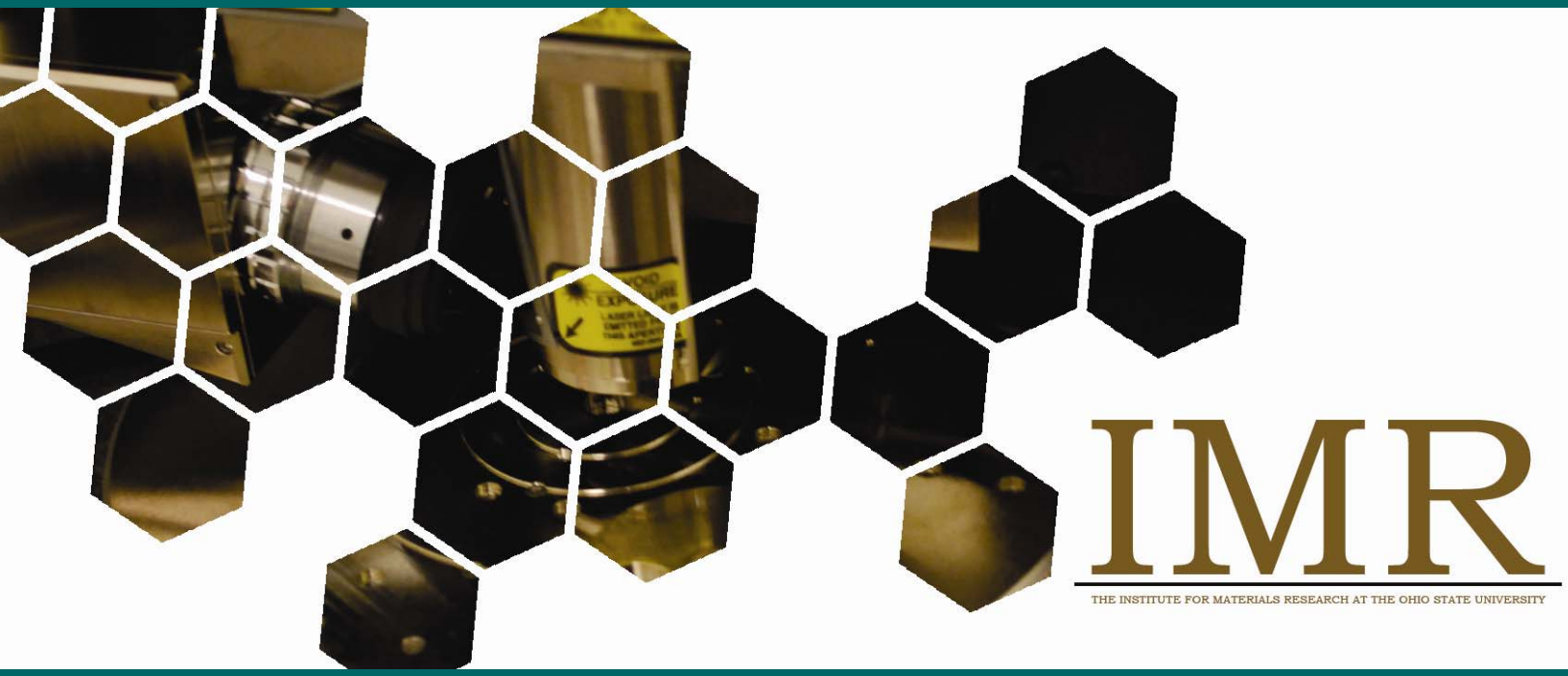
THE OHIO STATE UNIVERSITY

INSTITUTE FOR MATERIALS RESEARCH

REPORT 2007 - 2009



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IMR Overview

The Ohio State University Institute for Materials Research (IMR) is an interdisciplinary organization established in 2006 with the purpose of facilitating, promoting and coordinating research activities and infrastructure related to the science and engineering of materials throughout the University. IMR serves as the gateway to the materials research enterprise at The Ohio State University.

The OSU materials community is made up of a diverse and distinguished group of faculty researchers. Members of the materials community at Ohio State include 5 National Academy members, 7 Ohio Eminent Scholars, 5 Distinguished University Professors, and dozens of Fellows at various professional associations such as AAAS and IEEE. IMR's membership includes over 130 faculty members and research staff representing 20 departments and 7 colleges - the Colleges of Engineering; Mathematical and Physical Sciences; Food, Agricultural and Environmental Sciences; Biological Sciences; Medicine; Pharmacy; and Veterinary Medicine. OSU's materials community ranks 3rd in external research funding expenditures amongst all US universities in materials research, according to latest National Science Foundation statistics.

IMR VISION: A multidisciplinary research institute that propels OSU to the recognized international forefront of materials-allied research and scholarship

IMR MISSION: To nurture, grow and support research groups leading to small, large and center-level awards; to provide strategic planning, resources, infrastructure, and educational/outreach activities; to coordinate, support and assist with management of campus-wide materials-allied research and related resources

Background/History

In 2005, a Materials Vision Committee of 13 OSU faculty from a broad range of departments involved in materials research from the Colleges of Engineering, Math & Physical Sciences and Medicine was formed by the OSU Senior Vice President for Research to develop a compelling and strategic vision for materials-allied research at OSU. This Committee's mission was to assess OSU's materials community and its activities and make recommendations designed to propel OSU to worldwide leadership in materials research. In September 2005, the Materials Vision Committee submitted its report, and based on critical assessments of the status, assets, needs and unique strengths of materials research across the University with respect to international trends and future opportunities, the Committee recommended formation of a strong and vibrant Institute

for Materials Research (IMR). This first section is meant to calibrate the reader in order to observe the impact of IMR since its inception.

Status of Materials Research at Ohio State (September 2005)

During this time in which the University was considering how to better organize its materials research enterprise, OSU materials research already encompassed a broad range of scientific endeavor, ranging from nano-science to large-scale applications. In particular, there existed resident strengths and interests in basic and applied materials research involving electronic, structural, magnetic, biological, photonic, organic, inorganic, nanoscale materials, among other topics. At the time, this research was conducted within many departments and colleges, and with few notable exceptions was typically performed in an independent fashion across the University. State of the art materials research facilities, while present, were also distributed and mostly in a disconnected, and sometimes redundant fashion. Faculty members conducting materials research were often hired into various departments at OSU with very little exposure to the larger, university-wide materials research community already in place. In spite of this lack of cohesiveness, OSU already enjoyed considerable national prestige in materials research, a testament to the very high quality of our faculty-led research over many years and the hard work of individual PIs. In fact at the time the most recent federal rankings released by the National Science Foundation listed OSU as the 3rd highest funded university in materials research, a fact made more impressive when one considers the very small number of major materials research centers on campus. Thus, it was concluded that the distributed and questionably connected nature of materials research efforts at OSU prior to 2006 was not so much an indictment of a situation beset by unsolvable problems but, instead, it was a demonstration of OSU's considerable prowess and breadth in materials research. However, the committee found that while the ranking of OSU's materials research funding is extraordinary, the academic reputations of the primary departments engaged in materials research lagged slightly behind, typically ranking in the top 10-20 range (all within top 10-15 percentile). While this is very good, it was not good enough, and the committee determined that what was missing were major research centers since such centers are clear, identifiable indicators of broad excellence at the institutional level. The more recognized OSU as a university could become for materials research excellence, the greater will our successes be in attracting the best and brightest students and faculty, which should impact reputational rankings. This resonated strongly with all departments and colleges involved as it was clear that OSU needed to be better recognized as a top leader in materials research.

So, the situation in 2005-6 presented a realistic opportunity for OSU to achieve international recognition as a visionary leader in materials research. It became clear to the committee that a vibrant and proactive university-wide Institute, in which the whole can be coalesced to be greater than the sum of its already distinguished parts, can facilitate achieving this goal. Moreover, the University already possessed several unique attributes amongst tier 1 research universities due to the comprehensive nature of OSU's main campus. At the time these has been only partially exploited and they were anticipated to be important factors for IMR, particularly in the near term. These included: (1) the simultaneous presence of strong Colleges of Engineering, Physical

Sciences, Medicine, Veterinary Medicine and Agriculture on a single campus, (2) the presence of strong programs and unique facilities in energy, the environment and nanotechnology on our single campus, and (3) the presence of west campus research and industrial collaboration facilities.

The breadth of materials research at OSU presented an interesting opportunity, since the usual type of research center with a particular area of focus, could not possibly encompass and reasonably connect all the activities already ongoing in materials research here. Furthermore, the scope of such a center would have required funding and facilities well beyond the level typically available for materials research centers from organizations such as NSF. For the OSU situation it was felt that a comprehensive organization was in order, under which a number of more focused research centers could form and be sustained. Thus a key role that was envisioned for the as-yet-to-be-created IMR was to facilitate the competitive awarding and establishment of those centers and to provide synergistic links among them. An imperative objective for IMR was facilitate a progression from nurturing of novel and promising research, to generating strong research teams, making strong teams stronger, generating strong proposals, winning self-supporting center awards, and providing on-going service.

Some specific objectives identified by this committee for IMR to meet at the time were to:

- identify and develop strategic, multidisciplinary research themes exploiting the unique assets at OSU
- facilitate progression of research ideas into funded research projects, teams and centers
- identify major funding opportunities and facilitate strong responses in the form of team and center proposals
- support, enhance and provide connectivity to new and existing centers
- enhance existing strengths within OSU's materials community
- coordinate facilities and assist in facility management, operation and maintenance across campus to maximize usage and efficiency
- establish and manage linkages with strategic partners outside of OSU
- provide leadership and cohesiveness to the materials community across campus
- provide a first class scholarly environment for education through research that transcends traditional academic boundaries
- ensure and maintain OSU's pre-eminence in statewide materials leadership and international prominence
- achieve the above stated objectives through development of research, outreach and educational programs

The above commentary and recommendations made by the 2005 Materials Vision Committee became the basis for the creation of the Ohio State University Institute for Materials Research in early 2006. The entire committee report is available through the IMR Administrative Office. The following section describes the structure and general function of IMR.

IMR Committees

The Institute for Materials Research reports to a single Executive Committee and is advised by two other committees, the Faculty Science Advisory Committee (FSAC) and the External Advisory Board. This organizational structure was created by the original vision committee, and has proved to be an effective way to obtain a wide range of guidance from university, industry, and national laboratory leadership.

IMR Executive Committee

The IMR Executive Committee is made up of Ohio State leaders from the three units of the university that provide direct operational funding for IMR: OSU's Office of Research, College of Engineering, and College of Mathematical and Physical Sciences. This committee meets two to three times each year with the IMR Director to review IMR activities, finances, and future plans, and in turn provides oversight and guidance regarding IMR's strategic planning and ensures that IMR activities are aligned with college priorities in materials and are in the best interests of the colleges supporting IMR. The balance in this committee between equivalent financial stakeholders is critical and has allowed IMR to assist in creating unique college-to-college interactions that leverages the strengths of each.

The current IMR Executive Committee consists of the following members:

- Dr. Caroline Whitacre, Vice President for Research, Committee Chair
- Dr. Gregory Washington, Interim Dean of the College of Engineering
- Dr. Matthew Platz, Interim Dean of the College of Mathematical and Physical Sciences

IMR Faculty Science Advisory Committee

The IMR Faculty Science Advisory Committee (FSAC) is made up of Ohio State faculty representatives of the entire university materials community. The Faculty Science Advisory Committee meets quarterly to advise the IMR Director and Associate Directors regarding near and long-term strategies, important external opportunities for funding and collaboration, decisions on priority areas for IMR Research Enhancement Support, and issues related to facility clusters. The Advisory Committee provides representation of faculty associated with their own departments and colleges to the IMR. The composition is balanced as follows: 4 members from the College of Engineering, 4 members from the College of Biological, Mathematical and Physical Sciences and 2 at large members from

other colleges (currently Agriculture and Medicine). The Associate Vice President and Director of the OSU Industry Liaison Office is an ex-officio member.

Currently there are 10 FSAC members, representing three OSU colleges and two Ohio Wright Centers of Innovation:

- Paul R. Berger, Professor, Electrical and Computer Engineering and Physics
- Prabir Dutta, Professor, Chemistry
- Hamish Fraser, Professor, Materials Science and Engineering
- P. Chris Hammel, Professor, Physics
- Joseph Heremans, Professor, Mechanical Engineering
- Ezekiel Johnston-Halperin, Assistant Professor, Physics
- L. James Lee, Professor, Chemical and Biomolecular Engineering
- Sharell Mikesell,* Associate Vice President, Industry Liaison Office
- Stephen Myers, Director, Ohio BioProducts Innovation Center (OBIC Wright Center)
- Matthew Ringel, Professor, Endocrinology, Diabetes & Metabolism
- Yiying Wu, Assistant Professor, Chemistry

*Ex Officio

IMR External Advisory Board

The IMR External Advisory Board (EAB) was formed in 2009 with the purpose to provide IMR leadership with non-OSU perspectives and experience-driven advice from other universities, industry and federal laboratories, to help ensure the success and relevance of IMR activities moving forward. An important goal for the EAB is to assist IMR in maximizing its impact and to enhance its collaborations with partners from the industrial and non-profit sectors, including federal laboratories, by providing advice on both technical directions and mechanisms for interactions with external organizations. The EAB meets annually with IMR leadership (normally during IMR Materials Week) to review IMR research activities, directions, facilities and programs and provide a written assessment and recommendations for future success. The report will be made available to the IMR Executive Committee.

