Faculty Spotlight: Gunjan Agarwal, Biomedical Engineering

Gunjan Agarwal joined The Ohio State University in September 2003 as an Assistant Professor with a joint appointment in the Biomedical Engineering department and the Davis Heart and Lung Research Institute (DHLRI). Dr. Agarwal was promoted to the rank of Associate Professor in 2009, and she also directs the multi-user AFM core facility within the Davis Heart and Lung Research Institute. Prior to joining OSU’s faculty, Dr. Agarwal was a Research Scientist at the Air Force Research Laboratory at Wright Patterson Air Force Base, and held Postdoctoral Researcher positions with Procter and Gamble Pharmaceuticals and Albert Einstein College of Medicine in New York.

Dr. Agarwal’s major research interest is to understand extracellular matrix (ECM) regulation at the cellular and molecular scale and its implications in vascular and bone diseases. She employs techniques such as atomic force microscopy (AFM), electron microscopy and fluorescence microscopy along with biochemical assays for her research. Another vector of her research is the development of novel biomedical applications of AFM. Her research has been funded by the NIH and American Heart Association as well as internally by OSU materials research centers such as the NSF NSEC and MRSEC centers and the IMR.

Extracellular Matrix (ECM) Remodeling

Remodeling of the extracellular matrix (ECM) is important for a variety of physiological and pathological processes. Collagen type 1 is the most abundant ECM protein present in the adult mammalian tissues. Dynamic interactions between collagen and cells via specific receptors and signaling pathways control processes such as cell migration, proliferation and survival. The overall goal of Dr. Agarwal’s laboratory is to elucidate the functional role(s) of the widely expressed collagen binding proteins, discoidin domain receptors (DDRs) in modulating collagen structure and mechanics at the molecular, cellular and tissue levels (Figure 1).

Continued on page 6
Director's Note

Dear Colleagues,

It has been said before and it will be said again: Materials research is truly entering a renaissance period. With the multitude of new materials and concepts being explored as a result of the converging energy, health, environment, security and sensing needs we face today, there may never have been a period of time with so many new entrants to the field of advanced materials. Ohio State's leadership recently announced its strategic plan precisely along these lines of societal needs, with three Discovery Themes identified as Health and Wellness, Energy and Environment, and Food Production and Security. Our community is uniquely and exceedingly well positioned to work with our colleges and departments toward enabling and achieving their strategic plans through the creation of new opportunities that are now only at the intersections of traditional disciplines. After all, materials science and engineering was born from such connections between various fields of engineering, chemistry and physics, and now the addition of the biological/biomedical sciences, energy technologies, sustainability and security is generating an exciting new era for IMR and Ohio State, much less the nation and world.

For the past 6 years, IMR has intentionally focused much of the biological/biomedical sciences, energy technologies, sustainability and security is generating an exciting new era for IMR and Ohio State, much less the nation and world.

For the past 6 years, IMR has intentionally focused much of its efforts toward enabling and achieving its strategic plans through the creation of new opportunities that are now only at the intersections of traditional disciplines. After all, materials science and engineering was born from such connections between various fields of engineering, chemistry and physics, and now the addition of the biological/biomedical sciences, energy technologies, sustainability and security is generating an exciting new era for IMR and Ohio State, much less the nation and world.

OSU’s newly created Technology Commercialization Office has been all about change in its first nine months of operation. Led by the new Vice President for Technology Commercialization Brian Cummings, the office is undertaking a substantial overhaul in just about every way possible. "From the organization, to the programs we offer, we cannot say that we wanted much more streamlined and simpler processes to achieve success," said Cummings. "It's our job to ensure that the breakthrough research at Ohio State finds its way to the public sector in the shortest time possible and to do that we need to build creativity, responsiveness and accountability into new programs and partnerships so we can maximize the impact of our research and enhance student and faculty education.

Warm Regards,

Steven A. Ringel, Ph.D.
Neal A. Smith Chair Professor
Director, The Ohio State University Institute for Materials Research

N-polar GaN Light Emitting Diodes

GaN based light emitting diodes (LEDs) have been commercialized for lighting and displays due to their higher efficiency and longer lifetime compared to conventional light and display sources. Making efficient emitters in the green wavelength range however, has been very challenging due to several fundamental physical limitations. These emitters have several applications ranging from displays to communications and sensing.

