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NQPI
OHIO UNIVERSITY

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NSF gives researchers grant to study cancer

In the trenches of the war on cancer, NQPI member and Associate Professor of Physics Dr. David Tees is helping researchers from several colleges at Ohio University unravel the mysteries of cancer stem cells and metastasis. Their research just became easier with a three-year grant totally $499,996 from the National Science Foundation.

Dr. Monica Burdick, assistant professor of Chemical and Biomolecular Engineering at OU, and Dr. Fabian Benencia, assistant professor of Biomedical Sciences at OU's College of Osteopathic Medicine, have joined Tees in this multidisciplinary effort to describe cancer stem cells.

Currently, scientists know that cancer stem cells play a major role in the formation of tumors. Normal stem cells are involved in the growth and maintenance of the human body. After 50 to 60 cell divisions, most normal cells stop dividing (a process associated with differentiation into tissue like muscle or skin), but normal stem cells retain the ability to divide and produce additional tissue.

"Your cells take an enormous amount of DNA damage every day," Tees said. "Most of it is repaired, but over the years, that damage can allow some normal cells to mutate and redevelop the ability to divide."

Researchers believe such damaged cells cause tumors. Typically, in the early stages of cancers the cells will remain in the tumor, allowing for relatively easy surgical removal of the tumor. However, most cancers are detected in late stag-

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NQPI director Arthur Smith (right) stands with mechanical systems technicians Doug Shafer (middle) and Todd Koren beside Ohio University's new helium liquefier.

Helium liquefier will save researchers time, money

After five years of planning, designing and building, NQPI finally has a renewable source of liquid helium, one of the most important and expensive materials used in research like scanning tunneling microscopy (STM).

Ohio University's new helium liquefier facility, housed in the Clippinger Research Annex, cost roughly $800,000 and is expected to pay for itself in four to seven years, according to NQPI director Dr. Arthur Smith.

"For us, it's an economical issue as well as having a much easier, plentiful, efficient and reliable source of helium for our experiments," he said.

Researchers can use helium to cool their STM systems to the point where molecular motion slows, allowing for clearer readings with atomic resolution. Dr. Saw-Wai Hla, an NQPI member and one of several helium users, consumes as much as 200 liters of the precious element per week, which would cost up to $150,000 per year. Typically the liquid helium would vaporize and vanish into the atmosphere. The new facility will recapture the gas and convert it back into its liquid state, ready to be reused.

Howard Dewald, interim dean of OU's College of Arts and Sciences is proud of the new facility, which he helped plan.

"It seemed like the right move to

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CHEMICAL ON/OFF SWITCHES
NQPI member controls chemiluminescence with cucurbiturils - pg. 3

DOCTOR HONORIS CAUSA
Department of Chemistry and Biochemistry Chair receives prestigious award - pg. 4

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Director's Corner

Dear Colleagues,

Welcome to the 6th Edition of the NQPI Newsletter. The first important development to mention is, as depicted on the front, the completion and commissioning of our new helium liquefier facility. As of August 2011, after 5 years of planning and sustained effort, liquid helium at last began to flow. This accomplishment represents a key step in our quest to establish a world-class cryogenics program as part of NQPI's overall nanoscience research agenda.

NQPI members have continued to make substantial progress with their research and funding in 2011. The final count for FY11 in funding dollars showed $131k/member, which already exceeds the initial target set 5 years ago in the Graduate Education & Research Board (GERB) initiative. With this level of funding, NQPI members can concentrate on their research and education efforts in order to reach for the high level of performance to which we aspire.

New committees focusing on research equipment and software have been formed to sharpen NQPI's ability to identify and provide for member needs. These committees will provide written recommendations to the Director concerning key research-related acquisitions and investments.

Another recent key achievement is the renaming of the former "Zoology" facility to be the new "Clippinger Research Annex," which houses both the helium liquefier and the MBE/PLE/SP-STM laboratory. Our continuing goal to achieve a new, dedicated state-of-the-art building for nanoscience research has resulted in this future facility being promoted to a target for OU's Office of Advancement. It may take some time, but I am confident that ultimately we will get there.