Our newly-formed External Advisory Board members are:

- Jeffrey Wadsworth, President and CEO, Battelle (External Advisory Board Chair)
- Timothy Armstrong, Vice President, Resaerch and Development, Carpenter Technology
- Robert Chau, Senior Fellow and Director, Transistor Research Department, Intel Corporation

- David Eaglesham, Vice President of Technology, First Solar
- James Merz, M. Freiman Professor Emeritus, University of Notre Dame
- Timothy Sands, Professor and Director, Birck Technology Center, Purdue University
- James Sturm, Professor and Director, Electrical Engineering, Princeton University
- Susan Trolier-McKinstry, Professor and Director, W. M. Keck Smart Materials Integration Laboratory, Pennsylvania State University
- Thomas Zacharia, Deputy Director for Science and Technology, Oak Ridge National Laboratory

IMR Administration and Management

IMR has several technical and administrative employees who work closely together and with OSU researchers to realize our organization's unique mission. Below is a brief overview of IMR's employees and their roles within the Institute. An organizational chart showing how IMR is structured administratively is shown in Figure 1.

IMR Director: Steven A. Ringel, Ph.D.

Dr. Steven A. Ringel has served as the Director of IMR since its inception. Dr. Ringel is a Professor the Department of Electrical and Computer Engineering and holds the Neal A. Smith Endowed Chair in Electrical Engineering. He also holds courtesy appointments as a Professor of Physics and a Professor of Materials Science and Engineering. Dr. Ringel's research program is internationally recognized and is focused on electronic materials, devices, photovoltaics and defect science with a particular interest in integrating basic science and engineering issues to create new device technologies.

The IMR Director is appointed by the Vice President for Research, with the advice and recommendation of the entire Executive Committee, and serves 50% of his time as the chief administrative officer of the IMR and is responsible for the external and internal leadership, vision, overall direction, general welfare and progress of the IMR. The Director is also responsible for the accomplishment of IMR's programs, financing and staffing, and serves as the linkage for the IMR community to OSU central administration, and to state and federal government and external agencies as may be appropriate.

IMR Associate Directors: Malcolm Chisholm, Ph.D., Robert J. Davis, Ph.D., Michael Mills, Ph.D.

IMR's three Associate Directors are representative of the OSU materials community, with one Associate Director with a home department in the College of Engineering, one Associate Director with a home department in the College of Biological, Mathematical and Physical Sciences, and a third Associate Director who represents leadership from OSU's materials-allied research facilities on west campus. Each Associate Director

assists with the leadership and planning of IMR, and serves as a formal liaison between his/her college or unit constituency and the IMR. The Associate Directors more generally help to plan and participate in major IMR events and coordinate and review IMR Members of Technical Staff. They meet with the IMR Director at least monthly to consult with and provide advice regarding strategic decisions that include research priorities, facility planning, modifying and proposing new plans, and related issues. They create and recommend review processes regarding allocation decisions to the Director for funding of programs and support of technical staff through its Research Enhancement Program.

IMR's three Associate Directors are:

- Malcolm Chisholm, Distinguished University Professor and current department chair, Chemistry
- Michael J. Mills, Taine G. MacDougal Professor of Engineering and Professor, Materials Science and Engineering
- Robert J. Davis, Director, Nanotech West Laboratory and Director of OSU site, Wright Center for Photovoltaics Innovation and Commercialization

IMR Program Manager: Layla Manganaro, MBA

The IMR Program Manager manages all IMR programs, including internal seed grant programs, external research proposal submissions, summer workshops, member of technical staff program, and seminar series. She is responsible for program development, planning and coordination, marketing and communications, and handling logistics for all IMR programs and activities. The IMR Program Manager also assists the IMR Director with overall management of the research center, serves as the primary contact for the IMR community and outside constituents regarding IMR programs, membership and activities, supervises administrative staff, and oversees IMR financial and human resources administrative functions.

IMR Administrative Associate: Angela Dockery

The IMR Administrative Associate provides a broad range of financial and administrative support services for the Institute and affiliated research programs. She serves as IMR's fiscal and human resources professional, provides administrative support for the center, and coordinates or assists with the coordination of IMR programs, including seminars, meetings, events, internal and external research programs and grant proposal submissions, and faculty and staff.

IMR Administrative Support: Undergraduate Student Employees

Each quarter, the Institute for Materials Research hires between 3 and 6 undergraduate students to provide a wide range of support services for our organization. All of our student employees are drivers of the IMR shuttle van, a free service which operates six shuttle runs every weekday between Ohio State's central campus and the Nanotech West Laboratory and Center for Automotive Research, two key research facilities located

approximate 3.5 miles west of central campus. This shuttle service is a simple but effective way to improve connectivity between our west campus research facilities and our central campus users. Some IMR undergraduate student employees also assist our Members of Technical Staff with laboratory maintenance, while others help our administrative staff with general clerical duties.

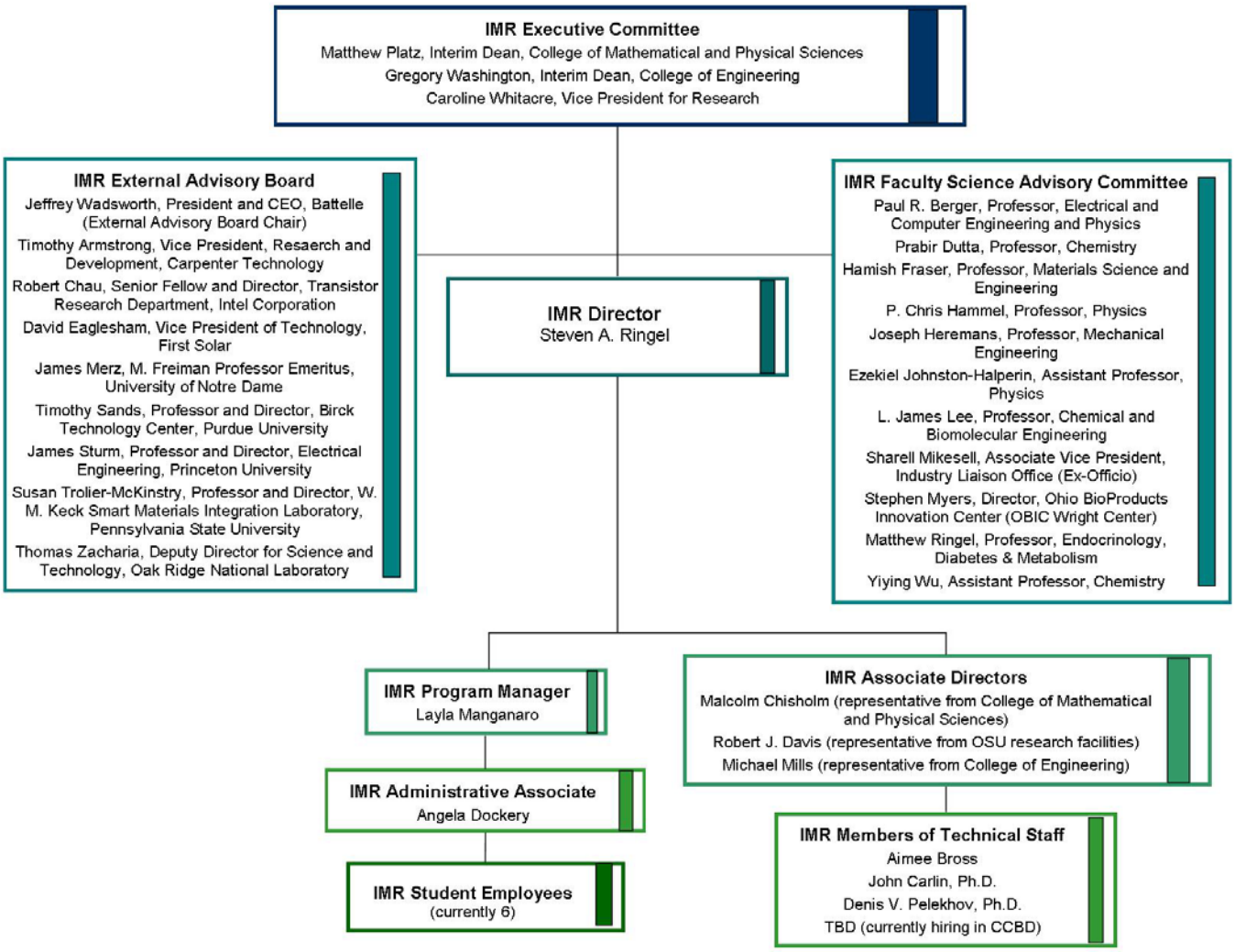


Figure 1. Institute for Materials Research organizational chart.

IMR Members of Technical Staff

One of the most important recommendations from the 2005 Vision Committee was the need for a layer of highly skilled staff engineers/scientists who are able to maintain large facilities at peak conditions, perform experiments and sometimes full-blown research, always enable access to users, provide training and generally be available to assist with research programs from various sources. Importantly, a layer of such individuals, each of whom would be assigned primarily to one major facility, would themselves create a

human interface that would network between the many laboratories across colleges. In other words, the creation of the IMR Members of Technical Staff (MTS) would become glue for enabling cross-disciplinary research, assist in the avoidance of redundant lab development and at the same time provide engineering and scientific support on any number of projects. Generally speaking, MTS employees serve as laboratory coordinators to enable access by researchers not only from OSU but also from outside the university. In addition to dealing with all aspects of maintaining complex instrumentation, including scheduling, data management and financial responsibilities, MTS employees are encouraged to develop research programs and contracts depending upon their own level of expertise and education.

Departments or centers receiving an IMR MTS to support their activities execute a Memorandum of Understanding with IMR that details specifics of the agreement regarding MTS supervision, salary support, and expectations for the arrangement. Success metrics are jointly agreed upon between the faculty member or senior staff member in charge of the particular facility and the MTS, with approval by the IMR Director. MTS may be reassigned by the IMR Director in consultation with the Associate Directors to another research area based on university demands, needs and history of performance. It is understood that any facility that is supported by an MTS must become itself an "earnings" center so that the facility can be accessible to users throughout the IMR community, irrespective of home department, via a fee-for-use model.

We currently have three Members of Technical Staff to assist researchers at the Nanotech West Laboratory and the ENCOMM NanoSystems Laboratory:

- Aimee Bross, Senior Research Associate in Nanotech West Laboratory, specializes in electron beam lithography, scanning electron microscopy, various metrologies and device fabrication
- John Carlin, Ph.D., Research Scientist in Nanotech West Laboratory, specializes in atomic layer deposition, metal organic chemical vapor deposition and device processing
- Denis V. Pelekhov, Ph.D., Research Scientist, specializes in focused ion beam/scanning electron microscopy, x-ray diffractometry, and SQUID magnetometry, and is the lab manager for the ENCOMM NanoSystems Laboratory

IMR Accomplishments to Date – Overview

The Institute for Materials Research began as a startup center in early-mid 2006, moving into its administrative office in September 2006 and starting to fill its staff shortly thereafter. By 2009, IMR had grown from one half-time Director and a new Program

Manager in a small office with bold new mission to fulfill and a skeptical faculty base to convince, into a full-fledged University Institute with 134 faculty members from 27 departments and 7 colleges, a staff of 14 full- and part-time technical and administrative professionals, supporting more than 78 internal grants, with responsibility for more than $35M in new block grant funding from external sources. In addition, by 2009 IMR had created a series of successful faculty cluster hires in four departments, is managing/maintaining massive infrastructure facilities on both west and central campus and is running a very successful weeklong materials conference in which our community gets together to observe and celebrate the breadth of great research in materials at OSU. As a result, IMR has woven itself into the fabric of the OSU materials community while at the same time becoming the primary voice for materials research at the highest levels of OSU. Office of Research officials commonly acknowledge the IMR approach as the model it is following in its efforts to create additional OR-level centers in other broad areas such as Energy and the Environment. This section attempts to summarize the most pertinent achievements during the past 3 years, with somewhat more focus on FY2009.

