

Chemists Determine Viability of USB Microscopes for Forensic Examinations

Analytical chemist Anthony Stender pointed a green-color, palm-sized microscope at some crystal samples and pressed the capture button. As the microscope was plugged into a desktop via a USB plug, an image of the crystals' fine texture popped up on the screen in no time.

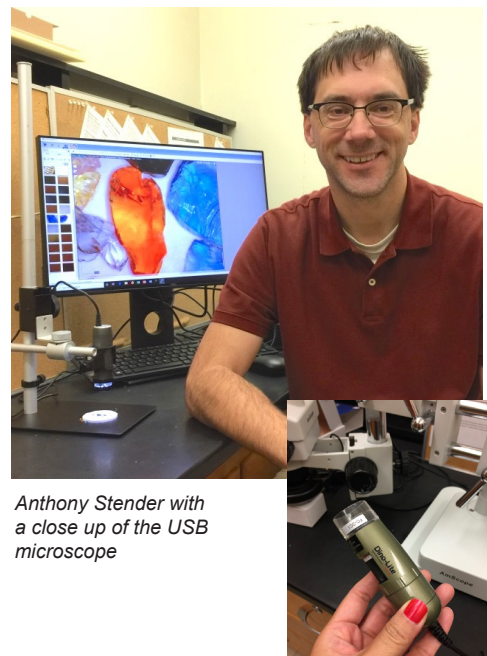
While microscopes play a key role in forensic chemistry, they are traditionally bulky and expensive, said Stender, an assistant professor of Chemistry and Biochemistry at Ohio University and NQPI member. In recent years, USB microscopes have been developed, which are simple, portable, and can be pointed at any angle. They are also more affordable, ranging from hundreds to thousands of dollars.

Last year, Stender purchased two USB microscopes for his microscopy class. To compare their imaging performances against those of traditional microscopes, Stender and OHIO graduate student Rachel Bracker used a variety of forensic samples such as dollar

bills, colored threads, and cotton fibers. They found out that the USB microscopes are a reasonable option for basic imaging of objects larger than 10 micrometers in the near-ultraviolet, visible, and near infrared.

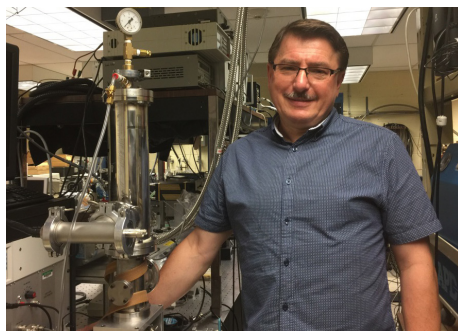
"The findings are interesting because the USB microscopes actually do quite well at low magnifications, and they performed as well as a traditional stereomicroscope currently used in our lab," Stender said. Details of their study, which is among the first performance tests on USB microscopes, have been reported in *Forensic Science International, Volume 304, November, 2019, 109961*.

Stender plans to use these USB microscopes for his microcopy class in the future. Students can simply take them outside and point them at anything during field work. "I'm surprised to see how handy and powerful USB microscopes can be, and they make an ideal tool for hands-on undergraduate research." ✨



Anthony Stender with a close up of the USB microscope

The Quest for Red-Emission and Cost-Efficient Novel Light Sources



Wojciech Jadwisienczak researches cost-efficient novel light sources.

As a materials research scientist, Wojciech Jadwisienczak is especially interested in two categories of materials: lanthanides and III-nitride semiconductors. Mixed together, the two can help develop different colored light-emitting diodes (LEDs), a type of semiconductor light source widely

used for their long lifespan and low energy consumption.

Lanthanides, also known as rare earths, are a family of metal elements with outstanding optical/magnetic properties "for versatile technological applications, from indoor and outdoor lighting to the materials used to build electric cars and stealth aircraft," said Jadwisienczak, an associate professor at Ohio University's Russ College of Engineering and Technology and a founding member of NQPI.

Adding a small amount of a lanthanide to a III-nitride LED material — a process known as "doping" — enhances the material's quality and performance in the resulting LEDs. A recent study by Jadwisienczak and his collaborators from OHIO and the University of Puerto Rico found that doping indium gallium nitride (InGaN) with ytterbium could improve the structure and intrinsic optical properties of the material as a whole.

Spectroscopy results showed that ytterbium helps indium atoms migrate to the right position in the process of material growth. "It's like when you bake a cake," Jadwisienczak explained. "You want all the raisins to end up distributing evenly all over the cake rather than clustering in one spot."

Jadwisienczak said this finding is important because by adding ytterbium and varying the concentration of indium, scientists can extend the material's emission spectrum from blue and green to red, which is still a missing fundamental color for III-nitride LEDs, so that all three fundamental colors could be produced in one material.

