Volume 3 Issue 2 Winter 2011

IMR Quarterly

Faculty Spotlight : Jon Parquette

Jon Parquette has been an Ohio State faculty member in the Department of Chemistry since 1996. He received his Ph.D. in 1994 at Stanford University under the supervision of Barry M. Trost, was awarded an American Cancer Society Postdoctoral fellowship with Peter Dervan at the California Institute of Technology, and received the Early CAREER Award from the National Science Foundation in 1998.

Dr. Parquette's research program revolves around the theme of synthetic macromolecular and supramolecular organic chemistry, with particular interest in the design and synthesis of functional macromolecules that fold or self-assemble into well-defined nanostructures. These molecules have tremendous potential to function as enantioselective catalysts, targeted drug delivery agents and electronic materials, among many other applications. Research highlights of Dr. Parquette's work provided below show just some of the diverse applications of the innovative work by him and his research group.

The Self-Assembly of Functional Materials

The spontaneous self-assembly of small molecules into highly ordered nanostructures produces many of the functional materials found in nature, ranging from the membranes of cell walls to the amyloid fibrils responsible for a variety of neurological disorders. Inspired by the efficiency, self-correcting capability and simplicity of molecular self-assembly, the Parquette group seeks to replicate this process using designed building blocks programmed to organize into well-defined nanoscale objects. Although the level of complexity achieved by the *de novo* assembly of synthetic systems pales in comparison to that of natural systems, synthetic nanostructures offer many potential opportunities to create new electronic, biomedical and catalytic devices.

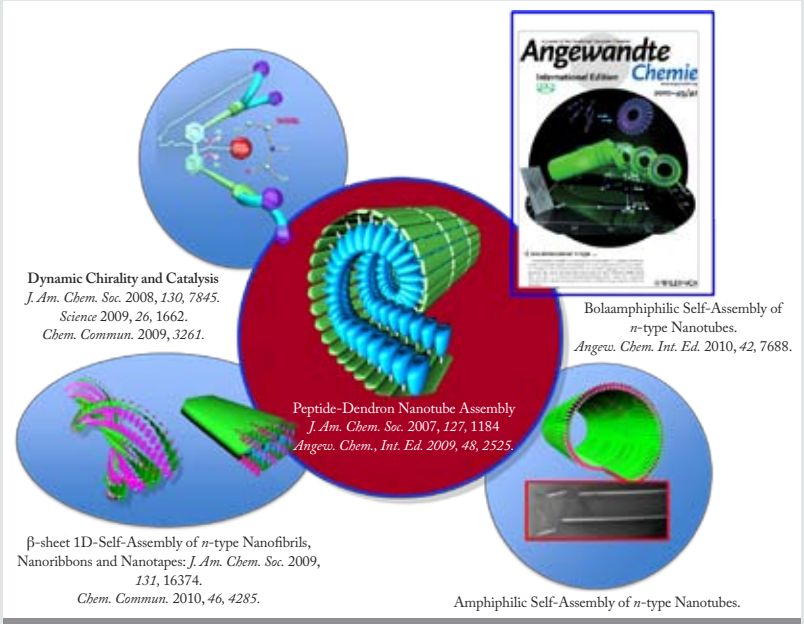


Fig. 1 Selected publications describing the Parquette group's progress toward controlling the intra- and intermolecular folding and self-assembly.

For more information on Dr. Parquette's research see page 6.

IMR Institute For Materials Research
THE OHIO STATE UNIVERSITY

Director's Note

Dear Colleagues,

Yes, it has been a long and cold winter, but that has not stopped IMR researchers from making great strides in everything from performing innovative materials chemistry to creating newly funded partnerships with private industry, and even to initiating a new international collaboration with a top European university in Spain in the area of electronic materials that was kicked off with a week-long event in early February. This issue of IMR Quarterly provides glimpses into the remarkable breadth and depth of materials research at OSU that continues to place Ohio State at the forefront of materials research nationally and internationally.

Inside, our faculty spotlight shines on Chemistry Prof. Jon Parquette, a materials chemist who is focusing on the synthesis of self-assembled nanostructures for potential applications that range from catalysis and drug delivery to optoelectronics and energy conversion. The role of chemistry in advancing the state of the art in materials research and innovation is growing at a remarkable rate and its importance cannot be overstated. Ohio State is fortunate to have a strong, interdisciplinary chemistry program that is pushing hard into materials research as one of its strategic goals. Much of this is being driven by the urgency of our planet's current and future energy and environmental needs and challenges, as well as the demographic shift of our population to one that demands transformational and rapid advances in the medical community. To those points, this issue of IMR Quarterly also presents a successful commercialization of biomedical-oriented materials research being conducted within The Center for Affordable Nanoengineering of Polymeric Biomedical Devices (CANPBD), OSU's NSF supported Nanoscale Science and Engineering Center, through advances being made in a new spin-off company co-founded by Prof. John Lannutti, an MSE professor who is also the Deputy Director of CANPBD. In addition, photovovoltaics research through both IMR faculty and the Wright Center for Photovoltaics and Commercialization continues to have a major impact, with IMR and PVIC being key collaborators on three of the five awards (out of 35 total submissions) recently announced by the Ohio Third Frontier program on Photovoltaics.