Best Regards,
Arthur R. Smith, NQPI Director

NanoUpdates

Grants

Saw-Wai Hla received $132,511 from DOE to study the manipulation of nanoscale molecular superconductivity.

Nancy Sandler and Sergio Ulloa received $292,599 from NSF to study the symmetry, local-environment and time-dependent effects in nanoscale systems.

Publications

Beth Anne McClure's (Rack Group) article "Ultrafast Spectroscopy of a Photochromic Ruthenium Sulfoxide Complex" was published in *Inorganic Chemistry* **50**, 16.

Kushal Wijesundara (Stinaff Group) and Juan Rolon's (Ulloa Group) article "Tunable exciton relaxation in vertically coupled semiconductor InAs quantum dots" was published in *Physical Review B Rapid Communications* **84**, 8.

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

NanoBytes

Allan Showalter accepted the appointment of Chair of the Department of Environmental and Plant Biology.

The Ulloa Group welcomes visitors Mariama Rebello de Sousa Dias, from the Universidade Federal de Sao Carlos in Brazil, and Robert Sanchez, from the Universidad del Valle in Columbia.

Dr. Saw-Wai Hla accepted a position at Argonne National Laboratory as Group Leader for the Electronic and Magnetic Materials and Devices Group under the Center for Nanoscale Materials. Dr. Hla retains a 25% appointment at OU.

Daiara Faria, Universidade Federal Fluminense, Brazil, will be visiting the Sandler Group.

David Ingram accepted the appointment of Interim Chair of the Department of Physics and Astronomy.

NQPI's SPIRE group on the steps of the Institute of Applied Physics at the University of Hamburg during their summer workshop. Students and faculty shared research and explored the port city. From left to right: TOP ROW: Gabriela Herzog, Stefan Krause, Mike Giamfi, Robert Wieser, Jessica Bickel, Noboru Takeuchi, Milo Swinkels; MIDDLE ROW: Heath Kersell, Ben White, Oswald Pietzsch, Roland Wiesendanger, Julia Ulloa-Sandler, Jeongihm Pak; FRONT ROW: Vincent Roberts, Daniel Bergman, Sergio Ulloa, Arthur Smith, Nancy Sandler, Saw-Wai Hla

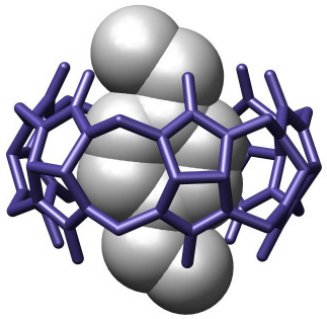
Interdisciplinary research controls chemiluminescence in compounds

NQPI members Dr. Eric Masson and Dr. Martin Kordesch may be from drastically different scientific backgrounds, but they have joined forces to harness the power of Cucurbiturils to control light emission in chemical compounds.

Masson's body of work within OU's Department of Chemistry and Biochemistry revolves around supramolecular chemistry with a particular affinity for Cucurbiturils - hollow macrocycles which received their name from their pumpkin-like appearance. These unique systems display extreme affinities towards a variety of guests and can undergo mechanical motion along organic axles if triggered by external stimuli, such as pH changes, heat or light.

A recent paper in *Organic Letters*, **13**, 15 published by Masson and Kordesch (a professor in OU's Department of Physics and Astronomy), former OU research associate Yasser M. Shaker, undergraduate student Citra Yuwono and scientific collaborator Jean-Pierre Masson, describes the use of Cucurbiturils as "on/off switches" in a benchmark chemiluminescent reaction.

"Imagine a soup of components - a very complex mixture of different species that are in equilibrium with one another. If I add the macrocycle to the mixture, it selectively encapsulates some of the components of the mixture and stabilizes them. Their concentration will increase at the expense of the inert species," said Eric Masson. "Then, imagine that the intensity of a subsequent chemiluminescent reaction depends on the concentration of one of the species present in the equilibrium mixture: adding Cucurbiturils can then interrupt or dim light emission by messing up the equilibrium!"



