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ONQPI
OHIO UNIVERSITY

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Engineering professor receives CAREER grant

NQPI member Wojciech Jadwisienczak of the Russ College of Electrical Engineering and Computer Science was recently awarded a National Science Foundation CAREER Grant of $444,000 over five years to study new materials for use in future optoelectronics, photonics and spintronics.

Dr. Jadwisienczak, known as "Dr. J" around campus, teaches undergraduate and graduate courses and studies semiconductor materials, their devices and related technologies. The central focus of his research is the incorporation of rare-earth ions in III-Nitride semiconductors and their alloys. These ions (typically RE (3+)) have several interesting and profitable traits like producing a very pure color when excited by different means, including electrical current. The III-Nitrides technology has already hit the market in the form of Blu-ray players, which use a very small pure blue laser to read information packed into smaller chunks than DVDs.

One of Dr. Jadwisienczak's goals is to study materials which contain different rare earth ions and have interesting optical and magnetic properties. For example, Erbium, one of the most intriguing members of the lanthanide family, emits light at the wavelengths used by fiber optic cables, so it could prove to be very valuable in the telecommunications field due to an expected reduction in signal attenuation. Dr. Jadwisienczak explained that scientists have been trying to harness and use the strange properties of the rare-earth ions that occur naturally.

"We are simply lucky to have this opportunity, a case of an Erbium ion elec-

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NQPI celebrates ten years of excellence, plans for bright future

A decade has passed since Ohio University established the Nanoscale and Quantum Phenomena Institute (NQPI), and much has changed since fall 2001. The momentum behind NQPI has only increased with time, and the future of the institute holds much promise for the institute's nanoscience research and international presence.

We asked five current and past members of NQPI, all members at the time of its inception, to take time to reminisce about NQPI's first ten years and look forward to its bright future.

Did you foresee NQPI becoming what it is today when it began?

Dr. Jean Heremans (first director of NQPI, current professor at Virginia Tech): "The original idea was to achieve a certain mass so that the forward momentum could be maintained without being unduly imparted by various scattering events. I am glad to see that that approach was strengthened and bore fruit."

Dr. Gregory Van Patten: "I think especially now the benefit has become pretty apparent in that we have a way to focus the research overhead money that we bring in with the research overhead grants and make sure it goes into supporting nanoscience."

What has NQPI's greatest accomplishment been?

Dr. Arthur Smith (current director): "One of the things we accomplished was really building up the

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NEW MEMBERS JOIN NQPI
New faces include mathematician with background in alloys - pg 3

"3D" INFO STORAGE?
OU u-grad receives honorable mention for Goldwater - pg 4

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Director's Corner

2011 brings new decade, funding for NQPI

Dear Colleagues,

I am pleased to greet you in this 5th Edition of our bi-annual newsletter. I believe you will find a variety of articles of interest regarding recent activity and progress within the NQPI. Ranging from our cover story about one member's new CAREER grant to news about important promotions and awards to an article about the research of our two newest NQPI faculty members, this latest issue gives a glimpse of the exciting developments happening here at Ohio University.

I am very happy to report that in a year of many economic challenges and hardships, NQPI members are faring quite well with funding. As of March this year, NQPI grant income is up by an impressive 45% over a year ago, with a hit rate of 27%, also up from 21% last year. While mostly from federal sources, some of this funding is coming from private companies as well as partnerships with other universities.

As also highlighted in this issue, 2011 represents an important milestone in NQPI's development, namely its 10th year anniversary! Successfully launched by early visionaries such as Jean Heremans (our first director), Victoria Soghomonian, and Sergio Ulloa, the NQPI we know today has come a long way. But NQPI's accomplishments have come at the price of much hard work by many devoted members across the campus. Thanks go to all those who have worked tirelessly to advance NQPI towards becoming a great research institute. One can only imagine how NQPI will look a decade from now.

With Best Regards,
Arthur R. Smith, NQPI Director

NanoBytes

Ido Braslavsky and David Tees received $100,000 from NSF to study the interaction between antifreeze proteins and ice.

Tanya Savin's article "A dynamical mother body in a Hele-Shaw problem" has been published in Physica D: Nonlinear Phenomena.

Saw-Wai Hla received $125,000 from DOE to study single atom and molecule manipulation and its application to nanoscience and nanotechnology.

Kangkang Wang's (Smith Group) article "Novel Two-Dimensional Mn Structure on the GaN Growth Surface and Evidence for Room-Temperature Spin Ordering" was published in Phys Rev B.

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

NanoBriefs

Nancy Sandler and Saw-Wai Hla have been promoted to associate professor and full professor, respectively.

Several NQPI members participated in Young Scholars OHIO, a series of programs for gifted students.

Joseph Morris (Jadwisienczak Group) received two national competitive awards from DoD: SMART scholarship and NDSEG fellowship.