For future research, Jadwisienczak plans to collaborate with materials scientist and NQPI director Eric Stinaff to grow single-layer 2D materials doped with lanthanides and explore their optical/magnetic properties. ✨

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Director's Corner



Dear Colleagues:

Warmest greetings from the Athens campus of Ohio University, we hope you enjoy reading the 22nd edition of the NQPI newsletter. As beautiful autumn colors gave way to the changing season, it is a pleasure to go over the many accomplishments of our members and students and share them with you.

I would first like to welcome Joni Staggs as our new Administrative Specialist. As an alumna with two children attending OHIO, Joni is a true Bobcat. She has hit the ground running with NQPI and we are very happy to have her experience and enthusiasm. I would also like to welcome two Glidden Visiting Professors, Daiara Faria and Edson Vernek, highlighted in this issue.

This newsletter features several faculty and student achievements, including Anthony Stender's work on cost effective palm-sized microscopes and Wojciech Jadwisieniczak's work on novel light sources based on lanthanides and III-nitride semiconductors, as well as our most recent NQPI Graduate Fellowship winners.

It is always a pleasure to welcome new members of NQPI and in this issue we introduce Sarah Hormozi, Jessica White, and Travis White who have recently joined the Institute. Their research in areas ranging from non-Newtonian fluid mechanics to

photochemical and photocatalytic processes will certainly enhance and enrich NQPI's existing interdisciplinary research efforts.

A central goal of NQPI is to nurture our connections with our alumni, one of our most valuable resources for helping and guiding our current students beyond their time at OHIO. In addition to NQPI's 'Bring OUR Alumni Back' program, we were fortunate to have Dr. Greg Petersen return to lead a workshop on software design in an industrial setting. Events like these provide our students with invaluable insight and connections to 'real world' applications and we hope to continue to host similar events in the future.

Finally, our Institute was one of the sponsors of the University Industry Demonstration Partnership (UIDP) conference held on September 16-19 in Columbus, Ohio. UIDP is a forum to address issues affecting academic-corporate collaborations such as workforce development, sponsored research, tech-transfer, and intellectual property. Ohio University's membership in UIDP has provided resources to NQPI to further grow our industry relations and I look forward to sharing new developments underway in our 2020 spring newsletter.

Please enjoy the articles and visit our website to learn more. ✨

Best,
Eric Stinaff, NQPI Director

NanoBytes

■ Tatiana Savin (Mathematics) has been promoted to Professor; Katherine Cimatu (Chemistry & Biochemistry) has been promoted to Associate Professor with Tenure.

■ The trustees of The Ohio University Foundation have awarded Anthony Stender, Jixin Chen, Rebecca Barlag, Katherine Cimatu and Eric Stinaff \$65,989 of the 1804 Fund to purchase specialized equipment that will provide students access and training necessary to secure entry-level positions in the field of forensic chemistry.

■ A team of scientists including Saw-Wai Hla developed a robust molecular propeller that enables unidirectional rotations as reported in *Nature Communications*. Read the full article in 'Recent News' on NQPI's homepage.

■ A research team led by Alexander Govorov described ultrafast hot electrons in plasmonic metastructures in *Nano Today*. Read the full article in 'Recent News' on NQPI's homepage.

Hormozi Brings Complex Fluid Research to NQPI

Even as a teenager, Sarah Hormozi was fascinated by the way water flows.

"I was always thinking how we can express fluids in the language of mathematics," she said.

Driven by her curiosity in math and physics, as well as a background in her family business, she chose to study mechanical engineering in college. Now, as an associate professor at Ohio University's Russ College of Engineering and Technology, her expertise lies in soft matter physics, a discipline which aims at understanding the mechanics of complex fluids — fluids we deal with in daily life, from shampoo to food being cooked in the kitchen, as well as natural disasters such as landslides and avalanches.

As these systems behave in a complex fashion, Hormozi strives to find the connection between their complex behaviors and the underlying molecular structures. Such studies are crucial for material engineering, which requires understanding molecule-scale structures and integrating different length scales. For instance, one of her projects is

focused on developing a material that can better resist vibration and shock.

Her research is a combination of theories, experiments and computational simulations. "These tools are complementary," she said, which allows her to approach a scientific question from various perspectives at different stages of research.

Hormozi joined OHIO in 2014 and she has enjoyed the collegial environment and welcoming colleagues since then. As a new member of NQPI, she is very attracted to the Institute because of its interdisciplinary nature. She is looking forward to establishing close collaborations with colleagues from physics and chemistry departments in particular.

