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Ohio University Home of New Transmission Electron Microscope

After nearly $1.7 million in funding and four years of planinng, Russ Professor of Chemical Engineering and NQPI member Gerardine Botte unveiled Ohio University's new high resolution transmission electron microscope (TEM) at the Center for Electrochemical Engineering Research (CEER) in October.

The JEOL JEM 2100F TEM will be used to characterize new nanomaterials with applications in energy, alternative fuels, environmental remediation and the biomedical industry.

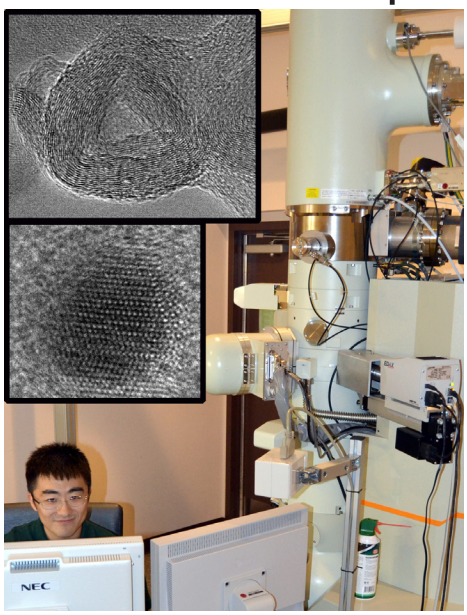
CEER is the only facility in the state with a TEM that allows observation and characterization of electrochemical reactions in progress. Normally, researchers would only be able to view images of the materials before and after, not during, the electrochemical reaction.

"What we offer our clients is the expertise on what properties make sense from an electrochemical perspective for the process that they are designing. If they want to push it to the next level, now it becomes research and not just an analysis, we can view electrochemistry in situ," she said.

Botte will use the microscope to understand the synthesis of graphene from coal and developing catalysts for electrosynthesis, batteries and fuel cells, while NQPI member Savas Kaya, a professor of electrical engineering, will investigate nanowires and nanosensors for applications in optical and electronic devices.

The microscope was funded by a $1.16 million grant from the National Science Foundation, $250,000 from the Ohio Board of Regents, and another $250,000 from the Ohio University Vice President of Research.

For more information on the TEM, visit www.ounqpi.org or email CEER scientist Yuxuan Wang at wangy6@ohio.edu.



Yuxuan Wang, microscopy and advanced instrumentation scientist, analyzes materials with the new transmission electron microscope. Also shown are some of the first nanoscale images taken with the microscope: graphite (above) and gold (below). ***TEM photos provided by CEER.***

Jeff Rack Wins Keck Foundation Grant to Study Photonastic Materials

NQPI member Jeff Rack is one of five scientists who received a slice of a $1 million W.M. Keck Foundation grant made to Oregon State University to study materials that change shape when exposed to light.

"We are mostly interested in the generation of materials that can change shape when irradiated by light. The correct term is photonasty. It refers to materials that reversibly, repeatedly change shape in a pre-programmed direction," said Rack, a professor of physical inorganic chemistry at Ohio University.

Max Livshits, a fourth-year chemistry doctoral student, bends strips of polymer with light using a 532 nanometer laser pointer.

One of the potential applications of this research is a creative way to store hydrogen, which would be useful to automobile manufacturers who are looking for methods of vehicular hydrogen storage that are safe, light, compact and cost effective.

Rack and his research team discovered a method to make a variety of polymers bend in light. Essentially, the interaction between the light and the shade of dye the polymer is coated with causes the polymer to bend when irradiated by light.

Rack received $75,180 this year to explore how to make this process more efficient. Altogether, he will receive a total of $200,000 in funding over a three-year period.

"So we've discovered a way to use lots of different polymers that bend. So once you find it, then the whole idea is how does it work? We have to try to figure out exactly how it works and what happens. What's the efficiency of the process? Where did it go? How does it lead to light bending?" Rack said.

THE FUTURE LOOKS BRIGHT
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Director's Corner

Dear Colleagues,

Greetings! I am happy to welcome you to the 12th edition of the newsletter and to update you on the exciting events taking place within the institute!

First, I would like to welcome Dr. Jixin Chen from the Department of Chemistry and Biochemistry as the newest member of NQPI! Dr. Chen, an experimental physical chemist, brings expertise in super-resolution techniques for studying molecules and nanoparticles at surfaces and interfaces.

