-elected members, Megan Robertson (University of Houston) and Rafael Verduzco (Rice University). Other changes in the UEC committee roster for 2015 include the succession of Nazanin Bassiri-Gharb (Georgia Tech) to Chair and Vivek Prabhu (NIST) to Past Chair. Please join in thanking two departing UEC members Nina Balke (ORNL, 4 years) and Tony Hmelo (Vanderbilt University, 5 years) for their service to the CNMS User Group. Visit the CNMS User Group website for the complete list of UEC members and updates on their activities throughout the year, including minutes of their monthly teleconferences.

In parallel with the UEC election, CNMS Users voted to approve three amendments to the By-Laws. These amendments define procedures for filling mid-term vacancies on the UEC, resolving ties in an election, and clarify that an At-Large member must complete their current term before seeking an Officer position. The User Group website includes a link to the updated Charter and By-Laws (direct link http://www.cnms.ornl.gov/uec/CNMSUG_Charter.pdf).

Users and Non-Users Provide Input on Capital Equipment for CNMS

CNMS approached the UEC for advice last fall as it was updating its short- and long-range capital equipment plans. The UEC in turn initiated a survey to gauge interest in different pieces of equipment that are currently being considered for purchase in FY2015. An online survey was distributed to 1600 researchers during the week of November 10-14, 2014, including both users and non-users. Five capital items were proposed in the survey – 3D lithography, *in-situ* TEM upgrades, electrical probes for microscopes, x-ray diffraction upgrades, GISAXS detector – and for each item participants were asked whether they would use it, knew someone else who would, or had access to similar equipment elsewhere. The interest level was very uniform across the board, with none of the proposed items being clearly favored or disfavored by the respondents. For each of the five items, more than a third of the respondents answered that they would use the equipment if available at CNMS and 45% or more indicated that they know someone else who would use it. In addition, 85% of the respondents reported they would not have access to such equipment elsewhere. These are all important factors that will be considered when making capital equipment decisions at CNMS, and CNMS and its UEC greatly appreciate the community taking time to provide this input. Also suggested by the UEC, a new field has been included on the CNMS Proposal Form giving the opportunity for users currently applying for access to CNMS facilities to voice their suggestions for new capabilities. We hope to report back here within the next few months that one or more of these new instruments will be available to users at CNMS.

2015A Proposal Call Results

For the 2015A Proposal Call, there were 170 proposals submitted and 125 were approved. Extensions for eligible 2014A projects are underway. *More information* on extensions…

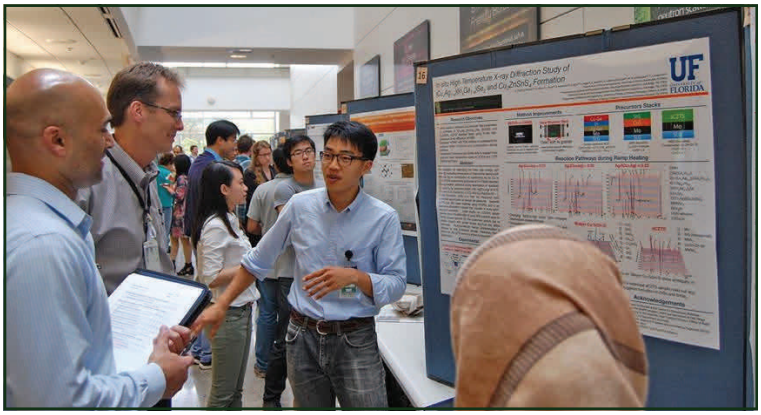
Career Opportunities at CNMS

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

The 2014 Annual CNMS User Meeting

The annual CNMS User Meeting was held on the Chestnut Ridge campus of ORNL on September 16-17 with over 200 registered attendees. The program for this year's meeting was planned in its entirety by the CNMS UEC and included several new events such as a Best Student Poster Award competition with more than 29 entries (winners list below), oral session on New CNMS Capabilities (4 talks), and a panel session in which CNMS and SNS leaders fielded questions from the attendees as well as users not in attendance who had the opportunity to submit their questions via the UEC. The User Meeting program, including abstracts, is available online. The User Meeting was bracketed by two workshops: "Nanoscale Electromechanical phenomena in functional materials" was held Sept. 15-16 (over 70 registered), and "Advanced Electron Microscopy" on Sept. 18-19 (over 90 registered). Both workshops included in-lab demonstrations of relevant cutting-edge equipment that is available to CNMS users.

Scenes from the CNMS User Meeting poster session that included more than 50 posters and featured the first **Student Poster Competition**.