Recently, OSU’s Siddharth Rajan (Assistant Professor of Electrical and Computer Engineering and Materials Science and Engineering) and his colleagues have indicated that using a new orientation of the GaN crystal structure, the N-polar orientation, could have significant advantages for making longer wavelength LEDs. The N-polar orientation has been found to be better for making high composition InGaN light emitting diodes in the crystalline form. In addition, ECE PhD student Fath Akylow’s simulations show that the potential profiles seen in the N-polar LEDs could improve power and efficiency from these emitters, potentially solving one of the biggest challenges in the area of research. The Rajan research group’s findings have received attention in multiple publications and trade journals. Their work featured in the June 2011 issue of Semiconductor Today (http://tinyurl.com/7fsdg). used molecular beam epitaxy, a method for synthesizing atomically perfect crystal structures for semiconductors, to demonstrate the first N-polar light emitting diodes in the green wavelength range [Akylow et al., Japanese Journal of Applied Physics, 50, (2010)]

New Commercialization Office Focuses on Change

The objectives of the new office are as follows:
- Build a culture of innovation, service, responsiveness, creativity and accountability
- Restructure the support systems and programs of the commercialization office
- Create customized initiatives that enhance our research colleges
- Develop a robust start-up culture that drives economic development
- Increase deal flow and revenue while decreasing transaction costs
- Establish unique public/private partnerships that facilitate commercialization
- Increase Industry sponsored research and long term partnerships
- Engage students in every aspect of the process to enhance the learning experience and support Ohio State’s mission
- Engage Alumni and Friends of Ohio State to participate in commercialization
- Measure success to continually improve

Our ultimate goal is to be a top five office in technology commercialization and create a new model that others can replicate across the country. This requires not only a much greater level of engagement from our faculty but a cultural shift at many levels throughout the campus. In a recent speech, President Gee mentioned the importance of these efforts and stated that, “in order for us to thrive, we need to rethink, recreate, re-examine, redefine, and re-conceptualize a whole new model, a brave new paradigm for the 21st century University. We are missing vital opportunities to transform the magnificent brainpower centered at our University into products and services that will create new businesses, generate resources, and improve lives.”

The Technology Commercialization Office (TCO) is committed to these principles and will you see many new programs over the coming months but it will all start with researchers submitting their ideas to the TCO. Nothing is more critical than capturing an idea before it is published or presented.

From there an idea or invention is handed to a team of professionals that begin the commercialization process by:
- assessing the idea or innovation
- developing an intellectual property strategy
- determining a business strategy
- creating a development plan
- finding and connecting to the proper resources and partners
- restructuring the deal monitoring its success

We engage students, companies, entrepreneurs and capital partners to provide feedback on an idea and develop a milestone based plan to success. Located at the gateway to the University on 9th and High St, we have an open door policy to all collaborators and serve as the facilitator for all industry and business relations on campus. We’ve just moved into the new office and encourage all faculty members to come over and see the space. The fast-paced, creative culture at the TCO realizes the importance of celebrating success and highlighting positive outcomes of our faculty.
Materials Facilities Updates

Nanotech West Laboratory

Nanotech West Lab is the largest nanotechnology user facility in the State of Ohio, consisting of a 6,000 square foot class 100 cleanroom facility, a 4,000 square foot Biohybrid Laboratory, and other laboratory and office space in the Science Village Building at 1381 Kinnear Road on the West Campus of the University.

New X-Ray Materials Analysis Capability at Nanotech West Lab

In January 2012, Nanotech West Lab installed a new Oxford X-Max 50mm2 silicon drift detector on the Zeiss Ultra Plus field emission scanning electron microscope (FESEM, tool code SEM02) in Bay 2 of the cleanroom. Silicon drift detectors (SDD) are advanced detectors for energy dispersive x-ray spectroscopy (EDS) which allow for chemical (elemental) analysis of surface features. SDDs can utilize the high x-ray count rates that result from the high brightness of a field-emission SEM electron source, which in turn allows for elemental mapping in a much shorter time frame than earlier detectors (often minutes instead of hours), and has the ability to handle materials composition maps overlaid on SEM images. Furthermore, unlike traditional EDS detectors, the Oxford X-Max (like other SDDs) is cooled by a Peltier cooler and does not have to be filled with liquid nitrogen. Potential users should contact Aimee Price (price.798@osu.edu) or via phone at (614)688-1158.