IMR Accomplishments: Block Grants

As already mentioned, OSU materials researchers have been historically quite successful in raising funds for their research, mostly in the form of single PI grants. A primary goal for IMR is to bring in block awards that not only enhance collaborations in a substantial way, but also bring great prestige to the university, with the faculty, students and institution all sharing the benefits of such recognition. Consider that OSU is now one of only eight universities in the nation with an active NSF MRSEC and NSEC simultaneously as one measure of excellence. Overall IMR and its constituency are responsible for obtaining external block grant awards totaling approximately $35M to OSU since 2007. Consider that IMR's annual core budget is approximately $800,000 plus its annual share of the internal materials Targeted Investment in Excellence (TIE) program of $418,000, the return on investment is rather extraordinary. This section briefly summarizes the block programs awarded through IMR's leadership and direct involvement. We make no attempt to include the much larger number of proposals and projects awarded at the single or small group level that have resulted from our various forms of seed grant support. Also listed are major proposals still pending. We describe the transparent process that IMR developed and deploys to run internal competitions for major and/or limited submission opportunities to select the proposals and teams with the best chances of winning the external competitions.

Awarded Block Grants

Title: Center for Emergent Materials

Funding Institution: National Science Foundation - Materials Research Science and Engineering Center (MRSEC) Program

Principal Investigators: PI: Nitin Padture, Co-PIs: Leonard Brillson, P. Chris Hammel, Ezekiel Johnston-Halperin, Patrick Woodward

Duration: 9/1/2008 – 8/1/2014

Amount: $10.8 million + $6.8 million cost share

Description: The IMR, Professor Nitin Padture and his team were jointly responsible for landing OSU's first NSF Materials Research Science and Engineering Center (MRSEC), a $10.8 million award which founded the Center for Emergent Materials. MRSECs are arguably the award from NSF that signifies a truly elite materials research program from the NSF perspective. The Center for Emergent Materials performs integrated research on emergent materials and phenomena in magnetoelectronics. CEM's goal is to lay down the scientific foundation for building both future oxide-based electronic devices that can perform multiple functions and energy-efficient, fast computers that have integrated memory and logic. The scientific foundation encompasses a deep and comprehensive understanding of emergent materials and phenomena, and the development of highly-sophisticated experimental and theoretical tools required to study them.

Two Interdisciplinary Research Groups (IRGs) are at the heart of the CEM:

- IRG-1: Towards Spin-Preserving, Heterogeneous Spin Networks
- IRG-2: Double Perovskite Interfaces and Heterostructures

Enhanced classroom education and research internship opportunities are integrated within all of the CEM's research activities, widening the Science-Technology-Engineering-Math (STEM) "pipeline" and enhancing diversity in STEM. The overall goal of the enhanced classroom education program is to identify, study, and document a variety of misconceptions relevant to materials education and to develop and test curricula to address those misconceptions. The programs work with instructors teaching introductory/undergraduate courses with materials science content, as well as contributing to the development of a high school materials science course curriculum. To fully engage students, especially those from underrepresented groups, a Research Experiences for Undergraduates (REU) program has been established at the college level and additional research activities target students at the high school level. CEM has developed programs to expose middle and high school students to the excitement and relevance of materials science through a series of workshops that increase their awareness of careers in materials science.

Title: Technology-Enabling and Emergent Materials

Funding Institution: Ohio Department of Development - Ohio Research Scholars Program

Principal Investigators: PI: Steven Ringel, Co-PIs: Jeffery McNeal, Steven Slack, Gregory Washington

Duration: 8/18/2009 – 8/17/2013

Amount: $18,153,846 ($8,953,846 to Ohio State) and cost share of $17.2 million

Description: IMR is the lead organization for a state-wide materials program funded by the State – the $18+ million Ohio Research Scholars Program award entitled Technology-Enabling and Emergent Materials, with a total of 5 endowed chairs being created and coordinated in 3 universities. This award creates a university coalition consisting of The Ohio State University, the University of Akron and the University of Dayton. Five endowed chairs with the title of Ohio Research Scholar – three at OSU and one each at the University of Akron and the University of Dayton - are currently being established**,** with the first hiring to occur as early as fall 2009. IMR Director Steven Ringel serves as that award's Principal Investigator and IMR performs all program management and research administration for the award.

The goal of this program is 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. By targeting the Scholars positions toward advanced microscopy, including applications toward biomaterials, chemical synthesis from bio-based sources, and scalable processing based on nanostructure-enhanced composite and also bio-based materials, this unique cluster aims to build upon and coordinate strategic strengths existing at the partnered universities in areas of international impact. A prime area of focus is the exploration and development of innovative materials that possess tailored functionalities and are derived from nontraditional (including bio-based) sources, with the state's universities and industries being the prime beneficiaries. IMR has established a Materials Innovation Council that includes leaders at each of the three state universities and a wide range of industry leaders and other state-supported industrial consortia, in order to maintain alignment and communications up and down the value-chain from basic science to commercialization.

Title: Wright Center for Photovoltaic Innovation and Commercialization (PVIC)

Funding Institution: Ohio Department of Development - Wright Centers of Innovation Program

Principal Investigators: PI: Robert J. Davis, Co-PIs: Paul Berger, Malcolm Chisholm, Arthur Epstein, Joseph Heremans, Nitin Padture, Steven Ringel

Duration: 2/16/2007 – 2/15/2010

Amount: $18.3 million total ($6.8 million to Ohio State) and $30M in matching from Ohio industries and participating universities

Description: IMR's first major sponsored project award created the current Wright Center in solar energy – the Wright Center for Photovoltaics Innovation and Commercialization - which is co-directed with the University of Toledo. PVIC was established in early 2007 through an $18.6 million award from the Ohio Department of Development, along with matching contributions of $30 million from universities, federal agencies, and industrial collaborators. PVIC is a scientific partnership of the University of Toledo, Bowling Green State University, and The Ohio State University, and more than 25 Ohio-based companies engaged in various aspects of photovoltaics technology. PVIC has a primary goal of enabling Ohio to become the nation's leader in photovoltaics research, development and commercialization. The overall PVIC mission is to accelerate the photovoltaic (PV) industry in Ohio by reducing solar costs, improving technologies, and transferring these new techniques from the laboratory to the production line. The OSU/IMR node of PVIC has a specific focus on so-called 3rd generation photovoltaics, which inherently involves advanced materials and nanotechnology using both inorganic and organic materials. Primary thrust areas are multijunction solar cells, heterogeneous integration of high efficiency PV with low cost platforms, nanostructured solar cells, polymer photovoltaics and basic optical-thermal processes. IMR administers the Ohio State University PVIC site and IMR Associate Director Dr. Robert J. Davis serves as the Principal Investigator of the OSU PVIC site.

Title: The Advanced Materials Initiative

Funding Institution: Ohio State University Office of the Provost

Principal Investigators: PI: Steven A. Ringel (Director, IMR), Co-PIs: P. Chris Hammel (Physics), W. "Bud" Baeslack (Dean of Engineering), Richard Freeman (Dean of MAPS)

Duration: 7/1/2006 – 6/30/2011

Amount: $9.7 million (split between IMR, Colleges of MAPS and Engineering; $2.1M to IMR core) plus 1:1 matching from IMR, MAPS and COE

Description: In 2006 the OSU Office of the Provost conducted a unique internal competition designed to provide targeted funds to areas of existing excellence at the University, with the goal of making those areas to be the pre-eminent programs of research in their fields. The program is called the Targeted Investment in Excellence, or TIE, and the response to the call for proposals yielded approximately 100 proposals from across the entire University, of which 9 were awarded. The IMR, collaborating with the College of Engineering and the College of MAPS teamed to develop the "Advanced Materials Initiative," which received the largest total sum of funds from the competition. The funds were split into three sub-areas, one for each of the two colleges, and one for IMR to enhance its core programs, but all integrated via IMR's overarching, multi-college mission. The entire program has been coordinated and with funds being used strategically for support of new faculty hiring and their start up packages, outfitting core laboratories with major shared instrumentation, team building exercises that contributed to the creation of both successful IRGs of the recent MRSEC award via the creation of the interdisciplinary ENCOMM group that is centered in the Department of Physics. For the IMR core, funds assisted in procuring some limited ($418k) strategic equipment, but most of the award went toward creating and supporting teams of researchers through our Research Enhancement Program, increasing the breadth of technical staff being distributed to various major facilities, and supporting the two joint faculty hires in Electronic Materials and in Photovoltaics that were awarded to the Department of Electrical Engineering and the Department of Materials Science and Engineering.
**Note: this is not an external grant; however the scope and magnitude of the program demanded its inclusion here.*

Pending Major Proposals

During the FY09 fiscal year, IMR worked with research teams to develop three proposals to the National Science Foundation (2 infrastructure, 1 IGERT), two to the Department of Energy – Energy Frontier Research Centers (EFRC), with each EFRC having total budgets of approximately $25,000,000 and one of which was jointly developed with the OSU Institute for Energy and the Environment (IEE), and seven DOE ARPA-E preproposals, one jointly developed with IEE. In addition, we are in the early stages of coordination for a major Engineering Research Center (ERC) proposal to NSF, with a five-year budget of up to $18.5 million. This ERC is in the area of energy systems,

technology and science and is a joint development between IMR, the Energy TIE (Center for Energy, Sustainability, and the Environment) and the Center for Automotive Research (CAR).

We have chosen to not list the even larger number of proposals created with IMR support that were submitted through the participating colleges (see note after this list), since we desire to explicitly focus on those activities that are particularly significant in a multi-college sense, having a large number of investigators, consistent with the mission of IMR.

Working with the lead PIs and their teams, IMR has either facilitated or is leading the coordination and response of each proposal listed below this fiscal year to date:

- Department of Energy Frontier Research Center (EFRC) proposals (2)
  - Center for Molecular Separations, PI: Hendrik Verweij, Co-PI's: P. Dutta, J. Gupta, W. Ho and S. Olesik, Proposal Submitted Oct. 1, 2008, DOE request $25,000,000.
  - Center for Interfacial Photoconversion Processes, PI. M.J. Heben (U. Toledo), Co-PIs; Steven A. Ringel, Yiying Wu, M. Chisholm, A.J. Epstein, plus co-PI's from National Renewable Energy Laboratory, Argonne National Lab, Johns Hopkins University, Rensaelaer Polytechnic Institute, Bowling Green State University, Proposal Submitted Oct. 1 2008, DOE request $25,000,000.
- National Science Foundation Integrative Graduate Education and Research Traineeship Program (IGERT)
  - IGERT – Thermodynamics: Cornerstone of Energy Conversion, PI: Susan Olesik (Chemistry), Co-PIs: Joseph Heremans (Mechanical Engineering), Jeffrey Sutton (Mechanical Engineering), Kathryn Sullivan (Glenn School), Hendrik Verweij (Materials Sciences and Engineering), Pre-proposal submitted March 2009, NSF request $2,700,000
- National Science Foundation Major Research Instrumentation Program (MRI)
  - MRI: Acquisition of a Hybrid Diamond/III-N Synthesis Cluster Tool, PI: Ezekiel Johnston-Halperin (Physics), Co-PIs: Harris Kagan (Physics), Roberto Myers (Materials Science and Engineering), Siddharth Rajan (Electrical and Computer Engineering), Steven Ringel (Electrical and Computer Engineering), Fengyuan Yang (Physics), submitted January 2009, NSF request $421,323; total project $601,890
  - MRI: Acquisition of a Local Electrode Tomographical Atom Probe for Advanced Materials Research, PI: Suresh Babu (Materials Sciences and Engineering), Co-PI: Hamish Fraser (Materials Sciences and Engineering), submitted January 2009, NSF request $1,224,300; total project $1,749,000

- National Science Foundation Engineering Research Center (ERC)
  - Working Title: Integrated Solar Energy Technology, PI: S. Sen, Co-PIs: Steven A. Ringel, Giorgio Rizzoni (other participants (not complete) are S. Rajan, R. Myers, P. Berger, L. Brillson), partner universities: MIT, Purdue, proposal was due July 15, 2009. NSF request: $18,500,000.

Note that this list above does NOT count the many proposals developed by the individual IMR faculty or groups (such as MURIs) that are also directly benefitting from the Research Enhancement Program.

Description of Internal Proposal Development Process

The development of competitively awarded, externally funded interdisciplinary centers and major research initiatives is central to the goal of IMR for the materials community. The complexity of multi-college and multi-department block-type programs, particularly those with limited submission opportunities, is such that a high-quality, trusted, dedicated and open process is necessary that allows for distillation of the best proposed research, and identification of the optimum team of PIs and other affiliated researchers in an inclusive and fair fashion; and once that is done closely coordinate every aspect of the administrative development of the proposal through to its submission. This is a very difficult process to achieve and maintain at a university with a comprehensive materials enterprise made up of very strong individual researchers as we are fortunate to have at OSU, and an open process is precisely what has been largely absent, a fact that many in our community feel contributed to past inabilities to win the most prestigious center awards. Hence, we have focused substantial attention on developing these challenging proposals, having created and refined a process that provides to our community external proposal coordination, and an evolved internal process to triangulate on optimum responses to these very special opportunities, which are essential for any top tier program.