Student award list:
First place: Steven Brewer (Georgia Institute of Technology)
Second place: Ryan Nicholl (Vanderbilt University)
Third place: Danielle Lincoln (University of Tennessee)
Finalist: Jilai Ding (Georgia Institute of Technology)
Finalist: Yan Jin (University of Kentucky)
Finalist: Humaira Taz (Bredesen Center, University of Tennessee)

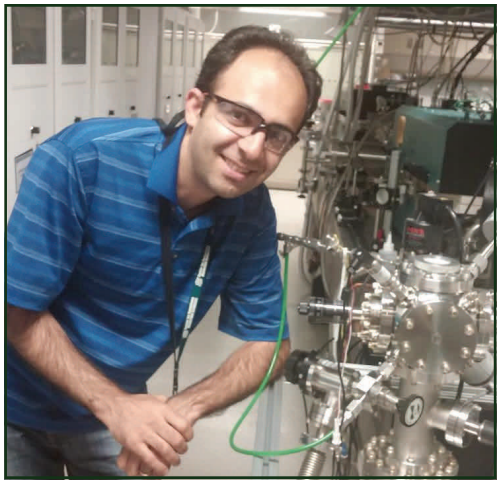
Results of the 2014 User Satisfaction Survey

In September of each year the CNMS conducts a User Satisfaction Survey to fulfill part of its annual reporting requirement to DOE's Office of Basic Energy Sciences (BES). The survey consists of 10 questions prescribed by BES that are designed to gauge user satisfaction about facility operation and user support, and to identify research benefits, best practices, and opportunities for improvement. It's also important to note that this survey provides a measure of user interest (or apathy) in terms of the fraction of users who take the time to respond (t_{ave} < 2min). The UEC has reviewed the results of the 2014 Satisfaction Survey and provided a report with some recommendations for improving the user experience. The overall response of the users was overwhelmingly positive, with 92-96% of users reporting they were either Satisfied or Very Satisfied with the schedule, availability, and performance of instrumentation and CNMS staff. Many users, while satisfied with their experience, also offered constructive suggestions for improvements. The 3-page UEC report concluded with four recommendations for addressing some of the more common themes that cross-cut the survey comments. Broadly, all four recommendations identify needs for better communication of facility/instrument operating schedules, possibilities for off-hours access based on user proficiency and staff availability, and changes in capabilities offered, especially as related to the incorporation of the former ShaRE user facility that occurred during 2014. The UEC looks forward to the continued dialogue with the CNMS and ORNL leadership over the coming months regarding these recommendations to improve the user experience.

Research Highlights

Masoud Mahjouri-Samani

Postdoctoral Researcher, Nanomaterials Synthesis and Functional Assembly Group

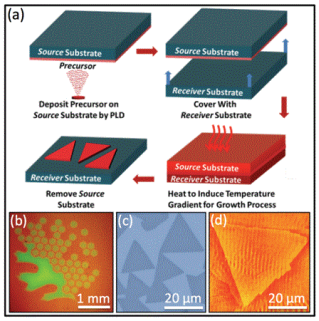


"I am interested in laser-material interactions for spatiotemporal-resolved studies and control of the fundamental growth mechanisms and properties of 0-, 1-, and 2 -dimensional nanomaterials. I am also interested in exploring the applications of nanomaterials in energy, optoelectronics, and sensing. Lasers have the ability to accurately deliver specific amounts of energy into confined regions of interest in order to achieve a desired response that cannot be easily achieved by other means. My research has been focused on utilizing the spatial coherence and temporal tunability of laser beams for localized heating or ablation, laser direct-writing, laser-assisted chemical vapor deposition, and ultrafast spectroscopy, thereby enabling a broad spectrum of applications in synthesis and characterization of functional nanostructures. My scientific goals and professional aspirations are greatly facilitated by having access to computational, synthesis, processing, and characterization capabilities as well as by interacting with highly experienced scientists at CNMS. Above all, interaction with other CNMS users has greatly expended my collaboration and scientific network."

Dr. Mahjouri-Samani is currently a postdoctoral researcher in the Nanomaterials Synthesis and Functional Assembly (NSFA) group. He received his Ph.D. in Electrical Engineering from the University of Nebraska-Lincoln in 2013 specializing in laser-assisted nanomaterials synthesis and applications.

Following is a recent highlight from Dr. Mahjouri-Samani's work at CNMS.