I am also delighted to report that we have added our second Ohio Research Scholar to the statewide Research Cluster on Technology-Enabling and Emergent Materials led by IMR, with Professor Scott Gold joining the University of Dayton this past Autumn. Professor Gold's expertise is in the area of processing of nanoscale materials. Finally, IMR recently awarded an IMR Industry Challenge Grant to Prof. Wolfgang Windl of OSU's Materials Science and Engineering department to supplement his promising new collaboration with L-3 Communications. Windl's group will assist L-3 by modeling III-V compound materials, heterostructures and devices for infrared sensor applications. One of IMR's missions is to support the advancement of the novel, pioneering research efforts of OSU's materials researchers. This Industry Challenge Grant project and the 13 new IMR Facility Grants awards on page 10 are some recent examples of IMR's continued promotion of innovative materials-allied research within our materials community.

There are many other important achievements that have occurred in the past few months, including faculty awards, and the continued installation of facilities of note in several shared labs. I hope you will enjoy reading about the activities and accomplishments made by our great research community in this issue!

Warm Regards,

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

PVIC Industry Collaborator, Replex Plastics puts PV System in Sun

Ohio State researchers, in collaboration with a team led by Replex Plastics in Mount Vernon, Ohio, are developing a low-concentration, low-cost photovoltaic array to produce solar energy. The project is intended to reduce the cost of photovoltaics by substituting most of the large surface area of a solar panel with relatively inexpensive optics. The design utilizes compound parabolic concentrators, or CPCs, which concentrate sunlight rays at 7 to 10 times their intensity onto silicon solar cells. Heat sinks passively cool the cells and at the same time serve as structural components. The optics design also has a wide angle of acceptance and, unlike high concentration (about 500 times the intensity) designs, should work well in the sunlight conditions of mid-northern latitudes. At Ohio State, the primary collaborator is Bob Davis, director of the Nanotech West Lab, co-director of the Ohio Wright Center for Photovoltaics and adjunct associate professor of Electrical and Computer Engineering. Ohio State is testing commercially available cells, performing materials tests and developing a silicon cell fabrication process tailored for the project. The project is funded by Ohio Third Frontier with matching funds from Replex and Ohio State and also includes support from Dovetail Solar and Wind in Athens, Ohio; the Edison Welding Institute; and a collaborator at Case Western Reserve University. The Replex engineering team includes OSU Mechanical Engineering alumna Kara Shell, a key participant in the 2009 Ohio State Solar Decathlon Team who joined Replex this year.

Article first appeared in News in Engineering, Volume 82, Number 3, 2010.

Replex Plastics employees Kara Shell, '10 M.S. ME, and Scott Brown set up the first-generation low-cost, low-concentration prototype array at Dovetail Solar and Wind in Athens, Ohio. Developed by Replex Plastics in conjunction with Ohio State researchers, the prototype consists of a 10-by-12-foot array of 120 modules, each consisting of a compound parabolic concentrator, or CPC, mirror on top of a 25-by-50-millimeter single-crystal, silicon solar cell. The array is passively cooled (without fans) by linear heat sinks. The array is currently mounted on a two-axis tracking system, although it requires only one axis.

2011 Ohio Innovation Summit – Returning to Ohio's Material Roots

This April, the Ohio Innovation Summit (OIS) will present its annual opportunity for Ohio innovators and leading companies to take center stage and show the world some of the most outstanding technology and industrial developments in the State. The 7th annual offering of this very unique conference (formerly called the Ohio Nanosummit) will be held in Toledo on April 19-20, 2011 with the theme "Returning to Ohio's Material Roots." The 2011 Ohio Innovation Summit will be jointly sponsored by three Wright Centers of Innovation at The Ohio State University: the Center for Multifunctional Polymer Nanomaterials & Devices (CMPND), the Ohio BioProducts Innovation Center (OBIC), and the Wright Center for Photovoltaics Innovation and Commercialization (PVIC).

The two-day event will feature noted speakers and world-class experts, most of whom are based in Ohio. "The first Summits were focused on nanotechnology to assist Ohio companies (especially the small- to medium-sized companies) in learning about the practical applications for new discoveries. These events have now been expanded to highlight innovations across a broader spectrum of technologies," said Sharell Mikesell, OIS organizer, CMPND Co-Director, and Vice President, The Ohio State University, Industry Liaison Office. Mikesell says that these Summits offer a unique opportunity for companies to learn about the practical applications of emerging technologies and to hear success stories by Ohio companies' new innovations. "The OIS has a reputation for providing insights on the applications of new discoveries and a major opportunity to expand company networks. The focus is to provide companies with actionable items when they leave."

Typically, the event has a nationally known keynote speaker, several opportunities to follow specific interests through concurrent sessions, an exhibition hall, and excellent networking opportunities. Many of the companies and organizations that will be in attendance at OIS have impressive track records of winning State and federal grant monies, including recipients of funding support from the Ohio Department of Development (ODOD) through several of its programs (Ohio Third Frontier, Wright Centers, Edison Centers). It is truly a value-added event for many technology-based industries in Ohio. Because many of these companies are smaller and started by Ohio innovators, their representatives are often experts in the latest applied technologies and great potential collaborators for companies seeking to incorporate technology advances.

Topics slated for the 2011 Ohio Innovation Summit include:

- nanomaterials in photovoltaics (solar);
- nanomaterials in biomedical devices;
- nanomaterials in electronics;
- how nano-computations can decrease development time and increase success for industry;
- the collaboration mixer (always a highlight);
- biobased materials;
- nano-enabled systems - new applications;
- aerospace materials; and
- polymer systems.