Cucurbiturils can act as an on/off switch for chemiluminescent reactions by taking some of the mixture's components into their cavities.

He also explains that adding a competitive guest that traps Cucurbiturils restores light emission, similar to a real switch that controls lights in a room. Chemists could one day use this type of stimulus-sensitive chemiluminescent system to design sensing devices for drugs, explosives or pollutants. For now, the young professor and his colleagues will continue to study the intriguing pumpkin-like macrocycles and their exceptional molecular recognition properties.

Masson, in his third year of NQPI membership, said he enjoys the discussion and multidisciplinary research the institute has offered - and that collaborations such as this are "the most important reason" he joined NQPI. Dr. Masson plans to discuss further interdisciplinary research with NQPI member Dr. Saw-Wai Hla concerning the design, synthesis and evaluation of molecular machines.

SPIRE visits Germany

NQPI's Spin Triangle - Partnership for International Research and Education (SPIRE) - held its first full-scale workshop at the University of Hamburg on June 29 - July 1, 2011. The workshop featured 25 faculty and student presentations from Ohio University, the University of Hamburg, and the University of Buenos Aires (see photo at left). The Ohio University and University of Buenos Aires talks were given using Adobe Connect, an online videoconferencing tool.

Additionally, NQPI and the SPIRE Study Abroad program funded research trips for three undergraduate students, two graduate students, one assistant research scientist, and one visiting scholar to Germany.

NQPI members also visited the Berlin Synchrotron Radiation Facility (BESSY) and several students conducted research at Humboldt University.

Please visit www.ounqpi.org/articles for more information about the workshop and research in Germany.

Grad student studies charge transfer in Berlin

Germany isn't quite as foreign for OU physics Ph.D. student Andrew DiLullo, at least not the third time around. As a fourth-year physics graduate student working with NQPI member Dr. Saw-Wai Hla, DiLullo has worked at the University of Hamburg for two quarters the past two years and this summer conducted research at the Freie University in Berlin.

DiLullo, the only Bobcat in the Department of Physics at the Freie University, worked in experimental research with Drs. Katharina Franke and Nacho Pascual. The scanning tunneling microscopes (STMs) at the Freie University have similar capabilities as those in Athens, Ohio.

"All the labs have their own unique qualities," DiLullo said in Berlin. "Many of the molecules studied here are synthesized by chemists locally."

Dr. Franke, with whom DiLullo spent most of his time, investigates the properties of single molecules and molecular networks that could be used in the next generation of electronic devices.

Specifically, the group studies transport phenomena, the Kondo effect, molecular charge transfer, and the new field of molecular switches. The primary focus of DiLullo's research is charge transfer between different molecules in covalently bound chains. DiLullo, who plans to form his doctoral thesis around magnetic molecular systems, no longer sees Germany as such a foreign culture and has learned to appreciate fine German food and drink.

"When I was first here, I instantly recognized things that were new to me," he said in Berlin. "Now, with the novelty worn off, I feel very comfortable in a culture and environment which I had once thought of as strange."

Since returning from Germany, DiLullo has continued his studies in the Department of Physics and Astronomy at Ohio University.

For more information about DiLullo's research in Berlin, please visit www.ounqpi.org/dilullo-berlin.

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make," he said. "Grants were key in being able to do the work."

NQPI funding from the Graduate Education and Research Board, the National Science Foundation SPIRE grant and an 1804 grant helped shoulder the costs.

Department of Physics and Astronomy Mechanical Systems Technicians, Doug Shafer, an OU graduate, and Jeremy Dennison, were key in helping plan and construct the complex system.

"When you look at the workmanship of that facility, I would say it is second to none," said Smith, who likened Shafer's engineering to 'Swiss craftsmanship'. "We did a lot of the installation ourselves, via our shop guys. This was crucial for the success of the facility."