Digital Transfer Growth of Patterned 2D Metal Chalcogenides by Confined Nanoparticle Evaporation



(a) Illustration of the digital transfer growth technique. Nanoparticles deposited by PLD onto a *source* substrate are covered by a *receiver* substrate and heated in a background gas. The nanoparticles evaporate and grow 2D crystals by confined vapor transport on the receiver substrate. (b) Complex patterns of PLD-deposited nanoparticles on the source substrate can be transferred into identical patterns on the receiver substrate that are composed of triangular monolayer 2D crystals, shown in (c) optical and (d) AFM images.

Work was performed as a User Project at the Center for Nanophase Materials Sciences.

Scientific Achievement

A new method was developed to synthesize large-area 2D metal chalcogenide crystals of controlled layer number and stoichiometry in prepatterned locations by confined evaporation of laser-deposited nanoparticles.

Significance and Impact

This unique approach overcomes several processing roadblocks for the scalable growth and patterning of 2D metal chalcogenide crystals for optoelectronic and energy related applications.

Research Details

- Pulsed laser synthesized GaSe (or $MoSe_2$) nanoparticles were deposited in patterns on a *source* substrate, which were then evaporated to grow large 2D crystals of GaSe (or $MoSe_2$) on a cooler *receiver* substrate in close proximity.
- Large monolayer crystalline domains (~100 µm lateral sizes) of GaSe and $MoSe_2$ were demonstrated in the patterned locations, as well as continuous monolayer films through the deposition of additional precursor materials.
- The technique combines the advantages of pulsed laser deposition (PLD), i.e., stoichiometry transfer and digital deposition control, with the novel confined vapor transport growth from evaporated nanoparticles.

M. Mahjouri-Samani, *et. al.*, *ACS Nano* (2014). DOI: 10.1021/nn5048124

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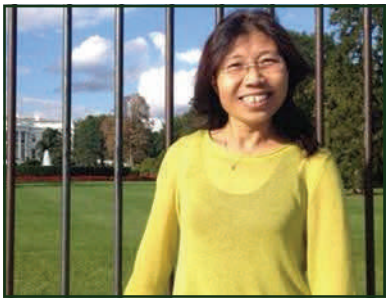
THE UNIVERSITY of TENNESSEE KNOXVILLE

OAK RIDGE National Laboratory

Zheng Gai

Staff Member in the Imaging and Functionality Group

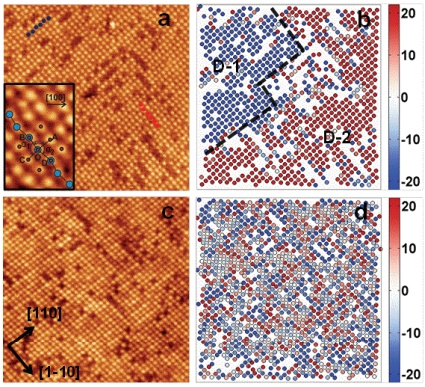


"The primary focus of my research lies on understanding fundamental novel properties of functional materials in the discipline of condensed matter physics, which includes the growth form and mechanisms, novel magnetic properties and electronic properties. The functional materials I am interested in are low-dimensional materials, such as surface-based materials, metal/oxide films, complex oxide films, magnetic films, as well as nanostructures. Especially, I am interested in the utilization of these materials for energy applications. I use various equipment/techniques at CNMS to conduct my research. I grow the materials using MBE or PVD system, monitoring the quality of the material with in-situ techniques like RHEED, LEED and Auger, in-situ studying the growth form, mechanisms and properties using variable temperature STM/AFM/MFM, and ex-situ studying the global properties using XRD, MPMS and PPMS. Nanofabrication is also used to make all kind of devices from the novel material. As an experimentalist, it is very exciting to work at CNMS where I have direct access to a large amount of state-of-art instrumentation and in-house theoretical collaborations. Also, I like the international environment at CNMS and ORNL with opportunities of collaborating with researchers from all over the world."

Dr. Zheng Gai is an experimentalist in the Imaging Functionality Group since 2005. Before coming to CNMS, she was a full professor at the Department of Physics of Peking University, China. She worked as a visiting professor in Max Planck Institute of Microstructure Physics, Halle, Germany, Tohoku University, Sendai, Japan, and State University of New York, Stony Brook. She received her Ph.D. in Condensed Matter Physics in 1995 from Peking University. She has published 105 peer-reviewed papers.

Following is a recent highlight from Dr. Gai's work at CNMS.

Chemically induced Jahn-Teller ordering on manganite surfaces



Direct visualization of the distortion domains in unoccupied state STM image of LCMO surface (a and b). Such domains are absent in the occupied state image (d and e). Calculation (not shown) of the density of states reveal that the origin of the distortion domains is the formation of the ordered Jahn-Teller distortions on the LCMO surface.