Presenters will include representatives from such industry-leading organizations as Ashland, PolyOne, Zyvex, Ethicon Endo, the US Air Force, NASA Glenn, Goodrich, Owens Corning, NanoSperse, Maverick, and others.

"Our goal is to spark connections for next-gen innovations that will keep Ohio growing and its industry participants in a leadership position," said Mikesell. "Part of the basis for the high level of success and participation of past annual events has been that the themes and focus have been presented for/by Ohio entities."

This Summit will feature many highlights. On Day 1 (Tuesday, April 19), the program will offer a variety of sessions devoted to new materials for biomedical, electronic and photonic (solar) applications, and concludes with a session tying together innovation and materials science to demonstrate the future of industry in Ohio. Several companies have been invited to share their success stories from the Third Frontier initiatives in materials developments. That evening's Collaborative Mixer will be an exciting event for networking and building new connections, and promises to be a major engagement opportunity for all stakeholders.

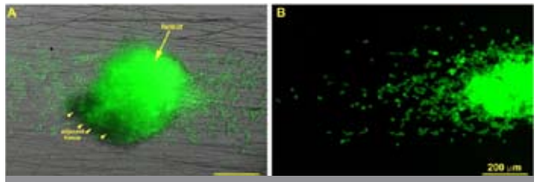
Wednesday, April 20, Day 2 of the event, will have a technology focus, including a highlight of new materials from renewable resources, a special session addressing EPA issues with new materials (especially nanomaterials) and a session on aerospace materials and nano-enabled systems and their respective new commercialization opportunities. These technologies offer many new applications for economic growth today and will be even greater drivers of significant future economic growth for Ohio moving forward. During the day, attendees learn about the practical applications and how to get connected to suppliers and groups which can facilitate new applications development, grant funding, access to resources, etc.

Some of the most talented students and graduate students also display posters and highlight their own research projects at OIS. For those who want to sample the pulse of the next generation of scientists and engineers, the student posters are a refreshing and thought-provoking part of the event. The OSU Institute for Materials Research will sponsor up to 20 OSU students to attend this conference and present their research posters at the Summit. This is the fifth year that IMR has been able to offer OSU student sponsorships, in an effort to provide the students with a valuable professional experience.

All activities and accommodations will be at the Crowne Plaza Toledo, 444 N. Summit St. For more information, see the OIS website at http://ohioinnovationsummit.org/2011/index.shtml.

Nanofiber Solutions Offers 3-D Aligned Polymer Nanofibers for Cell Culture & Migration Models

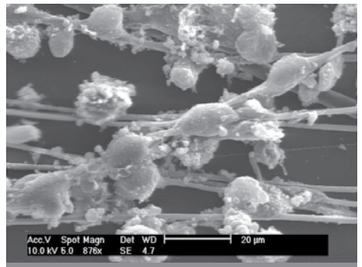
The Center for Affordable Nanoengineering of Polymeric Biomedical Devices (CANPBD), an NSF-funded Nanoscale Science and Engineering Center (NSEC) at The Ohio State University, has successfully translated biomedical research into commercial applications through the creation of several spin-off biotech companies. One example is **Nanofiber Solutions LLC**, a Columbus-based technology company that develops and markets patent-pending electrospun fiber multiwell plate technologies for cell culture and cancer research. As an extension their research, Nanofiber Solutions was founded in 2009 by Dr. Jed Johnson and Professor John Lannutti, Professor of Materials Science and Engineering and Deputy Director of OSU's NSEC program.



GFP– expressing intracranial tumors (GBM9 glioma-initiating cells) were dissected, cleaned, and cultures on aligned nanofibers. A) Representative image of a tumor specimen showing adjacent tissue and dispersed cells. B) Flouresence picture of the border from a tumor specimen, showing the detail of dispersed cells.

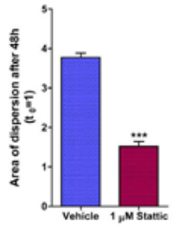
Nanofiber Solutions recently announced the introduction of its new patent-pending high-throughput nanofiber culture dishes, citing it as a major breakthrough producing much more realistic *in vitro* environments. By providing a surface that closely mimics the physical structure found *in vivo*, these 3-D nanofiber substrates allow more accurate modeling of cell migration while still meeting the needs of high resolution live-cell imaging. This in turn allows anti-cancer compounds to be developed and tested more efficiently, faster and less expensively.

Nanofiber Solutions develops and markets synthetic nanofiber multi-well plates for cell culture applications ranging from drug discovery to stem cell expansion. This technology uses aligned 3-D substrates to better mimic human *in vivo* environments and thus facilitate faster screening and more effective cancer research. The scaffold is composed of synthetic polymer nanofibers randomly arranged or aligned into parallel nanofibers at the bottom of standard cell culture dishes. This gives a 3-D surface upon which cells can attach and grow to allow researchers to model metastasis and cell mobility in vitro. This is especially important as researchers investigate cellular mechanisms of migration from the primary tumor. As a result, researchers are able to more accurately study the effects of various chemical compounds on cell behavior. Investigators can also coat the fibers with different biological coatings of interest (i.e. collagen, fibronectin, etc.) just like existing culture dishes or upregulate/downregulate genes to investigate different cellular mechanisms.