Congratulations are also in order for NQPI member Dr. Gerri Botte, who recently unveiled a new high resolution transmission electron microscope at the Center for Electrochemical Engineering Research. The new JEOL JEM 2100F with EDX and liquid cell capability brings exciting capabilities to Ohio University.

NQPI members Dr. Jeff Rack, Dr. Art Smith and Dr. Saw-Wai Hla were busy over the summer organizing conferences on photochromic compounds, spin-polarized scanning tunneling microscopy, and nanoscale spectroscopy. This is a testament to the national and international recognition of our members, and NQPI was delighted to help support these successful conferences.

Planning for the new Interdisciplinary Science Facility is continuing to move forward. At the end of October, interviews of potential design firms were completed and a selection is expected soon, meaning the programming phase could begin as early as spring 2015! As a member of the planning committee, I look forward to representing NQPI and its members to help us realize a world-class facility.

Finally, I would like to remind our members of two new initiatives to assist NQPI researchers with additional funding! These include the NQPI Research Challenge and new project Start-up/Wrap-up support to help initiate and/or transition funded projects. Please feel free to contact me for more information.

Eric Stinaff, NQPI Director

NanoBytes

Grants and Announcements

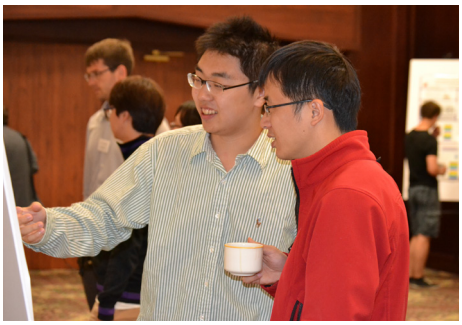
Art Smith received $180,000 from the U.S. Department of Energy to research spin-polarized scanning tunneling microscopy studies of nanoscale magnetic and spintronic nitride systems.

Martin Kordesch published "On the structural-optical properties of Al-containing amorphous Si thin films and the metal-induced crystallization phenomenon" in the *Journal of Applied Physics.*

Tadeusz Malinski earned his fourth Doctor Honoris Causa award from Adam Mickiewicz University in Poznan, Poland, for his contributions to biomedical engineering.

Gerardine Botte was named a fellow of The Electrochemical Society, and has been selected to teach at the 7th annual European Summer School on Electrical Engineering this summer.

For a full list of grants as well as publications, please visit www.ounqpi.org.



Yingqiao Ma, a physics doctoral student, discusses his poster presentation with Chunlei Gao, a professor at Shanghai Jiao Tong University, at the SP-STM5 conference in Huron, Ohio.

J. Perry Corbett, a physics doctoral student, presents his research on the development of a novel tip etching method for preparation of STM tips with magnetic coating at SP-STM5 in July.

NQPI Sponsors 3 Summer Conferences!

NQPI has sponsored three major conferences over the summer that advanced research in the fields of spin-polarized scanning tunneling microscopy (SP-STM), nanoscale spectroscopy and nanotechnology, and photochromic materials.

Chemistry Professor Jeff Rack organized an academic workshop for researchers of photochromic compounds and materials June 30-July 4 at the Telluride Science Research Center in Colorado.

Approximately 25 researchers attended the workshop, "Breaking and Making Bonds with Light." Talks focused on different types of photochromic compounds and their synthesis, how light can be used to affect biological processes, and how to use photochromic materials to store information.

Next, Physics Professor Art Smith chaired the fifth international SP-STM conference. Forty scholars heard information from 25 speakers and 15 poster presentations during the four-day conference held July 15-19 at the Sawmill Creek Resort in Huron, Ohio.

SP-STM5 focused on SP-STM theory and simulation, generalized STM techniques being applied to study nanomagnetics and nanospintronics, and SP-STM instrumentation and special techniques.

In the final conference of the summer, Saw-Wai Hla, a professor of physics and astronomy and leader of the Electronic and Magnetic Materials and Devices group at Argonne National Laboratory, co-chaired the 8th International Workshop on Nanoscale Spectroscopy and Nanotechnology (NSS-8) in Chicago.

More than 100 researchers from 15 countries attended the conference held July 28-31. NSS-8 featured presentations focusing on novel nanoscale materials, systems and devices.

NQPI Student Researches InGaN Solar Cells

Pratheesh Jakkala may hold the unofficial title for being the first person at Ohio University to successfully create a working solar cell, but his real ambition is to maximize solar cell efficiency with Indium Gallium Nitride (InGaN).