She also encourages young female scientists



Sarah Hormozi's research on complex fluids has a wide range of applications, including oil extraction. (Photo provided by Sara Hormozi)

to follow their passion in STEM fields. "I've always followed what I liked in life," she said, "and please remember to hold on to your dreams." ✨

Travis White Brings Special Energy to NQPI



Travis White in his office in Clippinger Labs

Travis White first became interested in solar energy, the process of how light deposits energy in materials, after completing a one-semester research course on the photochemistry of beer as an undergraduate student.

"I had just turned 21," explained White, now an assistant professor of Chemistry &

Biochemistry at Ohio University. "But I hadn't realized that light actually plays an important role (in beer production)."

Today, White's group is working to design chemical systems to convert solar energy into a new form for later use. White recently joined the faculty of the Nanoscale and Quantum Phenomena Institute, and he is currently working to design molecules that can be used to absorb light more efficiently.

White said the principle of his research is based on photosynthesis, the process in which plants harness light to produce energetic fuels (i.e., sugar). Solar energy technology is considered "green energy," as it is renewable and does not result in the emission of harmful greenhouse gases.

Much like the leaves of a tree are important for absorbing the light needed for photosynthesis reactions, White is working to develop compounds that can absorb light for use in electrical systems. White explained

that although this process may sound simple in theory, the development of a solar energy system presents unique challenges.

"Basically, we want to mimic what nature does. And it's hard, a lot harder than it seems," White said. "Nature has had billions and billions of years to evolve. We've been trying to catch up in the last 30 to 40 years."

White said he looks forward to collaborating with NQPI members with expertise in materials-based research. In the future, White plans to collaborate with Chemistry & Biochemistry professor and NQPI member Jixin Chen to develop solar cells that can absorb light energy.

Although White noted that his research is currently in the fundamental stage, the application of cheaper, more efficient light absorbers may help to make solar energy methods more feasible at a commercial scale in the future. ✨

New NQPI Member Breaks Chemical Bonds, Builds Professional Partnerships

The development of effective treatments for cancer and infections represents a crucial aspect of the modern field of medical research. Jessica White, a newly inducted member of the Nanoscale and Quantum Phenomena Institute, is working to contribute to the growing body of literature in this field.

"Our research is focused on making some interesting metal complexes that absorb visible photons efficiently and then use that energy to break bonds between a metal and some other molecule," said White, an Ohio University assistant professor of Chemistry & Biochemistry. "A long-term goal would be to make (compounds) that can kill cancer cells or bacterial cells selectively when they're irradiated with light."

When the treatment site is exposed to light, a cytotoxic molecule is activated that destroys cells only at the point of interest. Unlike traditional treatments, this approach (photodynamic therapy) would target the unwanted components (e.g., cancer cells or



Jessica White's research on metal complexes is relevant for medical research.

harmful bacteria) while preserving the integrity of healthy cells. Thus, photodynamic therapy may serve to mitigate the side effects often associated with these types of treatments.

White said she was originally trained in photochemistry as a doctoral student, where she worked with molecules that were involved in catalytic reactions. But during the next several years after the completion of her Ph.D. program, White's research focus shifted, and she applied her newly gained technical knowledge

towards her current field of study.

Although her research is still in the fundamental stage, White said she looks forward to ultimately building towards the biomedical applications of her work. Currently, she is collaborating with Monica Burdick, an associate professor of Chemical and Biomolecular Engineering and Biomedical Engineering, to study the effectiveness of her synthesized compounds against different cell lines.

White joined the OHIO community in 2016; since then, she has worked to balance teaching, setting up her laboratory, and training new graduate and undergraduate students. As a new NQPI member, White said she looks forward to learning more about the perspectives of researchers from other scientific fields.

"There are a lot of quantum processes that are (relevant to) the fundamental understanding (of this research) that I think we as chemists often don't have," White said. "I'm hoping to learn from the physicists of NQPI." ✨

Physics Alumnus Returns to Lead Workshop on Software Design

NQPI hosted physics alumnus Greg Petersen on August 5-7, 2019 who led a workshop for graduate and undergraduate students entitled 'Modern Software Design for Physicists' aimed at teaching modern design principles. Participants were offered a general framework to develop codes as well as tools such as source control and object-oriented design to help them to achieve their research goals faster. Petersen demonstrated how to use these tools to manage, stabilize and extend their code.

Petersen, a senior engineer and algorithm specialist at TSI Incorporated, a company that creates high-end sensors for aerosol particle detection, pharmaceutical monitoring and other uses, said these strategies will help participants work more efficiently.

The workshop was held in Clippinger Labs and co-sponsored by NQPI and TSI. Watch the video about Petersen's workshop in the 'Recent News' section on NQPI's homepage. ✨



Greg Petersen (center) with his workshop participants

Glidden Visiting Professors Investigate Electronic Properties of Materials



Edson Vernek and Daiara Faria share a research focus on nanoscience, leading to exciting collaborations with colleagues

Appointed in consecutive years, Visiting Glidden Professors Daiara Faria (2018-19) and Edson Vernek (2019-20) share a research focus on nanoscience that have led them to exciting collaborations with colleagues in Ohio University's Department of Physics & Astronomy.