Close up SEM image showing the "beads on a string" metastasis of glioma cells leaving the main tumor while cultured on aligned Nanofiber Solutions nanofibers.

Nanofiber Solutions products are available in all standard sizes for cell culture dishes. In contrast to lab testing involving human cells in flat plastic cell-culture dishes and plates, these products can yield more realistic, accurate results. "A flat plastic environment is so different from what exists inside the human body that any drugs that emerge from that type of research are, not surprisingly, limited in their ability to treat cancer," said Prof. Lannutti. With the company's nanofibers placed inside those dishes, however, potential new drugs can be tested in an environment that more closely resembles real-world applications, according to the company. As a result, companies can bring drugs to market faster by reducing the number of animal and human tests required to find effective compounds. Dr. Jed Johnson, Nanofiber Solutions' Chief Technology Officer, foresees nanofibers as the future of cell culture, stating, "As we make advances in cancer research and regenerative medicine the demand for more realistic *in vitro* models will grow."



GBM9 tumor specimens cultured as above were treated for 24h with vehicle or 1 µM Stattic, which inhibited cell migration out of the tumor core. (***p<0.001 by Student's t-test)

For more information, visit Nanofiber Solutions' website at www.nanofibersolutions.com

Facilities Updates

Nanotech West Laboratory

The new **CHA SOLUTION™ System electron gun evaporator** which is located in Bay 4 of the class 100 cleanroom (first announced in the Spring/Summer 2010 issue of *IMR Quarterly*) is now up and ready for use, and we are training users on it. The new e-gun evaporator features a six-pocket hearth and a programmable Inficon IC/5 deposition controller which will allow the semi-automatic deposition, with rate control, of a wide variety of materials. The system is pumped by a cryopump with auto-regeneration capability and has a base vacuum pressure in the upper-10^{-08} Torr range. The tool, designated EVP03, will have improved uptime, faster pumpdown rates, perform cleaner depositions, and will be easier to use than other evaporators at Nanotech West.

Also, the **GCA 6300-series i-line optical stepper**, located in Bay 2 of the Nanotech West cleanroom, is up/ready for use and we are doing initial training on it as well. This system is capable of photolithography down to ~0.70 microns.

For more information on these tools please contact Aimee Price at price.798@osu.edu, or John Carlin at carlin.9@osu.edu.

ENSL

Over the last quarter the ENCOMM NanoSystems Laboratory (ENSL) has continued its expansion through the acquisition of new state-of-the art instrumentation to further support OSU's materials community. The most recent addition to the list of the instruments that are being purchased for ENSL is a Magneto-optical Kerr Microscope that will be supplied by Evico magnetics GmbH (Dresden, Germany). The purchase of the instrument is made possible through OSU funding of the Advanced Materials Initiative Targeted Investment in Excellence (TIE) award. This highly flexible advanced wide-field Kerr-microscope will be used for magnetic domain research. Enhanced by image processing and equipped with electromagnets, domains and magnetization processes on all kinds of ferro- and ferrimagnetic materials will be studied at variable magnifications down to the resolution limit of optical microscopy. A unique capability for real-time visualization of domain formation and evolution in applied magnetic field will become available to OSU researchers. The microscope is expected to be delivered at the beginning of the summer of 2011. See future issues of the *IMR Quarterly* for updates on this piece of equipment.

In other news, the Seki Technotron Corp. AX5200M 1.5kW Microwave-Plasma Enhanced-Chemical Vapor Deposition system, a state-of-the-art deposition tool for synthesizing high quality poly crystalline and single crystal diamond films for research and production has arrived at the ENSL lab and is being installed in room 1119 Physics Research Building. The instrument is expected to become operational by the end of March 2011, and it was purchased as part of a multidisciplinary project funded by an NSF Major Research Instrumentation (MRI) award with Dr. Ezekiel Johnston-Halperin of Physics as the Principal Investigator.

The image of the Magneto-optical Kerr Microscope as provided by Evico magnetics GmbH (Dresden, Germany)

A new WS-400-6NPP-LITE Spin Coater by Laurell Technologies Corporation has been acquired for use in the ENSL clean room. The spinner is capable of spinning up to ø150mm wafers and 4" × 4" (102mm × 102mm) substrates. It will become available to users in February 2011.

For more information about ENSL and its excellent research capabilities open to all researchers, contact ENSL Lab Manager Dr. Denis Pelekhov, pelekhov.1@osu.edu.

Faculty Spotlight: Jon Parquette

(continued from page 1)

These opportunities require a capability to control the hierarchical organization of multiple functional components at both the molecular and supramolecular levels. Precise control of this level of assembly remains a significant challenge. Therefore, we endeavor to discover new methods to control the size, shape, and internal/external surface structure of these materials in a predictable and versatile manner in order to create new functional capabilities.