Silicon is currently the semiconductor material of choice for solar cell research. However, with an indirect bandgap, silicon has a limited solar cell efficiency. InGaN, which has a more efficient direct bandgap that is easily tunable, has the potential to replace silicon in solar cell technology.

Jakkala, a doctoral physics student, and Martin Kordesch, a physics and astronomy professor, have researched solar cell efficiency since 2012. The pair first researched the right combination of materials to create a working InGaN solar cell via the sputtering method, a process in which atoms are ejected from a solid target material due to bombardment of the target by energetic particles.

"We thought we would analyze each and every layer to see if they are suitable for solar cells. First, I made InGaN thin films on a glass substrate, and we verified that it is suitable for solar cells. Next, we bought commercial p (positive)-type silicon from an outside market. Then we checked if these are suitable for solar cells. Then we tried different combinations of metal contacts to each layer. We narrowed down to aluminum as the metal contact for an InGaN layer with an indium tin oxide metal contact and a p-type silicon layer with an aluminum-backed metal contact. This combination was used to create a test solar cell in December 2013.

Pratheesh Jakkala, a doctoral student in physics and astronomy, deposits Indium Gallium Nitride into a radio frequency magnetron sputtering machine used in his solar cell research.

"We verified that we can make InGaN solar cells using the sputtering method. The disadvantage is that the efficiency is very low. Since the current is very low, even though the open circuit voltage is very high, the efficiency is less than 1 percent," Jakkala said.

Even though the efficiency of the first test cell was low, the important outcome of the test is that it produced a working InGaN solar cell that functions in both laboratory and real-world conditions. Their research is now focused on finding ways to increase solar cell efficiency.

Jakkala and Kordesch will begin additional trials soon, hoping to increase the solar cell efficiency up to five percent by summer 2015. Meanwhile, the duo will present their results at the Materials and Research Society Fall Meeting in December.

Having Trouble Learning Organic Chemistry? There's an App for That!

For whatever reason, many students just cannot get the hang of organic chemistry.

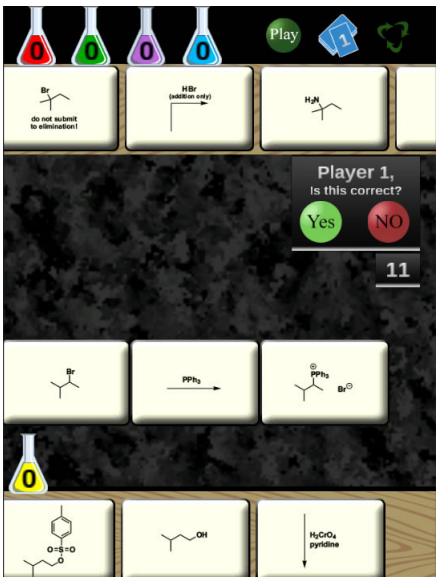
Ohio University Chemistry Professor Eric Masson encouraged his students to use flash cards to master the chemical reactions that form the building blocks of life. Then, a couple of years ago, he thought, what about a game?

He created a card game he called Orgomino, a mash-up of organic and domino, the game that served as his model. It was a hit with students, but making the paper playing cards was tedious work. Then he thought, why not turn the game into an application?

Now, a year later, the Orgomino app is a reality. Masson says the app should be for sale in Apple's App store sometime during the spring semester.

The game is simple in concept, but creating it presented some challenges. The game was designed with only one possible combination of each reactant and reagent. When all 30 cards are played, the end result is a molecule.

So one of Masson's challenges was finding molecules that broke down easily into 30 pieces, and these pieces could only combine to create that molecule.



Chemistry Professor Eric Masson created the Orgomino app as a learning tool to help students understand organic chemistry.

It takes at least two people to play the card game. The app makes it possible for one person to play against the computer. That meant designing some artificial intelligence. He also wanted to build in levels of difficulty to give beginning students a fighting chance against a machine that, after all, knows all the answers.

So alongside all the correct reactant-reagent combinations built into the artificial intelligence, Masson also created a list of plausible but incorrect combinations, reflecting some of the common mistakes that students make.

Masson said he put at least 100 hours of work into creating the app, which he did with the help of a university grant, along with two graduate students who took his game rules, designed mockups and completed the programming.