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Investing in the STEM Pipeline

The Center for Emergent Materials, a National Science Foundation (NSF) supported Materials Research Science and Engineering Center (MRSEC) at OSU, welcomed Professor Jan Jacob from the University of Hamburg in early 2011 to teach a three-week LabView short course to undergraduate and graduate students as well as post-doctoral researchers and staff during the month of February. The MRSEC also hosted 6th and 7th grade students from Columbus City Schools for the annual Breaksfast of Science Champions event on campus.

LabView Short Course presented by Dr. Jan Jacob

In February, Dr. Jan Jacob from the University of Hamburg taught a LabView short course for undergraduate and graduate students as well as post-doctoral researchers and staff. Twenty-nine students regularly attended these sessions, taught 3 days per week for 3 weeks. Specific topics that were taught included: general approaches to software development, debugging and error handling, datatypes, basic constructs and concepts as well as error handling, datatypes, basic constructs and concepts. Additional software topics included the design flexibility of semiconductor photonics to enable enhanced performance of LEDs and photodetectors across the ultraviolet to visible spectrum.

In December 2011, twenty Ohio State faculty were elected to the prestigious role of Fellows of the American Association for the Advancement of Science, the world’s largest general scientific society. New AAAS Fellows include three active IMR members, as detailed below:

TV. RajanBabu, professor of Chemistry, was elected AAAS Fellow for distinguished contributions to the field of organic synthetic and asymmetric catalysis mediated by transition metal complexes.

Claudia Turr, professor of Chemistry, was selected for distinguished contributions to the understanding and elucidation of processes of inorganic complexes, including excited states and reactive intermediates important in solar energy and photodynamic therapy.

Joseph Herrmann, professor and Ohio Eminent Scholar of Mechanical and Aerospace Engineering, was honored for his distinguished contributions to the field of thermal engineering, specifically the development of high-efficiency thermoelectric materials and the discovery of thermal spin-polarization in semiconductors.

Dr. Jan Jacob of the University of Hamburg taught a LabView short course over three weeks for OSU students and staff.

Recent Publications:

ECG Remodeling


"The influence of discoid domain receptor 2 on the persistence length of collagen type I fibrils" Synaramat L and Agarwal G Biomaterials (2010); 31(18): 4802-4808

AFM


"Magnetic force microscopy of an oxygen-sensing probe" M. Sela, R. Paudhan, P. Keppens and G. Agarwal" invited article for special edition of Israel J of Chemistry (2008) 48 (1) 33-38. (Figure published on cover page)

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Materials Centers Updates: Center for Emergent Materials (CEM) Update

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Faculty Spotlight: Gunjan Agarwal, Biomedical Engineering

(continued from page 1)

Novel Biomedical AFM applications

Another vector of Dr. Agarwal’s research is to develop novel biomedical applications of AFM. The Agarwal research group has been pursuing two projects in this direction: (1) development of magnetic force microscopy (MFM) (Figure 2) for detection of superparamagnetic nanoparticles encountered in biological samples and (2) development of dip-pen nanolithography (DPN) for creating desired assembly of proteins/nanoparticles on surfaces. In addition, the AFM core facility enables users to image single-molecules, cells and tissues in a fluid environment and perform force measurements using the AFM.

For more information about Dr. Agarwal’s research, contact her at Gunjan.Agarwal@osumc.edu

IMR Member News

The OSU Center for Automotive Research (CAR) was awarded the Outstanding Technology Team award at TechColumbus’ 2011 Innovation Award. The program recognizes forward-thinking individuals, companies and technology teams from central Ohio for innovation. CAR has served as an incubator for two companies and technology teams from central Ohio for innovation.

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Spring 2013

Materials Week is moving! Due to The Ohio State University’s academic calendar changing from quarters to semesters in 2012, the next OSU Materials Week will be scheduled for Spring 2013. Announcements of dates, events, and registration will be posted on IMR’s website: imr.osu.edu and in future issues of IMR Quarterly newsletter.

A program planning committee has been created and has begun planning technical sessions for the next Materials Week. If you would like to share feedback on past Materials Week conferences or suggestions of topics, speakers, or events for 2013, please send your ideas to Layla Manganaro, IMR Program Manager, at manganaro.4@osu.edu.