Nanostructured Optoelectronic Materials

The need for a rapid transition from hydrocarbon-based fuels to clean, economically viable sources of energy has become critically important to meet rapidly increasing global energy requirements and to reduce CO_2 emissions. Therefore, we have recently been focused on creating nanostructured π-electronic materials because these materials have great potential to improve the performance of solar cells for the conversion of sunlight into electricity. Photovoltaic devices fabricated from organic materials offer lower processing costs than inorganic devices and a capability to cover large, flexible substrates and solution processibility. A directed self-assembly process that creates a defect-free, self-correcting, nanostructured *p*-*n* interface with dimensions that match the length/time scales of the charge carriers is needed to greatly improve the performance of organic electronic devices. Therefore, the critical challenge in developing nanostructured materials is learning how to assemble hierarchically ordered nanostructures in which both *n*- and *p*-type materials co-exist with controllable intermolecular dimensions. Ultimately, we hope to develop a molecular-level understanding of how the nanostructural features of optoelectronic materials can be tuned to optimize the energy and charge transport processes.

β-Sheet Assembly

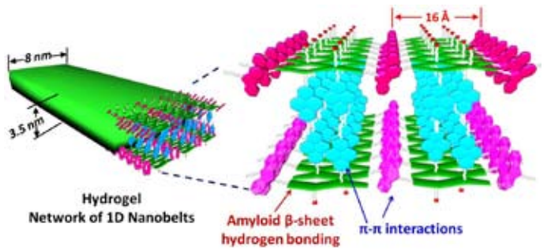


Fig. 2 Model of the self-assembly of Fmoc-KK(NDI) showing interdigitation of Fmoc chromophores.

We have developed several strategies based on peptide β-sheet formation and amphiphilic self-assembly in water to create a variety of 1-D nanostructures from very simple building blocks For example, the β-sheet self-assembly of naphthalene diimide (NDI, electron acceptor) functionalized dipeptide monomers produces nanofibers and nanoribbons in water (Figure 2). The structure of this assembly achieves a bicontinuous array of *p*- and *n*-type chromophores necessary for optimal charge transport, which is thought to be necessary for the optimal performance of photovoltaic devices.

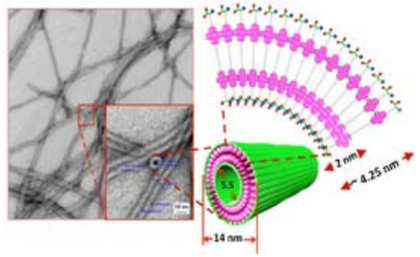


Fig. 3 Amphiphilic assembly of NDI-Lysine into nanotubes.

Photoconductive Nanotubes

The exceptional electronic properties of carbon nanotubes have inspired interest in creating flexible supramolecular approaches toward π-conjugated nanotubes. However, programming small π-electronic chromophores to spontaneously assemble into a nanotube structure is a daunting and elusive goal. In an effort to achieve the assembly of π-electronic nanotubes, the Parquette group utilized amphiphilic self-assembly of NDI-lysine conjugates to create well-defined nanotubes (Figure 3). Self-assembly proceeds via a bilayer membrane followed by the formation of twisted ribbons, which then transform into coiled ribbons and nanotubes. Based on the bilayer model of the assembly for the NDI-lysine amphiphiles shown in Figure 3, we elaborated this model to design a single, bolaamphiphilic version of the bilayer that also assembles into homogeneous nanotube assemblies. The bolaamphiles initially assemble into a monolayer membrane (MLM) that curves into a nanoring (Figure 4). Subsequent stacking of the rings into the nanotube structure sequesters the hydrophobic NDI cores within the interior of the MLM tube wall while projecting the hydrophilic lysine headgroups on the inner and outer surfaces of nanotube. Recently, we found this model of self-assembly was successful for the construction of a porphyrin-NDI nanotube containing a nanostructured *n*-*p* interface.

Multi-disciplinary Efforts

We are currently collaborating with several other research groups to explore the potential properties of these materials.

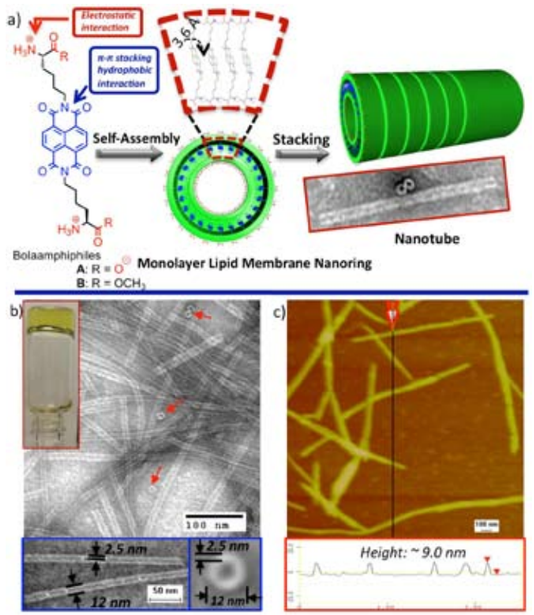


Fig. 4 (a) Bolaamphiphilic assembly of nanotubes. (b) TEM and (c) AFM images.

For example, magic-angle spinning (MAS) solid-state NMR (SSNMR) experiments performed in collaboration with Chris Jaroniec, Assistant Professor of Chemistry at OSU, showed that the bolaamphiphilic nanotubes were exceptionally homogeneous and comprised of A *in a single conformation*. In fact, the lysine residues inside and outside the nanotube could be distinguished in the NMR spectra, each displaying unique conformational dynamics. As expected for a curved nanotube wall, the lysine on the interior wall displayed lower conformational mobility than the lysine on the exterior wall. Similarly, we were able to demonstrate, in collaboration with Prof. David Modarelli's group at the University of Akron that the intermolecular interactions present in the self-assembled fibers, ribbons and nanotubes facilitate long-range charge migration. We are working with Prof. Duxin Sun at the University of Michigan to extend these strategies to develop a strategy to the nanoscale dimensions of these assemblies to selectively deliver anticancer drugs to various tumors.