Both physicists seek to push the boundaries of understanding electron properties in materials. Coming from Brazil's Rio de Janeiro State University, Faria works with Nancy Sandler on the properties of graphene, especially the effects of mechanical strains and deformations on the electronic properties of graphene membranes. Vernek is from the Federal University of Uberlandia in Brazil, and he specializes in the theoretical studies of nanoscale electronic systems and the description of materials when unusual properties arise due to strong interparticle interactions.

While here, both Glidden Professors are expected to provide insights into local experimental work as well as ongoing

theoretical efforts, create synergy among different research groups and promote the spirit of international collaboration, said Sandler and Sergio Ulloa who is Vernek's main collaborator at OHIO.

The Robert and René Glidden Visiting Professorship program supports short-term academic appointments for distinguished visitors to OHIO. Faria's and Vernek's award, each totaling around \$27,000, came from a variety of sources, including the Glidden Program, Physics & Astronomy, College of Arts and Sciences, and NQPI.

Earlier this year, Faria also shared with the OHIO Margaret Boyd Scholars her experiences of organizing social activities in Brazil, including what she did to maintain a basic working environment at her home university and community-based science outreach. She loves her life in Athens, especially its music, culture and diversity. Vernek has also picked up his favorite sport—soccer—in Athens, and he and his family are looking forward to an exciting year ahead. ✨

Physics Doctoral Student Spends Summer Interning on Wall Street

Nilaj Chakrabarty, a doctoral student in Physics & Astronomy, recently spent his summer interning at a global investment bank in New York City. He worked at the bank's risk management department using the math and computer skills he's learned through his research.

Chakrabarty, whose research is in cellular biophysics, studies the transport mechanisms of actin and neurofilaments using theoretical and computational approaches. These skills, and an interest in studying quantitative finance made him a perfect candidate to help the bank predict future losses and protect the value of assets on its books. During the internship, he helped build statistical models and presented his research to the firm's senior management.

"My internship involved using some of the computational and statistical tools that I use for my research, and I think my mathematical and research background put me in a very good place," Chakrabarty said.

Chakrabarty said his research under the direction of Distinguished Professor Peter Jung has allowed him to work with people from a diverse range of educational and cultural backgrounds, which aided him during his internship.

"We work constantly with biologists and experimentalists who might have limited background in the methods we use," Chakrabarty said. "Yet we have to work effectively with them and make sure everyone is on the same page. In finance, you have people from very different backgrounds and effective communication is vital for the success of the firm. So, I feel, my background really helped me." ✨



Nilaj Chakrabarty

2019 NQPI Fellowships Awarded

Up to six graduate students receive a one-semester stipend which is bestowed annually on a competitive basis.

Talha Furkan Canan

*Faculty Advisor: Savas Kaya
Electrical Engineering*

Canan uses engineered Schottky contacts to enhance the functionality of logic circuits, making them area and power-efficient compared with the current standard. He pursues research on the engineering of gate work functions for novel circuit structures that have improved utilization of digital circuitry.

Nilaj Chakrabarty

*Faculty Advisor: Peter Jung
Physics & Astronomy*

Chakrabarty's doctoral research is aimed at studying the various strategies a neuron employs to transport structural proteins from their synthesis sites along the axon. He works closely with his experimental collaborators at OSU and UCSD and focuses on the computational aspects of these projects.

Dasmeet Kaur

*Faculty Advisor: Allan Showalter
Environmental & Plant Biology*

Kaur studies biological functions of sugars decorating the highly glycosylated cell wall proteins known as Arabinogalactan proteins. She uses CRISPR-Cas9 gene-editing approach in the model plant species, *Arabidopsis thaliana* to knock out multiple enzymes responsible for adding first galactose sugar onto the Arabinogalactan proteins.

Eva Yazmin Santiago Santos

*Faculty Advisor: Alexander (Sasha) Govorov
Physics & Astronomy*

Santiago Santos studies the optical and photothermal properties of various plasmonic nanostructures. Her research focuses on the theoretical and computational modeling of these materials.

Juvinch Vicente

*Faculty Advisor: Jixin Chen
Chemistry & Biochemistry*

Vicente focuses on the understanding of surface reactions of lead halide perovskites using single-particle and super-resolution fluorescence microscopy. Fundamental insights on surface reactions on these materials will help design a much more stable interface for their promising applications in photovoltaics and optoelectronics.

*Writing, design, editing and photos by Ling Xin, Kate Nichols, Rachael Beardsley and Amanda Biederman.
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