The most poignant example of this process is the development of OSU's proposal to the NSF MRSEC, a coveted national program. The proposal development process itself took more than 6 months prior to the NSF preproposal deadline (9/07) and one research group worked for a year prior to that though its own preliminary process of team building. IMR hosted intense and very frequent meetings that started first with an open request to the community soliciting white papers from any group interested in developing an IRG (Interdisciplinary Research Groups, which are ~ 10 PI group focus areas that together constitute an entire MRSEC) with the stated desire that OSU would be best served to submit only one MRSEC proposal (2 were allowed by NSF in this limited submission opportunity). These white papers were received, combined into a single document (originally 13 IRGs), redistributed and a process of distillation down to 4 IRGs began. A half-day retreat was hosted by IMR during which each IRG team was requested to make open presentations to all competing groups. All remaining IRGs were then sent out for multiple external (non-OSU) reviews in order to obtain objective evaluation. This extensive process culminated with a single MRSEC preproposal team and topic with 4 IRGs, the maximum allowed. It must be stated that without the patience and trust of the materials community in IMR, this could not have happened.

At this point, IMR funds were then used to bring in a professional proposal development/consultant team (who guided the completion of the official proposal to NSF), funds were used for the core MRSEC team to travel to NSF for presentations and meetings prior to proposal completion, then to develop the budget, provide proposal finishing and editing, and to ensure that the central administrations of the participating colleges and the university were in lockstep in the process with maximum coordination and elimination of last minute surprises. The reverse site visit then took place, with 3 of the 4 IRGs continuing at that point, and in summer 2008 the MRSEC award was announced.

IMR has since replicated this model for several other research proposals, and the great success of this organized, open process resulted in community building, information sharing, and the awarding of various block grant type centers. We continue to follow this successful model and IMR is either leading, guiding or heavily supporting the next round of block center proposals to develop the strongest possible responses to major research funding opportunities. While IMR's involvement in each proposal may vary slightly to best suit the research teams' needs and sponsor guidelines, in general IMR staff regularly hold open "town hall"-type meetings where the materials community can discuss upcoming funding opportunities, brainstorm ideas and share insights. IMR's contributions may include any or all of the following: coordination of planning meetings for research teams, drafting presentations for internal or external stakeholders, payment for and coordination of travel to sponsors' sites, connecting research teams with professional proposal development experts, drafting budgets and obtain necessary internal approvals, and coordinating the actual submission of the proposals.

IMR Accomplishments: Research Enhancement Program

IMR created and manages a Research Enhancement Program which provides internal research funding to Ohio State materials researchers using three distinct award programs, Interdisciplinary Materials Research Grants (IMRGs), Facility Grants and Industry Challenge Grants. An important goal for IMR is to expand our ability to provide competitively awarded, early-stage funding to OSU researchers, allowing them to explore cutting-edge materials-allied research in anticipation that these activities lead toward major, externally supported interdisciplinary research groups and centers. The IMR Research Enhancement Program was developed as a formal, transparent process to invest in OSU's researchers and nurture very futuristic research that lays the seeds for areas where OSU can claim pre-eminence by defining new waves of materials research.

IMR created its own Request for Proposal (RFP) format for the IMRG and Facility Grant programs, examples of which are found in the attached Appendices. RFPs are broadly advertised via the IMR listserve and website, and the RFP format,

which we have found to be quite successful for internal funding, is available for other OSU centers to use (in fact the OSU Institute for Energy and the Environment has recently adopted it as a baseline for their own seed grant program). The support IMR provides through the Research Enhancement Program is a key component of our commitment to support and enhance OSU's highly-rated materials research enterprise.

Since the inception of this program in February 2007, IMR has invested $1,177,065 in internal research awards to 78 multidisciplinary teams of OSU researchers representing 15 departments from 5 colleges. In FY 2009, IMR awarded 18 Facility Grant awards totaling $36,000 and 5 new IMRG awards totaling $225,000. Details of the IMR Research Enhancement Program awards and the distribution of awards and funding to various OSU departments are also provided below. A list of all known publications, conference proceedings, invited talks and presentations, and external research proposals directly attributable to IMR-funded research through our Research Enhancement Program is provided in the Appendices.

Interdisciplinary Materials Research Grants

The **IMR Interdisciplinary Materials Research Grants** (IMRG) awards provide seed funding to support pioneering interdisciplinary research in materials-allied fields with the goal of generating highly competitive external grant proposals that target large, multi-investigator and center-level opportunities. Grants up to $45,000 are competitively awarded and may be renewable for a second year. The IMRG proposal review process is extensive and we rely on an external peer review process in order to maintain objectivity and to provide the most useful reviews for the applicants. We aim for three external evaluations for each IMRG proposal received. Those external evaluations are then reviewed in detail by IMR leadership, resulting in funding decisions. The 2009 competition funded 5 new IMRG awards of $45,000 each, for a total of $225,000 in IMRG funding for Fiscal Year 2009. The funding amount for an IMRG award is designed to support one Graduate Research Student or Postdoctoral Researcher for a year, along with some materials and supplies. To date we have awarded 24 IMRGs totaling $1,052,149 to support the research of IMR members from 5 colleges and 13 academic departments. A listing of all IMR Interdisciplinary Materials Research Grants awards and sample Request for Proposals and evaluation form are provided in the Appendices.

Facility Grants

IMR Facility Grants provide up to $2,000 to assist OSU faculty with facility user access fees and related minor charges associated with conducting innovative materials-allied research. The Facility Grants program was created based in part on feedback we received early on from the IMR materials community regarding the many barriers a researcher may face when especially pursuing early stage and novel research, where new data dramatically helps the chances of a proposal in securing funding. These smaller-dollar grants provide much needed financial support that typically are used by researchers to access shared facilities by paying for user fees. During Fiscal Year 2009, IMR awarded

two rounds of Facility Grants, with 18 new awards totaling $36,000. To date IMR has awarded 54 Facility Grants to support the research of 79 IMR members from 3 colleges and 9 academic departments. A listing of all IMR Facility Grants and a sample Request for Proposals is provided in the Appendices.

Industry Challenge Grants

The newest funding opportunity proved by IMR is the IMR Industry Challenge Grants, which are intended to strengthen collaboration between OSU researchers and private industry partners in materials-allied research. These grants provide one-to-one matching funds up to $20,000 per year to allow OSU researchers to conduct research in collaboration with private industry partners that will lead to major external proposal development. IMR Industry Challenge Grants are eligible for renewal for a second year of funding. This third grant program was announced in March 2009 and while we have not yet funded any award at the time of this publication, we anticipate approximately 3-6 Industry Challenge Grants to be active at any given time.

Distribution of Funds

As mentioned earlier in this section, in three years the IMR has distributed nearly $1.2 million through various seed grant mechanisms to OSU researchers with a goal to nucleate and advance early stage research that can lead to external funding, primarily focusing on interdisciplinary teamed efforts for future block-grant type awards. Figure 2 shows one view of how the various IMR awards have been distributed, according to the home academic departments of all research project PIs and Co-PIs. The multidisciplinary distribution is very dramatic. The dominant departments receiving support from IMR are from the two colleges who provide core financial support to IMR, namely the College of Engineering and the College of MAPS. Figure 3 shows a distribution of total funding based on the identity of the lead PI for each project. It should be noted that in the two primary colleges that MAPS includes 2 departments, Chemistry and Physics, that are core materials research units, whereas Engineering includes 5 core departments similarly engaged (MSE, CBE, ECE, WE and BME).

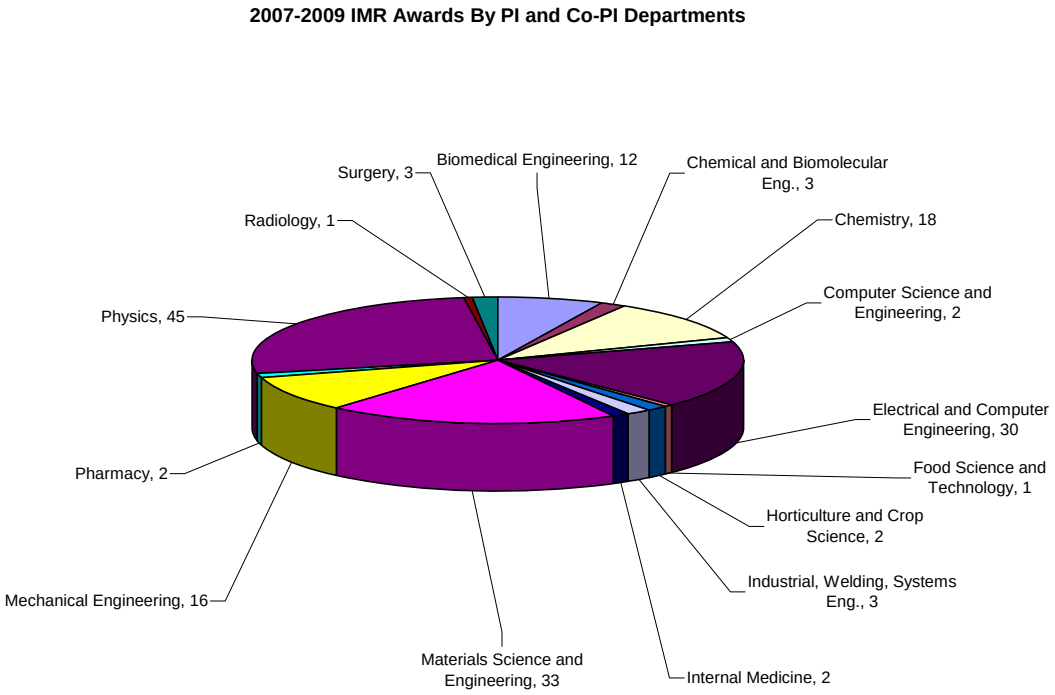


Figure 2. Distribution of awards to PIs and Co-PIs receiving support through the IMRG and Facility Grant programs, from FY2007 through FY2009.

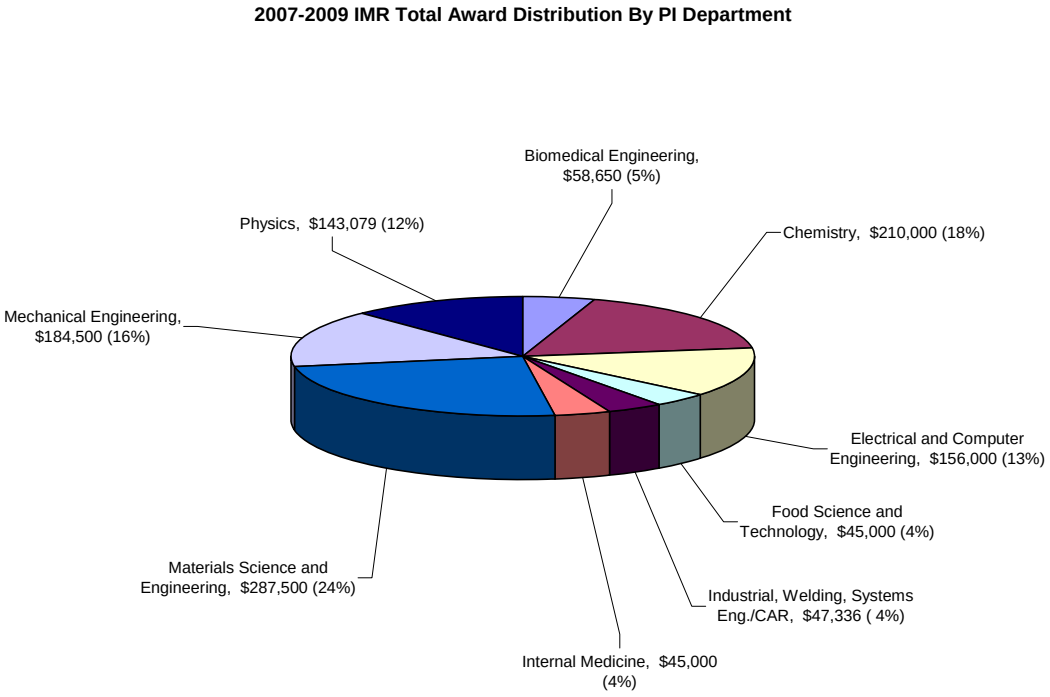


Figure 3. Distribution of awards by Lead PIs (only) receiving support through the IMRG and Facility Grant programs, from FY2007 through FY2009.