Kangkang Wang (Smith Group) received The Leo Falicov Student Award for best presentation of graduate research at the 2010 AVS International Symposium.

Dr. Beth Anne McClure (Rack Group) started a postdoctoral position with Dr. Heinz Frei of Lawrence Berkeley National Laboratory.

Chandrasiri Ihalawela (Chen Group) won First Place Graduate Student Poster Award at the 2011 American Ceramic Society GOMD meeting.

Above: Daniel Bergman and Milo Swinkels of Art Smith's group explain their poster titled "Design and Construction of a Pulsed Laser Epitaxy System for use in Ultra-High Vacuum" during the 2010 CMSS/NQPI Poster Session. Their poster placed third in the undergraduate category. Insert: Over 50 posters were presented by students to colleagues and faculty from across campus.

New members bring experience in nanomachines and mathematics

NQPI boasts two new faces this year as Dr. Eric Masson of the Department of Chemistry and Biochemistry and Dr. Tatiana Savin of the Department of Mathematics hope to further their research at the nanoscale.

Masson, an assistant professor, earned his Ph. D. in organic chemistry from the Swiss Federal Institute of Technology, Lausanne in 2005, and spent two years at Yale University as a post-doctoral fellow in bioorganic chemistry. He joined NQPI last year for its collaborative opportunities and research capabilities.

Masson has recently attracted attention for his molecular machines that incorporate Cucurbiturils, pumpkin-like hollow macrocycles that are currently generating a tremendous interest in the supramolecular community. Those unique systems display extreme affinity towards a variety of guests, and can undergo mechanical motion along organic axles, once triggered by an external stimulus, such as pH changes, heat or light. The Masson group has recently investigated the kinetic and thermodynamic self-sorting properties of such systems, and has published the first case of an organometallic reaction catalyzed by Cucurbiturils.

NQPI members Eric Masson and Tatiana Savin

"In addition to their theoretical and aesthetic appeal," Masson says, "these nanometer-scale assemblies can be applied to areas as diverse as catalysis, data storage, chemical sensing, and the controlled release of anti-cancer, anti-malaria, wound healing or anti-macular degeneration drugs".

Tatiana Savin, NQPI's sole mathematician, believes her background in analysis of alloys with shape memory drew her to the institute.

"When I learned NQPI exists, of course I wanted to join them," Savin said.

Savin's mathematical research interests are in the fields of complex analysis and differential equations. Her current interest in free boundary problems can solve real-life problems related to materials science and fluid dynamics. Her works in progress involve the Hele-Shaw problem and theoretical justification of the vapor-liquid-solid model (VLS) for growth of nanowires.

Savin knew she wanted to study

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name. We took up the responsibility to make NQPI a recognizable entity for nanoscience research … We hosted a major international conference here – 125 key people from all over the world. That helped get some recognition going."

Dr. Sergio Ulloa: "I think that NQPI managed to galvanize a lot of activity across campus in this area, which resulted in a lot of joint and individual proposals and projects. Over the years, this has also given some research infrastructure and a general high level of intellectual activity and better learning environments for our undergraduate and graduate students."

How important was OU's Graduate Education and Research Board (GERB) awarding NQPI $169,000 in annual base funding?

Smith: "GERB funding puts NQPI at a level that's unlike almost any other institute within the university."

Dr. Savas Kaya: "When you go to the national scale, often in competitions, you have to show that there is institutional commitment to your research or some other strategic areas which require sufficient investment to begin with. As much as monetary support, it confirms that the institution is very much in tune with our dreams and expectations."

Van Patten: "I think the GERB funding is key … GERB gives us sort of a base funding foundation for us to count on. Being able to count on something is important for long-term planning. You can't do that with soft money."

What do you think the future holds for NQPI?

Smith: "We need to focus on initiatives which advance our core missions. This includes forging more collaborations that lead to major proposal efforts, such as with SPIRE. Mentoring new faculty members in their proposal-writing efforts is also important. Educationally, we are planning and working towards introducing the Nano-Core program - which is a series of focused graduate courses team taught by NQPI faculty across two colleges and eight different departments."

Kaya: "NQPI will provide and facilitate more interdisciplinary research … which will be a backbone of campus initiatives and beyond.

We will become, I think, a Center of Excellence … I think we may actually issue a certificate or degree in either nanoscience or nanoengineering.

I will not be surprised in the next five years if some of our creative work and intellectual properties become licensed or lead to job and wealth creation for the region."