The helium liquefier was featured as part of the Department of Physics and Astronomy's Open House on November 5.

For more information about the helium liquefier, please visit www.ounqpi.org/helium-liquefier.

GRANT, from page 1

es where cancer cells have spread to other parts of the body and established new colonies, a phenomenon called metastasis.

It is unknown how cancer cells spread to other parts of the body but researchers believe these cells travel to new locations through the bloodstream, stopping only when they stick somewhere or capillaries become too small to let them through easily. Traveling in the bloodstream is risky since white blood cells patrol the blood vessels. Cancer stem cells, a rare subpopulation of cells within the original tumor, may have survival advantages that facilitate metastasis.

"There's a certain amount of luck involved," Tees explained. "You can have 1 billion cells and 999,999,999 get gobbled up by the immune system, but one can do the damage. If that one gets through and it's missed, then it can grow in a new location."

Researchers hope to find molecular and physical markers that can help determine whether a certain circulating cancer cell is indeed a cancer stem cell which is capable of metastasis.

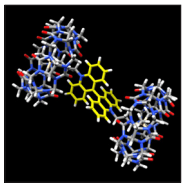
Currently, researchers have hypothesized that metastasizing cancer cells have different deformability from less metastatic cells. This can be used to identify the cells. Tees also believes that the success of cancer stem cells travelling through the blood stream may depend on the cell's deformability.

Burdick and Benencia plan to use OU's new Fluorescence Activated Cell Sorter, recently purchased as part of an NSF MRI grant, to look at thousands of breast cancer cells and select the ones displaying the molecular surface markers thought to be associated with cancer stem cells. Tees will then use micropipette aspiration to determine the deformability of these cells.

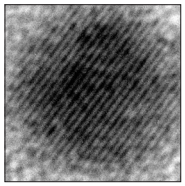
Such research at the nanoscale requires Tees' physics expertise, which complements the biomedical engineering and medical backgrounds of Burdick and Benencia.

The scientists hope their research will contribute to a new diagnostic tool, which will aid future scientists in treating and studying cancer.

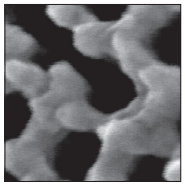
NanoGallery



Optimized structure of a Lucigenin derivative interacting with two Cucurbituril units. Courtesy of the Masson group.



A TEM image of a CdTe/CdS core/shell quantum dot scaled at 10 nanometers. Courtesy of the Van Patten group.



An SEM image of nanoporous alumina (Al_2O_3) scaled at 34 nanometers. Courtesy of the Chen group, taken using new FE-SEM.

Writing and design by Benjamin White. Editing by Dr. Eric Stinaff and Liz Stinaff. Please email ***nqpi@ohio.edu*** *with comments.*

Malinski receives prestigious Polish accolade

Tadeusz Malinski, NQPI member and chair of Ohio University's Department of Chemistry and Biochemistry, was recently presented with the Doctor Honoris Causa award from Poznan University of Technology in Poland.

He received the highly esteemed award for his research in nanomedicine, nanotechnology and nanoengineering. During his acceptance speech, entitled "Engineering the Heart", he presented his findings concerning the fundamental mechanisms that regulate the work of the beating heart.

"The discovery of this important mechanism was possible with the use of nanosensors implanted in the beating heart," said Malinski. "This mechanism led us to design new solutions for heart preservation, transplantations and a new design of an artificial heart."

Along with the Doctor Honoris Causa distinction, which was presented entirely in Latin in a ceremony full of traditional robes, Malinski also received another award for "Benefiting Humanity" through his research.

"The award ceremony was a very special and unusual event," he said. "It was attended by hundreds of people, including world-renowned professors."

Malinski is known worldwide for his research and inventions related to the human heart, vascular system, diabetes, aging and other contributions to the medical field. This award only adds to the slew of other notable honors Malinski has garnered throughout his career.