Summary of Individual IMR Member Accomplishments

The OSU materials community is made up of a diverse and distinguished group of faculty researchers. Members of the materials community at Ohio State include 5 National Academy members, 7 Ohio Eminent Scholars, 5 Distinguished University Professors, and dozens of Fellows at various professional associations such as AAAS and IEEE. IMR's 134 faculty members (listed on our website, www.imr.osu.edu) represent 20 departments and 7 colleges: the Colleges of Engineering; Mathematical and Physical Sciences; Food, Agricultural and Environmental Sciences; Biological Sciences; Medicine; Pharmacy; and Veterinary Medicine.

The faculty performing materials research are engaged in a wide range of scholarly and creative activities, including publishing of scholarly articles, writing books and chapters, generating intellectual property via patents, and commercializing research results. Based on an ISI search, from January 2006 – May 2009, IMR members published a total of 1,740 publications in professional, refereed journals with an average of 14.3 publications per faculty member in less than three calendar years. Equally impressive is the 7,919 times these faculty have been cited in other refereed journal articles during the same time period, for an average of 64.9 citations per faculty member.

The OSU materials community and IMR members have been extraordinarily successful in procuring sponsored program support. Total expenditures in materials research have been reported by the National Science Foundation Survey of R&D Expenditures, with OSU expending over $39 million in FY 2007, making The Ohio State University 3rd in the nation in materials research expenditures that year (the most recent year for which figures are available nationally). In addition, a query run by the Information Technology department at the OSU Research Foundation found that in the first 9 months of Fiscal Year 2009, IMR members were Principal Investigators for sponsored projects awards totaling over $116 million.

It is notable that several departments and colleges with significant involvement rank within their respective top 10 in total funding. Additionally, IMR members were Principal Investigators for 6 of the top 25 research awards at OSU in fiscal year 2008, including the top award, the ODOD Wright Center for Photovoltaic Innovation and Commercialization. In fiscal year 2007, IMR members were PIs for three of the top 25 research awards at OSU. Though we do not yet have statistics for FY2009, the major awards of the NSF MRSEC at $10.8M and the ODOD Ohio Research Scholars Program grant of over $18M will surely be in the top 5 for this year as well.

A list of all known publications, conference proceedings, invited talks and presentations, and external research proposals directly attributable to IMR-funded research through our Research Enhancement Program is provided in the Appendices.

Interdisciplinary Faculty Cluster Hiring

As part of the Advanced Materials Initiative TIE award led by IMR and its Director as PI, IMR coordinates the recruitment and selection of faculty in targeted hiring areas to further strengthen the OSU materials community. IMR initiated and coordinated a unique process to hire faculty members via a "cluster hiring' process, in which topical areas defined the positions, and not academic departments, to ensure that a focus on interdisciplinary hiring could be achieved. As candidates applied, appropriate departments were identified in order to position each candidate in the correct tenure-initiating unit and in some cases appointments were shared between two departments. The primary focus of the process was applied to two areas, Computational Multiscale Materials Modeling and Electronic Materials, the latter of which was augmented via a designed overlap with the Energy TIE in the area of Photovoltaics. Significant amounts of the startup funds for each position were provided to each of these positions via the Advanced Materials TIE award. During FY09, the modeling cluster was broadened somewhat to augment and complement the successful hires made in FY08, and now includes biomaterials and validation/verification computation methods to reflect the ever evolving nature of advanced materials. To date 5 new faculty members have joined the materials community through the cluster hiring process, with one position to be filled and a search will commence for this sixth and last TIE position in FY2010:

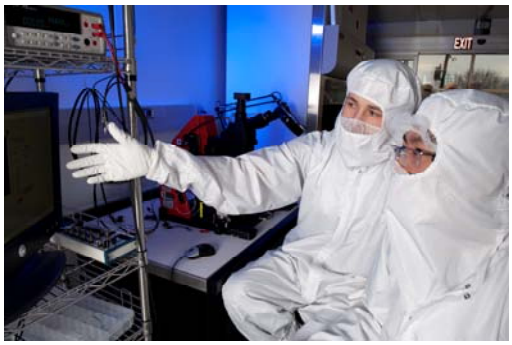
- **Sudarsanam Suresh Babu,** Associate Professor, Industrial, Welding and Systems Engineering Department, October 2007
- **Ji-Cheng (J.C.) Zhao,** Associate Professor, Materials Science and Engineering Department, January 2008
- **Siddharth Rajan**, Assistant Professor, Electrical and Computer Engineering (80%) and Materials Science and Engineering (20%) departments, October 2008
- **Roberto Myers**, Assistant Professor, Materials Science and Engineering (80%) and Electrical and Computer Engineering (20%) departments, October 2008
- Professor **David Wood**, currently at Princeton University, will be joining the OSU Department of Chemical and Biomolecular Engineering in October 2009.

Shared Research Facilities, Laboratories and Infrastructure

Materials research, especially at the cutting edge, requires an enormous infrastructure, specialized equipment that can be prohibitively expensive, and complex operations that require highly skilled technical staff. A world-class research program in materials must figure out a way in which the necessary capabilities are available and can be operated at the state of the art. Since the price tag on high end tools can reach in the millions of dollars and major laboratories like a semiconductor cleanroom can run into the tens of millions of dollars, with million dollar plus annual operating costs and service contracts that can be 10's to 100's of thousands of dollars per year per tool, an infrastructure operation where shared facilities are the rule rather than the exception is needed. Also,

available space and plans to integrate new tools over time is essential. Prior to the creation of IMR, this type of environment, with a few notable exceptions (such as the Campus Electron Optics Facility), did not exist at OSU and lab development, maintenance and access were generally handled by individual departments or individual faculty. Many departments whose faculty are engaged in materials research either are not able to support or do not understand how to support state of the art materials research capabilities. Therefore, a very important goal for IMR's first three years was to develop and implement a comprehensive infrastructure plan that would create a network of shared facilities operating at peak condition, which would be open to the community. Complementary capabilities at each facility would be coordinated and users would be trained on an as-needed basis. In fact, these are the primary reasons for the presence of the IMR Members of Technical Staff, described in more detail earlier. The expectation is that through a coordinated effort, resources could be optimally applied across the various laboratories, state-of-the-art equipment operation would be uniformly achieved, and interdisciplinary interactions would prosper. It is totally reasonable to expect that such a network of facilities can and should simultaneously support multiple research centers as well as individual and small group research efforts.

The next sections focus primarily on two facilities, since they have been the first to be fully staffed and managed by IMR Members of Technical Staff. In addition, there are other facilities receiving direct support from IMR as part of a growing network of labs that IMR has been working to integrate more efficiently. Below we provide more detail on both the capabilities and status of these research facilities that are currently supported, operated, and/or managed by IMR.



Integration of Central and West Campus Materials Research Infrastructure

Perhaps the first and most obvious coordination issue was to integrate the west campus facility at Nanotech West, located approximately 3.5 miles from main campus, with the core facilities on central campus. Until the implementation of IMR's plan and the stewardship of IMR Associate Director Bob Davis as the Nanotech Director, the Nanotech West facility was infamously disconnected from central campus, if not ignored altogether by the majority of OSU materials researchers (prior to IMR's arrival, the College of Engineering mandated that the NSF NSEC team occupy a significant fraction of the Nanotech West space using the biohybrid labs there as part of the required cost share for that program due to almost total availability of space). By any measure the facility was woefully under-utilized. To gain an objective perspective on options for OSU since keeping Nanotech running has been a very expensive proposition (it also houses 6,000 square feet of class 100 semiconductor cleanroom complete with basic process tools) especially given the lack of general interest in it at the time, the OSU Office of Research working with the IMR brought in a team of national experts from government labs and academia to evaluate and recommend how to move forward with the facility. It was determined that the best course of action was to re-vitalize the facility rather than put into play any negative options due to the unique and available space for

materials and nanotechnology research that could be supported if a proper plan were implemented.

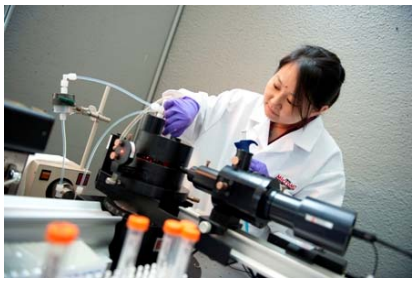
IMR concurred with this recommendation and in 2006 endeavored to first address and eliminate both real and perceived "barriers" that was evident throughout the materials faculty when it came to conducting significant research at Nanotech West. Three issues were identified as primary barriers: (1) in 2006 there was very little reason to use the processing cleanroom at Nanotech West since the available equipment was not unique from tools in the existing cleanroom on central campus in Dreese Laboratory that had not only been serving the interested community but also possessed several signature tools at the time that were not present at Nanotech West; (2) user fees were skewed to be much higher at Nanotech West due to a different financial structure there; (3) the distance from central campus with no easy mode of transportation was a real barrier for students who needed to go back and forth for classes.

From 2006 to the present, a sea change has occurred due to our addressing each of these issues. Considering the last two issues first, IMR procured and now operates the IMR shuttle, which is a van that runs 6 times daily between central campus and NTWest, with ridership that usually exceeds 200 per month. At the same time, IMR created the IMR-West Campus office suite for researchers to use while at NTWest. This space includes 25 cubicles, centralized office functions such as printing and copying, wireless internet, etc., and is free to OSU students, staff and faculty ($200/month for industrial users of NTWest). By early 2008, the access fees for both the Dreese and Nanotech cleanrooms were made uniform, and identical charges for access to similar tools were established. As a result, by 2009 all but two cubicles were occupied. Regarding the first issue – the need for unique and highly desirable equipment - this topic is discussed separately, below. Simultaneously and working with the faculty groups in charge of the Dreese Cleanroom, the mission of that facility was then revised to be one of both education and a home for more specialized equipment that would not make sense to become part of a totally open user facility such as at Nanotech West. In this way, IMR has attempted to develop complementary, not competing roles for each cleanroom. This process is still ongoing as of this writing.

Nanotech West Laboratory: Status and Accomplishments

Open to both academic and industrial users, Nanotech West Laboratory's state-of-the-art facilities include a 6,000 square foot biohybrid laboratory and a 6,000 square foot class 100 cleanroom specializing in micro and nanoscale fabrication and material synthesis with a full-flow 100mm process capability. As mentioned above, by 2006 Nanotech did not possess significantly unique capabilities that would stimulate the large materials research base to conduct its work there. Studying the problem carefully and working with the College of Engineering, IMR determined that a sensible re-arrangement of resources and creating a uniform user fee structure between the Dreese and Nanotech cleanrooms was required. At the time, OSU had recently been awarded a large equipment grant ($2M) from the State to purchase a high end electron beam lithography

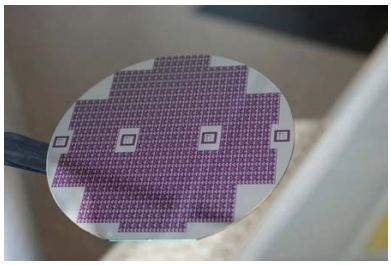
tool that would support nanopatterning and nanoelectronics research. As it turned out the Dreese cleanroom could not adequately support this tool and IMR quickly acted to move this state of the art gem to Nanotech West, making its first "anchor store." By 2009 this key move initiated an entire change of capabilities and culture at Nanotech, and as of this writing primary Nanotech capabilities in addition to this Leica electron beam lithography system included, a $0.5M Picosun atomic layer deposition (ALD) capability, a dip-pen nanolithography system a new $1.9M MOCVD system for epitaxy of III-V compounds based on As, P and Sb, with a special focus on advanced photovoltaics, among many other critical tools. These major facilities now anchor the fully equipped cleanroom facilities and are available to industry and university researchers. Users of this new set of major instrumentation generally require access to the Nanotech West cleanroom and its resident processing capabilities, and so there is an enormous secondary benefit to the cleanroom itself as a result. Importantly, these tools all require similar infrastructure support and as expensive equipment, their placement at an open lab such at Nanotech West means that all in the community can have access and benefit. To ensure this to be the case, IMR has brought in highly skilled Members of Technical Staff to run the MOCVD, ALD (Dr. John Carlin) and e-beam facilities (Ms. Aimee Bross) who also assist with the entire nano/microfabrication processes. Not only do these staff members work closely with university personnel and ensure peak performance of the labs, but they also serve as a direct link for industry collaborations and users. As a result, Nanotech has now become a central facility for wide areas of materials research. A partial list of primary capabilities at Nanotech West, not including the extensive bio-hybrid space is provided here:



- Electron beam lithography [Vistec® EBPG-5000]
- Metalorganic chemical vapor deposition [Aixtron / Swan® 3x2]
- Atomic layer deposition [Picosun SunALE® R-150B]
- Field-emission scanning electron microscopy [Carl Zeiss Ultra 55 Plus]
- ICP-RIE, inductively coupled plasma reactive ion etching [Plasma-Therm SLR 770] and several other plasma etch tools
- Wafer bonding and micro– and nanoimprint lithography [EVG 520HE]
- I-V, C-V, L-I-V, microfluidic, and solar device testing
- Atomic force microscopy [Veeco 3100, NanoInk, Asylum BioAFM]
- Full-flow 100 mm process capability including photolithography, wet/dry etching, deposition, oxidation, metrology
- 6,000 square foot class 100 cleanroom
- 10 full-time equivalent engineering and administrative staff

The impact of the IMR plan on facility utilization has been measurable and remarkable. Even though the ALD system came on-line only in January 2009 and its usage is just

starting, and even though the MOCVD system is still being commissioned at the time of this writing, the Nanotech cleanroom has already witnessed a 5-fold increase in number of users since FY06 and 6-fold increase in user fee income since FY07, the redevelopment of the cleanroom core facilities, and the implementation of new, standardized fabrication processes. User fee income alone is running at approximately $300,000/yr on a sliding average for the past 12 months. This number will certainly rise once the MOCVD system comes on line. The income is vital since it is used to offset costs of ownership of various tools and that is our goal with user fees.