For more information on Dr. Parquette's research, visit his website at: http://parquette.group.chemistry.ohio-state.edu/, or contact him via email at parquette@chemistry.ohio-state.edu

Dayton Hires New Ohio Research Scholar, Scott Gold

The University of Dayton School of Engineering recently announced the hiring of Dr. Scott Gold as an Ohio Research Scholar in Multiscale Composites Processing.

Dr. Gold's area of expertise is the processing of nanoscale materials and composites using surface tension, or how a liquid interacts with solid surfaces. Applications include the fabrication of nanostructured materials that can be used in electronic devices, batteries, fuel cells or composite materials. Dr. Gold comes to Dayton from the Institute for Micromanufacturing at Louisiana Tech University. His research interests include surface chemistry and the development of novel nanostructured materials, with a focus on energy related applications.

"We are very pleased to have Dr. Gold join our School of Engineering family. We look forward to his contributions to the excellent teaching and research in the School of Engineering," said Tony Saliba, dean of the University of Dayton School of Engineering.

This Ohio Research Scholar position is funded by the Technology-Enabling and Emergent Materials award from the Ohio Department of Development through the Ohio Third Frontier Program, and the project is administered by the Institute for Materials Research with IMR Director Steve Ringel as the Principal Investigator. This award created five new Ohio Research Scholars – three at The Ohio State University, and one each at University of Dayton and University of Akron – with the goal to pioneer revolutionary approaches to accelerate the development of materials for technological impact, by evaluating emergent materials at an early stage through the application of advanced characterization and predictive modeling.

Dr. Katrina Cornish, Endowed Chair in Bio-based Emergent Materials at The Ohio State University (featured in the Fall 2010 issue of *IMR Quarterly*), was the first Ohio Research Scholar hired through this award.

IMR Member News

Paul Berger, Professor of Electrical and Computer Engineering and Physics, has been promoted to Fellow status in the IEEE, one of the most prestigious honors bestowed by the organization. Berger was promoted for "contributions to the understanding, development, and fabrication of silicon-based resonant interband tunneling devices and circuits." In addition, his seminal work on the surface kinetics of highly strained epitaxial layers lead to advancements in quantum dot lasers.

Glen Daehn, Professor of Materials Science and Engineering, has been inducted as a Fellow of ASM International, the Materials Information Society, for his pioneering research in high-velocity metal forming, the implementation of unique processing technologies and effective leadership in the work of ASM Educational Foundation.

Gerald Frankel, Professor of Materials Science and Engineering, received the H. H. Uhlig Award from the Corrosion Division of the Electrochemical Society for outstanding contributions to both the fundamental understanding of corrosion processes and their practical applications. He also was awarded the Lee Hsun Lecture Award from the Institute of Metal Research, Chinese Academy of Sciences, Shenyang, China, in recognition of his contributions to materials science and technology.

Umit S. Ozkan, Professor of Chemical and Biomolecular Engineering, has been named a Fellow of the American Association for the Advancement of Science, as one of the nine Ohio State faculty members earning the designation in 2011. Ozkan received the honor for her distinguished contributions to the field of heterogeneous catalysis and its applications to energy and environmental protection and service to higher education as a teacher, mentor and administrator. In other recent honors, Ozkan received an Iowa State University Professional Achievement Citation in Engineering; received the John van Geuns Lectureship Award at the Van't Hoff Institute for Molecular Sciences at the University of Amsterdam; and was named a Fellow of the American Institute of Chemical Engineers and received that organization's Mentorship Excellence Award.

Stephen P. Povoski, Associate Professor in the Division of Surgical Oncology, Department of Surgery and **Claudia Turro,** Professor of Chemistry, both members of the Institute For Materials Research (IMR) have been awarded a $10,000 seed grant from the Experimental Therapeutics Program of The Ohio State University Comprehensive Cancer Center and Arthur G. James Cancer Hospital and Richard J. Solove Institute. This seed grant will be used to support preliminary work on the development of cancer-specific anti-TAG-72 monoclonal antibodies that will be dual-labeled with cold 127I (for x-ray fluorescence) and with 123I (for single photon emission computed tomography/computed tomography (SPECT/CT) imaging).

Nandini Trivedi, Professor of Physics, was recently elected Member-at-Large of the Executive Committee of the American Physical Society's Division of Condensed Matter Physics.

International Collaboration with Universidad Politécnica de Madrid Begins

Earlier this quarter, a newly formed international partnership between the OSU Institute for Materials Research and the Universidad Politécnica de Madrid (UPM), a top technological/engineering university in Spain, was announced. This formal collaboration was created to enhance educational, academic and research in areas central to advanced materials and related technologies at both institutions.