New Chemistry Professor Jixin Chen Joins NQPI

As an experimental physical chemist, new NQPI member Jixin Chen is interested in applications that can change the world, which is why one of his major research areas focuses on harnessing the power of solar energy.

"Energy needs are growing, but the resources are decreasing. Solar power is our best alternative energy resource. It's green, sustainable and abundant. The problem is we do not know how to harvest it both at very high efficiency and low cost," he said.

Chen joined Ohio University this fall as an assistant professor in the Department of Chemistry and Biochemistry. He comes to OU after working as a post-doctoral researcher at the University of Wisconsin-Madison and Rice University.

A native of China's Zhejiang Province, he first earned his bachelor and master of science degrees from Nankai University in Tianjin and later his doctorate in chemistry from Texas A&M University in 2010. His love of chemistry was inspired by a middle school teacher.

"My reason for majoring in chemistry probably goes back to middle school. I know that my interest was in fundamental sciences, either chemistry or physics or mathematics. My middle school chemistry teacher was very fun at the time. We did lots of experiments," recalled Chen.

Jixin Chen
Photo by Ben Siegel

As a post-doctoral researcher at the University of Madison-Wisconsin, Chen researched surface modification in the electrodes of solar cells with Chemistry Professor Robert Hamers from 2010 to 2012, and plans to continue this research at Ohio University.

"I will continue to work on nanomaterials for energy applications, basically batteries and solar cells. I probably will focus on the surface modification of functionalization. In order to get the solar cell to work, I try to focus my research on the liquid-solid interface," he said.

In 2012, Chen moved to Rice University, where he studied a super-resolution optical nanoscopy technique called motion blur point accumulation with Christy Landes, an associate professor of chemistry and electrical and computer engineering.

This technology is used for imaging in nanoscale topography and to study ion-exchange chromatography for single protein separation and DNA imaging. Ion-exchange chromatography is valuable to pharmaceutical companies, which are interested in research that could produce cheaper methods to separate proteins in medicine.

"There is a huge market behind this simple scheme. The market for biological protein drugs is about $100 billion a year, and 50 percent goes to separation, which means over $50 billion a year is used for just this separation process. There is a huge need to optimize this, and the whole process of observing this will develop a new process to separate protein or to purify protein," he said.

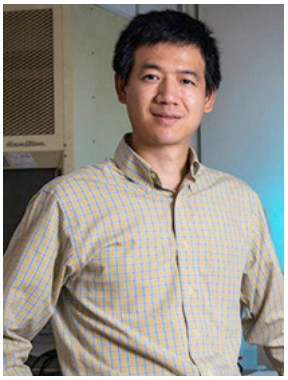
Chen will continue work in the optical mapping project, where he will explore methods to develop new strategies with super-resolution optical nanoscopy to improve the resolution of optical mapping.

"In many genome sequencing projects, such as the Human Genome Project, optical mapping has been used to construct ordered restriction maps for whole genomes. These maps provide scaffolds for shotgun sequence assembly and have been successfully applied in many genome sequencing projects," he said.

NQPI Member Organizes International Glass and Optics Conference

Can you imagine a world without glass?

Gang Chen, an associate professor of physics and astronomy, can hardly picture a day in which he does not use glass. From the glasses we use to drink to the optical fibers that allow us high-speed Internet access, glass is a major part of our lives.



Gang Chen
Photo by Rob Hardin

It's this knowledge that motivated Chen to organize a major research conference on glass and optical materials.

"Glass is a very active and important research field. It covers almost every aspect of our lives, not only in the traditional aspect of glass for buildings and decorations, but also to the more modern use of glass, ranging from computer memories to bone regeneration," he said.

Chen is the chair of the 2015 joint meeting of the Glass and Optical Materials Division of the American Ceramic Society and the Germany Society of Glass Technology. This conference is the last of a two-year experiment to combine the American and German annual conferences in an effort to strengthen ties between U.S. and European glass researchers.

The conference will be held May 17-21, 2015, in Miami, Florida. Rooms can be reserved at the Hilton Downtown Hotel. It will feature five symposia areas and more than 20 sessions headed by major leaders in industry, government laboratories and academia.

Presentations will explore optical and electronic materials and devices, the fundamentals of the glassy state, how glass is used in healthcare and energy, environmental aspects of glass and nuclear waste immobilization.

Another Ohio University professor, David Drabold, a distinguished professor of physics and astronomy, will serve as a symposium leader.

Paper submissions can be made through early December by visiting www.ceramics.org/gomd-dgg.

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