An impressive way to summarize the current state of Nanotech West is that as of FY09 Nanotech West is the physical home to 3 very large (>$15M each) interdisciplinary materials centers – The NSF Nanoscale Science and Engineering Center, the Wright Center for Photovoltaics Innovation and Commercialization, and the Wright Center for Multifunctional Polymer Nanomaterials and Devices, and is a primary user facility that serves the new NSF Materials Research Science and Engineering Center. Additionally, Nanotech West is now the primary location for university-industry interactions in advanced materials (at least 50 company users). It is fair to say that NTWest has turned the corner in FY09 for the first time in the history of its operation. In summary, by the end of FY09, IMR completely upgraded NTWest to a level that is approaching that of comparable facilities at the very elite universities in this field. As the primary IMR location on OSU's west campus, it has become a centerpiece for collaborative research in OSU's materials community.

ENCOMM Nanosystems Laboratory (ENSL): Status and Accomplishments

The ENCOMM NanoSystems Laboratory (ENSL) is another core component of the IMR infrastructure network, and is locally operated by the Center for Electronic/Magnetic Nanoscale Composite Multifunctional Materials (ENCOMM) within the Physics Research Building. ENSL was formed in 2007 and continues to build its unique set of assets. The mission of the ENSL is to provide internal and external users with access to an advanced and unique suite of material characterization and fabrication tools for research and development applications. Currently, facilities at ENSL include: Dual Beam Focused Ion Beam/Scanning Electronic Microscope (FIB/SEM); SQUID Magnetometer; Atomic/Magnetic Force Microscope (AFM/MFM); Langmuir-Blodgett Trough (LBT); and X-Ray Diffractometer (XRD). ENSL is operated as a centralized user facility to provide open access to members of the materials research community on a fee-for-use basis, and is both managed and maintained by an IMR Member of Technical Staff – Dr. Denis Pelekhov. Like Nanotech West, ENSL recovers its user fee income to support its equipment, while staff members are fully supported separately from that income stream. Since its creation ENSL has already benefited the work of 26 PIs, both OSU and external, involving 56 funded research projects. ENSL is the primary location for most of the research activities within the Center for Emergent Materials MRSEC, which emphasizes magnetoelectronic properties at the nanoscale for a wide range of materials systems.

ENSL houses unique and sophisticated equipment that complements capabilities at other materials research labs. The D8 Discover high performance X-ray diffractometer is a recent addition of particular note. Commissioned in January 2009, this multifunctional instrument combines capabilities for high-resolution x-ray diffraction studies of epitaxial films with the capabilities for powder diffraction studies, stress and texture measurements, x-ray reflectometry and Grazing Incidence Diffraction. This instrument is essential to the research of proposed by one of the OSU MRSEC IRGs and is a critical research instrument for several recently funded OSU research projects from different PIs. In addition to the D8 Discover high performance X-ray diffractometer, ENSL operates several research instruments with unique capabilities unavailable elsewhere at OSU, including: FEI FIB/SEM which combines capabilities for Focused Ion milling, high-resolution electron imaging, material specific X-ray microanalysis and e-beam pattern writing and Langmuir-Blodgett Trough is a unique instrument for molecular monolayer film deposition which is located in clean room class 1000 environment. All of these instruments play an important role in the cutting edge research of multiple OSU researchers, and their availability is also critical for attracting new research funding because in many cases the proposed research would not have been possible without this equipment.

Other Facility Development and Infrastructure Optimization

While this report emphasizes Nanotech West and ENSL, there are a large number of other major facility hubs that IMR includes within its network of research facilities. A list of these facilities is provided here:

- Campus Chemical Instrument Center (CCIC)
- Campus Electron Optics Facility (CEOF)
- Campus Microscopy & Imaging Facility (CMIF)
- Center for Chemical & Biophysical Dynamics (CCBD)
- Electronic Materials and Nanostructures Laboratory (EMNLAB)
- Mass Spectrometry and Proteomics Facility
- Microelectronics Laboratory
- Nanoprobe Laboratory for Bio- & Nanotechnology & Biomimetics (NLBB)
- Oxide MBE Laboratory
- Semiconductor Epitaxy & Analysis Laboratory (SEAL)
- Trace Element Research Laboratory

Of these, IMR is currently conducting a search with the Department of Chemistry to hire a Member of Technical Staff for the CCBD facility, which houses unique fast optics instrumentation that is of interest to a wide range of IMR researchers. This lab will be converted into an earnings center as are all IMR-staffed facilities, following the logic described above.

While all the labs listed are extensive, and together constitute primary materials capabilities, several of these labs, particularly the Campus Electron Optics Facility and the Semiconductor Epitaxy and Analysis Lab, house extremely sophisticated and expensive capabilities (for electron microscopy and for semiconductor epitaxy, respectively) and bear additional, brief descriptions since along with ENSL they have received augmentation via the IMR-led TIE program described earlier:

- The Campus Electron Optical Facility (CEOF) is the University's hub for electron microscopy. Based in the Materials Science and Engineering Department, CEOF operates world-class electron and ion microscopes and supporting equipment, including a 300 keV FEI Titan. In addition to scanning transmission electron microscopy, CEOF also provides researchers access to focused ion beam/scanning electron microscopes, and x-ray diffractometer instrumentation. CEOF operates as an earnings center with 2 full time technical staff members.
- The Semiconductor Epitaxy and Analysis Laboratory (SEAL) is the University's hub for materials epitaxy on campus. The centerpiece is an ultra-high vacuum integrated cluster housing 3 state of the art Molecular Beam Epitaxy (MBE) systems for growth of III-V compound semiconductors including III-As, III-P and III-IV materials, SiGe and crystalline metals, along with an array of fully integrated surface science equipment. Additional facilities include a wide range of advanced metrology equipment to characterize the range of materials, nanostructures and heterostructures synthesized in SEAL, including electronic, optical and nondestructive structural property measurements. SEAL operates as an earnings center with one full time technical staff member.

IMR Members of Technical Staff: Status and Accomplishments

As described earlier, IMR Members of Technical Staff (MTS) are vital to support the massive materials research infrastructure, particularly for expensive, one-of-a-kind pieces of instrumentation that are open to many users, and to support the large laboratories that house such instrumentation. Hence, their accomplishments, particularly those accounted for in this past FY09, are included here in this section on infrastructure accomplishments, since the relevance is made more obvious.

Every top materials program in the U.S. has some form of this support and until the creation of the IMR OSU had not supported this new class of research personnel in a centralized way with multi-department and multi-college access outside of one or two examples. During FY09, the 3 MTS individuals already mentioned above - Ms. Aimee Bross, Dr. John Carlin and Dr. Denis Pelekhov - have all been vital and outstanding performers in their MTS mission. Bross now directly interacts with approximately 60 PIs and other researchers in FY09, increasing from an already impressive 30 researchers in FY08. Significantly, this includes a growing number of users from industry, national labs and other universities. Dr. Carlin has been enabling various companies to work with NTWest particularly in the solar area (he is partially supported by PVIC) and is leading the development of both the ALD and MOCVD capabilities and creating NTWest as the home for solar cell fabrication in an outsourced model, all of which have been his primary areas focus in FY09. Dr. Pelekhov has been directly interacting with and

supporting 26 PIs and many more students and postdocs in the ENSL, a brand new facility. ENSL activities have generated over $100,000 in user fee billing since its inception. All three have been working closely together and have successfully realized IMR's vision of a layer of highly skilled research scientists/engineers who collaborate across all boundaries to connect the various major user facilities and building for the greater community.

We have recently (February 2009) entered into an agreement with the Chemistry department to cost share a fourth MTS individual to provide state of the art support for the Center for Chemical and Biophysical Dynamics Laboratory and a search for that individual is currently proceeding. As with all IMR supported facilities of this nature, CCBD will soon be run as an open facility for users from across campus.

IMR Integrated Laboratory Management

An important activity begun in FY09 is IMR's development of a system for Integrated Laboratory Management. This is essential for addressing proper cost recovery issues and to unburden the IMR Members of Technical Staff from wasting time on separately developed billing and tracking systems. Furthermore, a standard approach for tracking enables much simpler and easily provided reports on usage, impact, multidisciplinary involvement, industry involvement and so on. By working initially with the IMR-supported ENCOMM Nanosystems Laboratory we are creating a comprehensive tracking database data-entry software suite that tracks all forms of major facility use, and allows for timely and accurate billing and invoicing. The plan is that once developed and in place at each IMR-supported facility cluster, that IMR student employees will be deployed to and run the Integrated Laboratory Management program on behalf of each facility and IMR MTS, handle data entry, report generation and invoicing. This will be fully operational in FY10.

Outreach and Education

In addition to our major research funding and facility infrastructure responsibilities, the Institute for Materials Research also provides numerous educational opportunities to the OSU materials community throughout the year. Details about three major outreach and education activities IMR coordinates are provided in this section.

IMR Materials Week

In August 2008, IMR hosted its first annual IMR Materials Week, a conference to showcase the extraordinary research ongoing in materials-allied fields at Ohio State and beyond and to foster community building internally. In addition to over a dozen national experts from a wide range of materials-allied fields, this event had 185 attendees participate in various research sessions, poster presentations, and facility tours.

This three-day event was offered free of charge to the materials community, with all expenses covered by the IMR. Below are some highlights from 2008 IMR Materials Week:

- Keynote: Dr. Jerry M. Woodall, National Medal of Technology Laureate and Distinguished Professor of Electrical and Computer Engineering at Purdue University; *"What Happened to Curiosity-Driven Research in America?"*
- Three roadblock workshops, 4 ½ hour in-depth discussions with national experts about challenges we often face in our research:
    - Tools, Opportunities and Challenges in Spin Injection and Transport
    - The Science and Issues of Phonon Engineering
    - Biomaterials and Technology for Next Generation Public Health
- Overviews of three major externally-funded research centers at Ohio State: NSF National Science and Engineering Center (NSEC), ODOD Wright Center for Photovoltaics Innovation and Commercialization (PVIC), and proposed NSF Materials Research Science and Engineering Center (MRSEC)
- Presentations from our four newest faculty hired through the Targeted Investments in Excellence (TIE) program
- Tours of ten materials-related research facilities throughout Ohio State's campus
- Student poster session with 61 presentations featuring materials-allied work conducted by OSU students, including IMR-funded research projects

2008 IMR Materials Week

Dr. Jerry Woodall provided an informative and entertaining keynote address (left). Student poster awards luncheon (right).

Plans for an expanded 2009 IMR Materials Week are underway and the event is scheduled from August 31 – September 3, 2009 at the Blackwell Inn and Conference Center. Due to the success of the inaugural event an open request/competition was held

to determine topics for each of the symposia to be hosted during Materials Week and the event has been expanded to a 4th day in order to accommodate the popularity. A very helpful side benefit of this is that we are preparing OSU to become used to hosting significant conferences in materials at OSU and we have informal information that such discussions are already occurring. Having important conferences hosted at OSU will further enhance our national reputation.