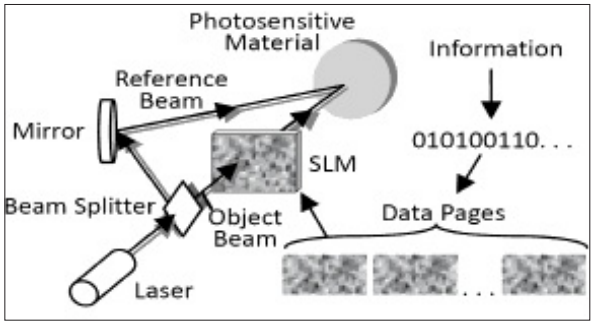
For more news, events, pictures, full articles and interviews, please visit: www.ounqpi.org

Sophomore recognized for research on new info storage system

Ethan Cottrill, an Ohio University sophomore Cutler Scholar studying chemistry, received an illustrious honorable mention from the Barry M. Goldwater Scholarship and Excellence in Education Program for his contribution to the development of holographic 3D information storage.

Cottrill, who worked with NQPI member Jeff Rack in his research, said he values the honorable mention of the nationwide award foundation even though it will not confer any scholarship money.

"It's pretty prestigious," Cottrill admitted.



When storing information, a bright pixel enables light to pass through the SLM; a dark pixel blocks light. The object beam carries with it a pixilated storage template to the photosensitive material, where information is stored in patterns of isomerization.

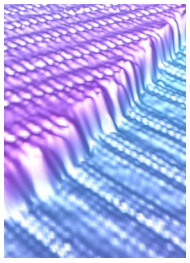
Dr. Rack's group is studying information storage models of the future that could hold "several terabytes" of information per cubic centimeter, an exponential leap from today's technology.

The system works by first directing a laser at a beam splitter, creating an object beam and a reference beam. The object beam then strikes the surface of a spatial light modulator (SLM), a type of liquid crystal display that translates raw binary data to be recorded into a pattern of bright and dark pixels. After passing through the SLM, the object beam carries with it a pixelated storage template to the photosensitive material, where it intersects the reference beam. The resulting interference pattern selectively isomerizes photochromic compounds in the solid-state media, creating a binary information storage system. The information is retrieved from the refractive index changes between the two isomers.

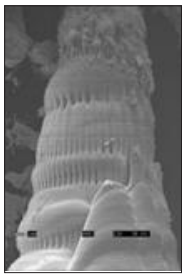
Currently, the research is still in its infancy, but Cottrill hopes his research will one day revolutionize technology.

"We want to develop the next generation of information storage," remarked Cottrill.

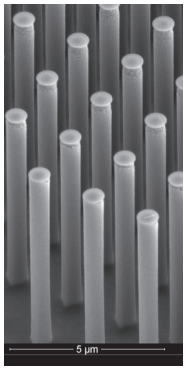
NanoGallery



3D-rendered STM image of Mn-induced stripes on GaN(0001) stepped surface.
Smith Group.



White House.
ZnO makes a huge tower like structure. The base is ~ 25 μm in diameter.
Kordesch Group.



Si posts (5 μm tall x 600 nm diameter) used for a mask in photomechanical studies of photochromic polymers.
Rack Group.

Design and writing by Benjamin White. Editing by Dr. Eric Stinaff and Ms. Liz Stinaff. Please email nqpi@ohio.edu with comments.

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tron energy level fitting exactly to the telecommunication window," explained Dr. Jadwisienczak. "Recent successes in developing Erbium-doped silicon-based compounds give hope that one day this opportunity will become a reality."

Rare-earth ions could possibly also be used to overcome the current limitations of the III-Nitride technology in producing red light emitting diodes (LEDs). For quite a long time, scientists have been attempting to fabricate an InGaN alloy having the high indium content necessary to generate red light needed for a full technological integration of all primary colors. It was not possible until recently, when a group of researchers in Japan engineered a way to efficiently use Europium, another rare-earth element, to produce very pure red LEDs.

When scientists find a way to create the three primary colors efficiently, they could make ultra-small LEDs which could improve technology, creating a new generation of high-definition flat TV screens and displays.

Currently, blue, green and red lasers use different semiconductors, but Dr. Jadwisienczak envisions a "one-pot" model in which materials emitting the three primary colors could be created using the same growth system. He also aims to increase the energy efficiency of the light emitters based on rare earth-doped III-Nitrides operating in ultraviolet and near the infrared spectral range.

Dr. Jadwisienczak has collaborated with NQPI partners on projects related to materials growth, characterizations and device development for more than a decade. Especially, he says, his alliances with NQPI professors Arthur Smith, Marty Kordesch and Savas Kaya, to mention only a few, are important for the success of his CAREER project thanks to existing collaborative efforts and shared visions in research.

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math and physics in high school when she interned at the Metal Physics Institute of the Russian Academy of Science in the Department of Theoretical Physics.

"I always enjoyed more doing a theoretical part of any research rather than experimental. That is why I received my Ph.D. in mathematics from Moscow University," Savin said.

Before she arrived in Athens, Savin worked at Technion (Israel) and Northwestern University as a mathematician in a team of physicists and engineers in the field of nanotechnology. She worked in the areas of crystal growth, thin films, quantum dots and nanowires.