Dr. Adrian Hierro, an Associate Professor in UPM's Department of Electrical Engineering and an OSU Ph.D. graduate, recently spent a week on OSU's Columbus campus in the first steps of implementing the IMR/UPM partnership. In addition to meetings with colleagues and facility tours to see OSU's newest research capabilities, Dr. Hierro spent part of his time on campus working on two ongoing collaborative research projects, one exploring the ZnMgO/ZnO material system, including nanowires and defects, for use in various optoelectronic devices, , and one exploring quantum dot-based photo detectors for visible-infrared sensors and emitters. Dr. Hierro noted that a major benefit of his collaboration with OSU researchers is access to the world class instrumentation available on our campus, which he described as "very state-of-the-art and quite unique." Dr. Hierro's Ph.D. student Gema Taberas will return to OSU later this year to assist these projects with measurements and analysis. Dr. Hierro talked more about this research on February 3 at a seminar jointly hosted by IMR and the Solid State Electronics and Photonics (SSEP) Seminar Series, titled "Oxide-based UV Photodetection."

The IMR/UPM collaboration was created with the expectation of leading to vibrant collaborations through the exchange of faculty members and researchers, the exchange of students, the exchange of information and academic resources that are of mutual interest, and activities such as collaborative research, joint symposia and exchange lectures such as Dr. Hierro's.

UPM and IMR agreed upon a set of research topics of initial common interest, based on assessing similar interests and assets at both institutions. At this time, collaborative activities are envisioned in the following areas: development of optoelectronic devices; advancement on semiconducting oxides; multispectral photodetectors in the VIS-IR based on III-V heterostructures; and High Electron Mobility Transistors (HEMTs) based on AlGaN/GaN.

OSU researchers interested in exploring collaboration opportunities with UPM materials scientists should contact IMR Director Steve Ringel at ringel.5@osu.edu

Windl Awarded IMR Industry Challenge Grant for Work with L-3

The Institute for Materials Research recently awarded an IMR Industry Challenge Grant to Professor Wolfgang Windl, Materials Science and Engineering, in support of a new research project he is undertaking with L-3 Communications Cincinnati Electronics. Through IMR's Industry Challenge Grant program, Dr. Windl will receive an additional $20,000 for direct costs on this industry collaboration.

Project Abstract

In this project, Dr. Windl's group will work in collaboration with L-3 Communications Cincinnati Electronics (L-3 CE) on the calculation of fundamental parameters in III-V compounds relevant for infrared-active optical devices, using electronic-structure methods commonly known as "ab-initio" methods in conjunction with device modeling within the framework of Technology Computer Aided Design (TCAD). State-of-the-art methods will be used that can be applied to any combination of elements (including straight III-V as well as alloyed semiconductors, heterojunctions, and systems under bias) and are able to predict the small band gaps of IR-sensitive materials correctly. The calculated parameters will be implemented into a TCAD device model for verification in comparison to existing experimental data, as well as to predict optimized materials compositions, doping levels, and device structures.

IMR's Industry Challenge Grant program accepts proposals at any time. For more information about our internal grant programs, visit our website: http://imr.osu.edu/programs/

Fall 2010 Facility Grants Awarded by the OSU Institute for Materials Research (IMR)

Thirteen new research projects were awarded by the IMR in December 2010, for a total investment of $26,000. The thirteen projects support faculty researchers from seven departments within the College of Engineering and the Division of Natural and Mathematical Sciences. Full abstracts for each of these projects are available on IMR's website: http://imr.osu.edu

- **Characterization of Single Domain Superparamagnetic Nanoparticles**
  Lead Investigator: Gunjan Agarwal, Biomedical Engineering; Co-Investigator: P. Chris Hammel, Physics
- **Characterization of Dendritic Barium Titanate Formed by Hydrothermal Conversion from Nanostructured TiO_2 Precursors**
  Lead Investigator: Sheikh Akbar, Materials Science and Engineering; Co-Investigator: Prabir Dutta, Chemistry
- **Freestanding Infrared Plasmonic Mesh**
  Lead Investigator: James Coe, Chemistry
- **Self Patterning of Zirconia Substrate Surfaces for YBCO Superconductors**
  Lead Investigator: Suliman Dregia, Materials Science and Engineering; Co-Investigator: Michael Sumption, Materials Science and Engineering
- **Spintronic Phenomena in Organic-based Materials and Organic-based Biosensors**
  Lead Investigator: Arthur Epstein, Physics; Co-Investigators: Bin Li and Jesse Martin, Physics Graduate Students
- **Hybrid Lamellar Lattices as a Platform for Molecular Electronics**
  Lead Investigator: Joshua Goldberger, Chemistry
- **A Novel Immunoisolation System for Islet Transplantation**
  Lead Investigator: Jianjun Guan, Materials Science and Engineering
- **High-Quality Gate Dielectrics by Atomic Layer Deposition for III-Nitride-based Power Electronics**
  Lead Investigator: Wu Lu, Electrical and Computer Engineering
- **Analysis and Characterization of Metal-Oxide Thick Films for Use in Gas Sensor Applications**
  Lead Investigator: Patricia Morris, Materials Science and Engineering
- **Self-Assembly of Nanostructured Hybrid Materials**
  Lead Investigator: Jon Parquette, Chemistry
- **Tissue Scaffolds: Connecting Synthesis, Structure, and Mechanical Environment**
  Lead Investigator: Heather Powell, Materials Science and Engineering; Co-Investigator: Peter Anderson, Materials Science and Engineering
- **Micro-Electro-Mechanical Switches for Integrated Optical Applications**
  Lead Investigator: Siddharth Rajan, Electrical and Computer Engineering; Co-Investigator: Gregory Washington, Mechanical Engineering
- **Micelle-Mediated Self-Assembly of Multifunctional Hybrid Nanoparticles**
  Lead Investigator: Jessica Winter, Chemical and Biomolecular Engineering; Co-Investigators: Barbara Wyslouzil, Chemical and Biomolecular Engineering; Gang Ruan, Chemical and Biomolecular Engineering

IMR Collaborates on Three New Ohio Third Frontier Photovoltaics Programs

The Ohio Third Frontier Commission announced $14 million in new funding of advanced energy sector awards last week, and The Ohio State University Institute for Materials Research is a central collaborator on three of the five Photovoltaics Program Awards for fiscal year 2011.