IMR Colloquia Series

The IMR Colloquia Series brings to Ohio State international materials experts in areas of strategic interest to the IMR community to share recent developments in research at other universities and national laboratories. The seminars encompass a wide range of materials-allied research topics, and our colloquia consistently have attendance of 50-80 individuals, at least half of which are OSU students. These presentations are meant to be cross-cutting and provide a layer of seminars that augment the more usual type of seminars typically hosted at the department level. During its first two years of programming, the IMR Colloquia Series hosted the following seminars:

- Robert S. Chau, Intel Senior Fellow & 2007 OSU College of Engineering Distinguished Alumni Award Recipient, *Research and Advancement in Nanotechnology & Nanoelectronics in the Semiconductor Industry,* August 31, 2007
- Jeffrey Wadsworth, Executive Vice President, Global Laboratory Operations, Battelle, *Advancing Science & Technology - Battelle & the National Laboratories,* October 25, 2007
- George Whitesides, Professor of Chemistry, Harvard University and NSEC Outstanding Achievement Award in Nanotechnology Recipient, *Unconventional Nanofabrication,* March 26, 2008
- Linda L. Horton, Director, Center for Nanophase Materials Sciences at Oak Ridge National Laboratory, *The Center for Nanophase Materials Sciences,* April 3, 2008.
- H. Eliot Fang, Deputy & Technical Assistant to the VP, Sandia National Laboratories, *Simulation Based Nano-engineering: From Nanotechnologies to Applications,* April 11, 2008.
- Tobin J. Marks, Department of Chemistry and the Materials Research Center, Northwestern University, *Self-Assembly Processes for Constructing Unconventional Organic, Organometallic, and Inorganic Electronic Circuitry*, October 16, 2008.
- James R. Baker, Jr. M.D., Michigan Nanotechnology Institute for Medicine and Biological Sciences, University of Michigan, *Nanotechnology for the Enhancement of Human Health*, November 12, 2008.
- Timothy D. Sands, Basil S. Turner Professor of Materials Engineering and Electrical & Computer Engineering and Mary Jo and Robert L. Kirk Director of the Birck Nanotechnology Center, Purdue University, *Metal/Semiconductor*

Superlattices as Thermoelectric Metamaterials for Solid-State Energy Conversions, February 3, 2009.

- Lawrence L. Kazmerski, Executive Director, Science and Technology Partnerships and former Director of the National Center for Photovoltaics, National Renewable Energy Laboratory, *Photovoltaics R&D: The Revolution Has Begun*, Tuesday, May 5, 2009

Ohio Innovation Summit

For the third year in a row, IMR has sponsored Ohio State students to attend the 2009 Ohio Innovation Summit (formerly the Ohio Nanotechnology Summit). This annual event is the premier nanotechnology event in Ohio, drawing both national and local leaders in nanotechnology. New in 2009 was the expansion of the conference to include the national sensors community. Through IMR and the Office of Research support, for the last three years OSU sponsored this event as a Summit Benefactor and had a significant presence in the Summit display area. IMR has sponsored OSU students (undergraduate, graduate, and doctoral) at the Summit for the last three years- 38 students in 2007, 19 students in 2008, and 20 students in 2009. IMR-sponsored students presented their research posters at the Summit and attended important workshops and seminars regarding advances in nanotechnology and sensor technology. Attendance at this conference also offered students the opportunity to network with potential employers and learn the latest in nano and sensors research from national leaders. We are particularly proud of the wide range of academic fields represented by the IMR-sponsored students, who came from 13 different departments in 4 OSU colleges.

Enhanced Communications

During this past fiscal year, IMR administrative staff focused their efforts on completing several marketing and communications projects to better communicate with IMR members and external constituents including other universities, national laboratories and industry partners.

In Spring 2009, IMR debuted its quarterly newsletter, *IMR Quarterly*, mailed out to over 2,000 materials researchers. This publication is available in print and online as a PDF document and provides scientific updates on IMR-funded research projects, facility updates from IMR-supported research facilities, and other timely information for IMR members.

Through a collaborative process with the Office of Research Information Technology department, IMR launched a newly designed website in June 2009 (www.imr.osu.edu). This updated website provides a great deal more information to IMR constituents with a more user-friendly interface. IMR staff members have been given WordPress editorial access and can now provide real-time updates to the website, ensuring the most recent news is available to our members immediately.

Other relevant marketing materials created by IMR this year include an IMR Supported Facilities Overview brochure detailing the services and instrumentation available at two

major user facilities currently managed by IMR Members of Technical Staff. An IMR Members of Technical Staff postcard was also sent out to IMR members and related academic departments introducing our three Members of Technical Staff, their training and skills, and how they can best support researchers. Finally, IMR completed a popular handout about Ohio State photovoltaics researchers, the first of a planned series of focus area information sheets highlighting the researchers, centers, and accomplishments of OSU's strongest materials areas.

Statistics and Metrics

IMR works hard to follow an established set of metrics for its trajectory and impact to be gauged. For the purpose of this report, we decided to include without revision the original set of metrics from the 2005 Materials Vision Committee report, excerpted here, to be followed by commentary based on a self-evaluation of performance.

Beginning of excerpt:

From September 2005 Vision Committee report:
Metrics for Success and Sustainability

It is vital that IMR be able to clearly and objectively demonstrate its success. Therefore, the Committee recommends development of metrics so that this can be gauged internally and externally. Metrics for near term success must be somewhat distinct from metrics for long term success and sustainability, but at the same time it must be clear that short term metrics lead to long term accomplishments.

Short term metrics: years 1-3

- Submission of IMR-facilitated Group Proposals – yr 1 and onward
- Submission of IMR-facilitated Center Proposals – year 2 and onward
- Awarding of Group Proposals – yr 2 and forward
- Establishment of IMR community
    - Demonstrable coordination of facilities across campus
    - IMR technical staff functioning
    - Seed grant program running
    - Equipment cost share program running
    - IMR Facility cost center running
    - Seminars and workshops running
    - Industrial Partners program and west campus coordination
- Establishment of formal linkages with state, national and international strategic partners
    - Funded collaborations
- Metrics of intellectual excellence
    - Co-authored publications with IMR members

- Invited talks
- Students graduated and placed

Long term and continuing metrics:

- Continuation of all short term metrics
- Winning Center proposals
- Maintenance of center programs
- Connectivity to other Ohio based universities
- Establish and occupy centralized state-of-the-art research and administrative space for primary functions
- Becoming a node on the NNIN (National Nanotechnology Infrastructure Network) user list

End of excerpt.

Self-evaluation: In looking at this list of metrics with respect to the information in this report, it appears that the IMR has more than adequately accomplished these metrics in its first three years of being established. With the exception of the NNIN node (though it is debatable as to whether this remains a good idea; recently the IMR Director has been in discussions with SRC regarding bringing the Nanotech West facility on board the SRC network) and perhaps being behind on making international collaborations totally functional (at least one has been formalized, with Universidad Politecnica de Madrid), IMR has met each metric.

Future Plans for IMR's Continued Success

- Maintain and improve communications between all types of materials centers at OSU – facility centers, industrial consortia, internal centers, state-funded centers and federally funded centers; we plan to develop a Council chaired by the IMR Director and populated by the director of each center, regardless of type. The purpose will be to discuss and share issues, ideas and how to maximize influence for the benefit of materials research at Ohio State.
- A plan for a dedicated building or significant space necessary for IMR facilities should be developed; the current mode of distributed facilities may create limits on future growth and consolidating would be a far more efficient use of resources, it would make the "interdisciplinarity" obvious, and it would alleviate space burdens on member departments. The original vision committee report suggested a building that would house 100 faculty, staff and visitors, have 40,000 assignable square feet of lab space plus 15,000 square feet of dedicated cleanroom space. A building on the order of 80,000 total square feet would be adequate.
- Establish a plan for modestly increasing financial support to IMR that is consistent with the existing mechanism of IMR shared support. The creation of

large new centers in the past 2 years has generated substantial demands on IMR staff. Additional technical staff members are already necessary.

- Create and implement plan on how to handle the sunsetting of TIE support, which is currently a substantial component of the IMR budget.
- Ensure that Nanotech West has a stable financial and staffing plan; this is currently being developed by IMR working with various central administration offices.
- Maintain an even closer alliance with other starting Institutes, such as the Institute on Energy and the Environment.
- Work closely with the OSU Industrial Liaison Office to develop an improved strategy for industry partnerships
- Maintain consistency with college and university strategic plans and goals

Fiscal Year 2009 Budget and Expenses

IMR's annual operating budget is approximately $1.346 million. In Fiscal Year 2009, IMR received $800,000 for operating expenses from three university sources in equal shares: the Office of Research, College of Engineering, and College of Mathematical and Physical Sciences. In addition, IMR received $418,140 from the Targeted Investment in Excellence program award in Advanced Materials (discussed in detail in the "Awarded Block Grants" section earlier in this report), and $146,324 came from the Office of Research through a prior agreement for partial support of two technical staff. As can be seen in Figure 4, in Fiscal Year 2009, 26% of our expenses were for the salaries and fringe benefits of our technical staff and 41% of our expenses was directed to the Research Program Support category; therefore, a full 67% of IMR's FY 09 funds directly supported OSU's researchers through investments in infrastructure, seed grants, technical personnel, and other key research support allocations.

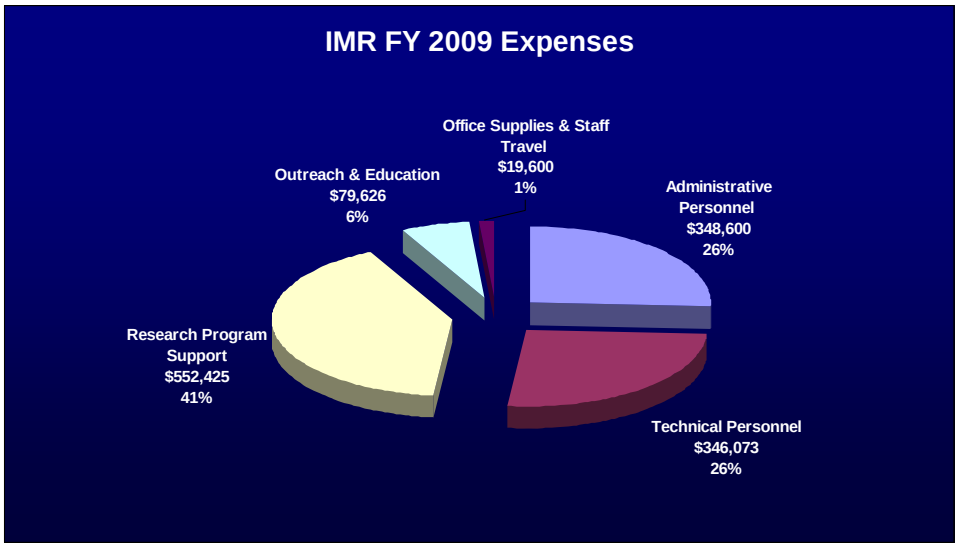


Figure 4. Allocation of IMR's Fiscal Year 2009 expenses by major category.

Table 1: Institute for Materials Research
Fiscal Year 2008-2009 Expenses

Category	Total Expenses FY 2009	Notes
Personnel		
Administrative Personnel: Salary and Fringe	$348,600	includes salary and fringe for staff and student employees, including partial CEM support, plus QOD payments for Assoc. Directors
Technical Personnel: Salary and Fringe	$346,073	
Research Program Support		
Research Enhancement Program (Seed Grants)	$286,000	includes general and CEM-specific IMRG and Facility Grants
TIE Funds for New Faculty Hires	$170,000	Rajan and Myers start up @ $85K each
TIE Funds to NSEC Program Support	$64,000	for nano-bio thrust, annual TIE commitment
Proposal Development Support	$30,125	
REP External Reviewers	$2,300	for IMRG external reviews
Outreach and Education		
IMR 2008 Materials Week	$46,200	
Outreach, Education & Sponsorships	$23,700	support for attendees to Ohio Innovation Summit, consultant and printing for marketing supplies, ICAM membership, collaborations
IMR Colloquia Series	$6,526	includes travel, honoraria, marketing
Event Catering and Business Meals	$3,200	Includes catering for 2009 Annual PVIC Meeting in May, business meals with visiting speakers
Other Expenses		
Office Maintenance: supplies, telephone, shuttle van fuel charges	$16,300	includes monthly phone, copier lease, and vehicle service and fuel charges; office supplies, software, computers, postage, etc. for both IMR offices
Travel	$3,300	IMR staff travel to conferences and manufacturer sites for equipment training/acceptance
Total Expenses	**$1,346,324**	

Appendices:

Appendix I: IMR Interdisciplinary Materials Research Grants (IMRG) Program Information

- 2009 Request for Proposals
- Sample External Reviewer Evaluation Form
- 2007-2009 IMRG Awards

Appendix II: IMR Facility Grants Program Information

- 2009 Request for Proposals
- 2007-2009 Facility Grant Awards

Appendix III: List of IMR Members and Affiliations

Appendix IV: List of Known Publications and Presentations Directly Attributable to Awarded IMR Funds

Appendix I:

IMR Interdisciplinary Materials Research Grants (IMRG) Program Information

- 2009 Request for Proposals
- Sample External Reviewer Evaluation Form
- 2007-2009 IMRG Awards

INSTITUTE FOR MATERIALS RESEARCH (IMR)
2009 REQUEST FOR PROPOSALS

IMR INTERDISCIPLINARY MATERIALS RESEARCH GRANTS

IMR Interdisciplinary Materials Research Grants (IMRGs) are intended to stimulate and advance collaborative and multidisciplinary research in materials-allied fields with the specific goal of generating highly competitive external grant proposals that target large, multi-investigator and center-level opportunities.