Scientific Achievement

Direct observation of structural domains on manganite surfaces originating from the surface-chemistry-induced stabilization of ordered Jahn-Teller displacements.

Significance and Impact

Measuring the sub 30 pm displacements of atoms from high-symmetry positions in the atomically resolved STM images allows the physical order parameter fields to be visualized in real space on the single atom level.

Research Details

- From atomic resolution STM images, we identify and refine the surface adatom locations and oxygen vacancies.
- Local distortion maps are constructed to demonstrate the domain boundaries.
- Density functional calculations provide insight into the intriguing interplay between the various degrees of freedom now resolved on the atomic level.

Research performed as staff science at ORNL's Center for Nanophase Materials Sciences and the Materials Sciences and Engineering Division, in collaboration with the University of Nebraska Lincoln and IHI Corporation.

Z. Gai, W. Lin, J. D. Burton, K. Fuchigami, P. C. Snijders, T. Z. Ward, E. Y. Tsymbal, J. Shen, S. Jesse, S. V. Kalinin, A. P. Baddorf
Nature Commun. 5, 4528 (2014). DOI: 10.1038/ncomms5528

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Notice Regarding Public Dissemination of User Project Information

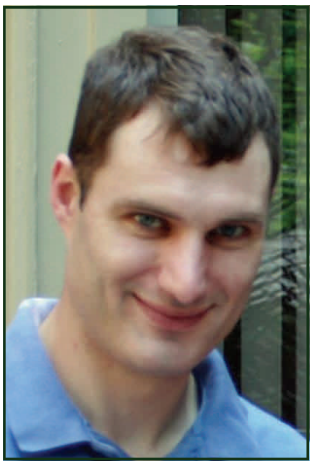
Beginning in FY 2015, the U.S. Department of Energy Office of Science (SC), which sponsors CNMS, will require that a limited set of information relating to user projects at all of its facilities be transmitted to SC at the conclusion of the each fiscal year. A subset of this information, including users' names, institutional affiliations, and project titles, will be publicly disseminated as part of an SC user project database on the SC website, http://science.energy.gov, after the conclusion of each fiscal year. For proprietary projects, the user will be asked to provide a project title that is suitable for public dissemination.

In a memo to DOE Office of Science Associate Directors announcing the creation of the database, Deputy Director for Science Programs Pat Dehmer stated, "The decision to create a user projects/experiments database is founded on a philosophy that SC should possess a balanced collection of information on both our grant recipient projects and our facility user projects/experiments. The SC user facilities are a public resource. A publicly-accessible SC user database has the potential to provide a richer snapshot … and enhance the transparency of a complex enterprise." Additional information about this new database and SC's collection of user statistics is available at http://science.energy.gov/user-facilities/.

CNMS Honors and Awards

Congratulations to Bobby Sumpter on being elected Fellow of the American Physical Society! Bobby Sumpter is the CNMS Deputy Director and was cited for "outstanding scientific impact and development in computational soft matter and nanoscience through the development and use of principles from computer science and mathematics and the results of theoretical physics and chemistry to facilitate solving materials problems and discovery of new functional materials."

CNMS Researcher a Victim of Mountain Biking Accident



The CNMS community was deeply saddened to learn of the passing of our friend and colleague Mike Biegalski in a tragic mountain biking accident at Haw Ridge Park in Oak Ridge on December 20, 2014. Mike was a highly respected scientist at CNMS, but he was also much more: a husband, a father to two girls, a son, a brother, and a friend to all of us who were lucky enough to know him. Professionally, Mike was widely known for his expertise in growth, characterization, and understanding of high-quality oxide films and interfaces, and his work attracted many high-profile users to CNMS to collaborate with him. He also had quite a record of accomplishment in bicycle road racing as well as mountain biking. Mike will be sorely missed by all who knew him.

A memorial fund has been established to assist Mike's wife, Amy, with the education of their two young daughters, Katia and Anya. External contributions via checks from friends, colleagues and collaborators should be made payable to Team UT-Battelle with "Mike Biegalski Memorial Fund" noted on the memo line. Checks may be delivered in person at the ORNL branch of the ORNL Federal Credit Union or mailed to ORNL FCU, Attn: Lab Branch – Ryan Bennett, P.O. Box 365, Oak Ridge, TN 37831-0365.

Friends and acquaintances may also leave condolences and memories in an online guestbook at http://obit.weatherfordmortuary.com/obitdisplay.html?id=1462956.

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.