GreenField Solar Corporation in Oberlin, Ohio will use its $1 million award to support its program titled *Low Cost Concentrated Photovoltaic (CPV) Design*, with the goal of lowering the cost of its high-concentration PV system and obtaining UL certification. As part of the collaboration, metals deposition capabilities at OSU Nanotech West will be used to examine cost-reduction and manufacturing improvements in the metallizations used in the GreenField Photovolt® vertical multi-junction silicon PV device that resulted from technology developed at the NASA Glenn Research Center. The team also includes the Edison Materials Technology Center (EMTEC) of Dayton. The Principal Investigator of the Ohio State portion of the work is IMR Associate Director Bob Davis.

Energy Focus, Inc. in Solon, Ohio will receive $1 million to support its project, *High Efficiency Photovoltaic Enabled Off-Grid System*. The goal of this program is to develop and manufacture a standalone outdoor lighting product powered by an integrated low concentration photovoltaic system. Low-cost concentrator fabrication and supporting design structures will be created by team member Replex Plastics (Mt. Vernon OH). The solar technology is based on an integrated compound semiconductor-on-silicon PV approach to enable low-cost, silicon-based high performance multijunction solar cells developed by Professor Steve Ringel's group in ECE at OSU, with partial support by the PVIC Wright Center. The primary OSU effort will transition this PV technology to an industry-compatible materials platform based on the new MOCVD (metalorganic chemical vapor deposition) facility at Nanotech West in collaboration with ECE's Semiconductor Epitaxy and Analysis Lab (SEAL). The Principal Investigators of the Ohio State effort are IMR Research Scientist John Carlin, and ECE Professor and IMR Director Steve Ringel.

Process Technology of Mentor, Ohio was awarded over $350,000 for its project *Commercialization of Inline Heater for Use in Photovoltaic Solar Cell Manufacturing*, a collaboration with Cleveland State University and the OSU Nanotech West Lab. The project will design and market an ultrapure, low cost, intrinsically safe, inline chemical/water heater utilizing positive temperature coefficient (PTC) heating elements. As part of the development, Process Technology will install one of the new heater units at Nanotech West and demonstrate its reliability and utility in PV processing. Dr. Bob Davis will be leading the Ohio State demonstration effort.

All three of these new programs were enabled by OSU's founding role in the Ohio Wright Center for Photovoltaics Innovation and Commercialization (PVIC), which funded staff and equipment at the Nanotech West Lab and other locations at Ohio State.

IMR Colloquia: Dan Nocera, May 3

On Tuesday, May 3, the Institute for Materials Research will close out its 2010-2011 IMR Colloquia Series with special guest Dr. Daniel G. Nocera of the Massachusetts Institute of Technology. At MIT Dr. Nocera is the Henry Dreyfus Professor of Energy, Director of the Solar Revolutions Project, and the Director of the Eni Solar Frontiers Center.

He will present a colloquium titled "Personalized Energy (for 1 x 6 Billion)" and he will discuss his work in developing a highly manufacturable and inexpensive method to effect a carbon-neutral and sustainable method for solar storage, with the goal of making personalized solar energy available to the 6 billion new energy users by high throughput manufacturing.

Among Dr. Nocera's many accolades, he was awarded the United Nation's Science and Technology Award for his contributions to the development of renewable energy. He is a member of the American Academy of Arts and Sciences and the U.S. National Academy of Sciences. He was named as one of *Time* magazine's 100 Most Influential People in the World and was 11th on the *New Statesman*'s list of the Most Influential People in the World. Dr. Nocera's 2006 PBS show was nominated for an Emmy Award, and it was used as a pilot to launch the PBS NOVA show, *ScienceNow*.

All IMR Colloquia are free and open to the public. For more details, visit IMR's website: http://imr.osu.edu/events/imr-colloquia-series/

2011 OSU Materials Week

Monday, September 12,
–
Wednesday, September 14, 2011

Ohio Union at OSU's Columbus campus

Jointly presented by the Institute for Materials Research and the Center for Emergent Materials

More details coming soon on IMR's website, via email, and mail!

Winter 2011

The IMR Quarterly is a free publication from The Institute for Materials Research at The Ohio Sate University.

Institute for Materials Research
Peter L. Clara M. Scott Laboratory
201 W. 19th Ave, Suite E337
Columbus, Ohio 43210

IMR Director
Steven A. Ringel
Electrical and Computer Engineering

Program Manager
Layla M. Manganaro, MBA
e-mail: manganaro.4@osu.edu

Contributions are welcome.
Please address correspondence to the Program Manager.

Institute For Materials Research
E337 Scott Laboratory
201 West 19th Ave.
Columbus, Ohio 43210