These grants provide funds of **$45,000 to be expended over a 12-month period.** Collaborative proposals between two or more faculty members across two or more OSU departments and colleges are strongly encouraged. IMRGs will be considered for a second year of funding on a competitive basis.

ELIGIBILITY

Eligible applicants must be regular faculty of The Ohio State University *and* a member of the OSU Institute for Materials Research who does *not* currently have an active IMRG. Researchers with an active IMRG who wish to request a second year of funding should follow a separate reporting/request process and not the instructions in this RFP. Preference is given to multidisciplinary collaborations submitted by Co-Applicants from multiple departments or colleges within OSU.

DEADLINE

Faculty planning to submit an application for an IMR Interdisciplinary Materials Research Grant must first submit a **brief letter of intent by 5:00 PM on Friday, January 23, 2009** via email to Layla Manganaro, IMR Program Manager, at manganaro.4@osu.edu. Letters of intent should include the name and departments of the Applicant and Co-Applicants (if known), the proposed project's title, a short description of the proposed research (less than 100 words), and the names and contact information for at least three suggested external reviewers.

The deadline for **proposals** for this fiscal year's IMRG competition is **5:00 PM on Friday, February 13, 2009,** with an anticipated start date of July 1, 2009.

APPLICATION INSTRUCTIONS

Eligible applicants who submitted a letter of intent before the deadline noted above may submit a proposal to the IMR office with the following information and length restrictions:

1. Cover Page (1 page maximum): the names, titles, and departments of the Applicant and any Co-Applicants and contact information for the Lead Applicant only (mailing address, email, phone and fax numbers)
2. Project Description (4 pages maximum): Summary of the proposed research including:

- Objectives of the proposed research project
- Description and scope of research
- Work plan and methodology
- Expected outcomes
- Research facilities that may be used to conduct the research
- A brief statement of the broader impacts of the proposed research
- Relation to Planned External Proposal(s): a short statement listing the external agency(ies) and program(s) targeted by the Applicant with deadlines, if known, and how meeting the objectives of the proposed research would translate into external proposal development for the research team

3. References (1 page maximum)
4. Budget Information: A detailed budget for the proposed project and a brief explanation of the proposed budget items. Refer to the "Budget Restrictions" section below when developing your budget proposal. (1 page maximum)
5. Curriculum Vitae of each Co-Applicant (2-page maximum per Co-Applicant)

All applications should use a minimum 11-point font size. Applications longer than the stated page limits or omitting information requested above will not be reviewed.

Please submit your application as an email attachment in one file in PDF format by 5:00 PM, February 13, 2009 to Layla Manganaro, IMR Program Manager, at manganaro.4@osu.edu.

BUDGET RESTRICTIONS

The intent of the IMR Interdisciplinary Materials Research Grants is to enhance research through the financial support of student and postdoctoral researchers and related fee authorizations and user fees, materials and supplies consumed in association with conducting the proposed research. The following expenses are not allowed: faculty salary or benefits (including release time and summer quarter salary), travel, computers and equipment purchases.

REVIEW CRITERIA

The IMR will allocate resources based on the quality of the proposed research, relevance to major funding opportunities and to college- and department-level strategic plans. The review criteria and process are modeled after NSF-style review panels, which will prepare Applicants for major external proposal development.

Review criteria for IMR Interdisciplinary Materials Research Grants are:

- Intellectual merit of proposed research activity: originality, potential contribution to science, technology and education
- Extent to which proposed research fosters interdisciplinary collaborations
- Plan for external proposal development and relation to strategic opportunities
- Relation to department- and college-level strategic plans
- Availability of resources
- Broader impacts

TERMS AND CONDITIONS

1. IMR Interdisciplinary Materials Research Grants must be fully expended **within twelve months** of award. Any unused funds at the end of the twelve-month award period must be returned to IMR, unless otherwise agreed upon in writing. If an extension is necessary, the PI should submit a written request to IMR by the end of the 10th month of the project period.
2. A brief technical and financial report will be due at the end of each award cycle.
3. IMRG recipients will be expected to share their research findings at future IMR events, including seminars and workshops.
4. IMR requests that all researchers inform IMR of external proposals and/or awards that result from IMR-funded projects.
5. Recipients of IMR funds shall acknowledge IMR support in publications resulting from IMR-funded research projects. The acknowledgement shall read as follows: *This work was supported in part by The Ohio State University Institute for Materials Research.*
6. Submission of a proposal to this IMR Interdisciplinary Materials Research Grant competition constitutes an agreement to follow the above terms and conditions.

CONTACT INFORMATION

Potential applicants may contact Layla Manganaro, IMR Program Manager (manganaro.4@osu.edu or (614) 247-4685,) with any administrative or procedural questions. IMR Director Steven Ringel (ringel.5@osu.edu or (614) 688-3924) is the primary contact for technical questions related to potential research activities.

The Ohio State University Institute for Materials Research
2009 Interdisciplinary Materials Research Grants

Evaluation Form

Applicant Information		Reviewer Information	
Applicant Name		Reviewer Name	
Applicant Department		Reviewer's University or Institution	
Project Title		Reviewer Email Address	
Co-Applicants and Departments/Affiliations			

Evaluation Criteria and Comments

Use the space provided to comment on the reviewed proposal as it relates to each of the criteria detailed below.

1. Intellectual Merit
Comment on the overall intellectual merit of the proposed research activity, including the originality and potential contribution it would make to science, technology and education in the materials-allied fields.

2. Collaboration
Comment on the extent to which the proposed research fosters interdisciplinary collaborations and partnerships.

3. Availability of Resources
Comment on the reasonableness of the proposed budget and use of infrastructure, facilities, and personnel to complete the research.

4. Applicant Qualifications
Comment on the Applicants' ability to conduct the proposed research.

Revised March 2009

5. Potential for Generating Successful External Proposals Comment on the plan for using the proposed project in future external proposal development in the materials area and its relation to strategic opportunities outlined by major sponsors (NSF, DOD, DOE, NIH, etc.).
6. Potential Timeframe for Publication and External Proposal Development In your opinion, what timeframe could be expected with respect to generating a viable, external group proposal that would be supported by publications resulting from the proposed research - short term (<12 months), mid-term (12-24 months) or long-term (>24 months)?
7. Broader Impacts Comment on the potential for broader societal impacts proposed by the research.
Overall Summary Use the space below to provide your comments and feedback regarding the overall proposal and how it relates to advancing materials research.

Overall Rating

Check the appropriate box to indicate your overall rating for this proposal

☐ Excellent – highest priority for funding

☐ Very Good –recommend for funding if funds are available

☐ Fair – recommend to modify for consideration in future competitions

☐ Poor – do not recommend for funding

Return form to Layla Manganaro, IMR Program Manager, via email to manganaro.4@osu.edu or via fax to (614) 247-2581.

Revised March 2009

2009 Interdisciplinary Materials Research Grants (IMRGs) Awarded by the OSU Institute for Materials Research (IMR)

IMR's Research Enhancement Program provides different funding mechanisms to support novel research at The Ohio State University. Six new research projects were awarded by the IMR in June 2009, for a total investment of $225,000.

2009 IMRG Research Projects

Metamaterials with Smart Reconfiguration for Broadband RF Antennas

Lead: Marcelo Dapino, Mechanical Engineering; Co-Applicants: Suresh Babu, Industrial Systems Engineering; John Volakis, Electrical and Computer Engineering.

Economical Platforms for FET-based Protein Detection to Support Sensor Clinical Translation

Lead: Stephen C. Lee, Biomedical Engineering; Co-Applicant: Paul Berger, Electrical and Computer Engineering.

Use of Electrospun Biomaterials as Carriers of Bone Marrow Derived Stem/Progenitor Cells to Stimulate

Lead: Nicanor I. Moldovan, Internal Medicine; Co-Applicant: John J. Lannuti, Materials Science and Engineering.

Exploring Electrically Tunable Magnetism in Gd-doped Nitride Quantum Structures

Lead: Roberto C. Myers; Materials Science and Engineering & Electrical Computer Engineering; Co-Applicants: Ezekiel Johnston-Halperin, Physics; Michael Mills, Materials Science and Engineering.

Synthesis of III-V Semiconductor Nanowire Heterostructures Using Metalorganic Chemical Vapor

Lead: Fengyuan Yang, Materials Science and Engineering; Co-Applicants: Ezekiel Johnston-Halperin, Physics; Roberto C. Myers, Materials Science and Engineering & Electrical and Computer Engineering.

2008 Interdisciplinary Materials Research Grants (IMRGs) Awarded by the OSU Institute for Materials Research (IMR)

Three new research projects and six renewals were awarded by the IMR in July 2008, for a total investment of $382,500.

2008 New IMRG Research Projects

Experimental and Computational Study of ALD-grown Dielectrics on III-Nitrides

Lead: Siddharth Rajan, Electrical and Computer Engineering and Materials Science and Engineering; Co-Applicant: Wolfgang Windl, Materials Science and Engineering

Multi-Scale Characterization of Battery Materials for Improved Performance

Lead: Sudarsanam Suresh Babu, Industrial, Welding and Systems Engineering and Materials Science and Engineering; Co-Applicants: Bharat Bhushan, Mechanical Engineering; Yann Guezennec, Mechanical Engineering; Giorgio Rizzoni, Mechanical Engineering; Shrikant C. Nagpure (PhD Student), Mechanical Engineering

Solving the "Contact Problem" of Molecular Electronics via Atomic Layer Deposition

Lead: Ezekiel Johnston-Halperin, Physics; Co-Applicants: Jonathan Pelz, Physics; Malcolm Chisholm, Chemistry

2008 IMRG Renewals

Chemically-triggered Materials Assembly from Synthetic Peptides and Soy Proteins

Lead: Dennis Bong, Chemistry; Co-Applicant: Stephen St. Martin, Horticulture and Crop Science (Year one extension and additional six months of funding awarded)

Hybrid Organic-Inorganic Solar Conversion Systems

Lead: Malcolm Chisholm, Chemistry; Co-Applicants: Arthur Epstein; Physics; Paul Berger, Electrical and Computer Engineering; Nitin Padture, Materials Science and Engineering; Terry Gustafson, Chemistry

Interfacial engineering and scaling of hybrid biological-electrical biosensing architectures based on wide-bandgap semiconductor GaN

Lead: Wu Lu, Electrical and Computer Engineering; Co-Applicants: Leonard J. Brillson ; Electrical and Computer Engineering; Stephen C. Lee, Biomedical Engineering

Intra-Operative Fluorescence for Cancer Detection

Lead: Claudia Turro, Chemistry; Co-Applicants: Joseph Heremans, Mechanical Engineering (previous Lead on this project); Robert Lee, Electrical & Computer Engineering; Edward Martin, Jr, Surgery; Stephen Povoski, Surgery; Vish Subramaniam, Mechanical Engineering; Ronald Xu, Biomedical Engineering ; George Hinkle, Pharmacy; Nathan Hall, Radiology

Materials with magnetic ordering and low loss for new high frequency applications

Lead: Hendrik Verweij, Materials Science and Engineering; Co-Applicants: John Volakis, Electrical and Computer Engineering; Patrick Woodward, Chemistry

Novel active structure design exploiting 3D multi-functional materials

Lead: Stephen Bechtel, Mechanical Engineering; Co-Applicants: Marcelo Dapino, Mechanical Engineering; Michael Mills, Materials Science and Engineering

IMR Interdisciplinary Materials Research Grant Awards

June 2007 IMRG Research Projects

Hybrid Organic-Inorganic Solar Conversion Systems

Lead: Malcolm Chisholm, Chemistry; Co-Applicants: Arthur Epstein; Physics; Paul Berger, Electrical and Computer Engineering; Nitin Padture, Materials Science and Engineering; Terry Gustafson, Chemistry

Electrical measurements of gold nanoparticles in biological tissue for cancer detection

Lead: Joseph Heremans, Mechanical Engineering; Co-Applicants: Robert Lee, Electrical & Computer Engineering; Edward Martin, Jr, Surgery; Stephen Povoski, Surgery; Vish Subramaniam, Mechanical Engineering; Duxin Sun, Pharmacy; Ronald Xu, Biomedical Engineering

Chemically-triggered Materials Assembly from Synthetic Peptides and Soy Proteins

Lead: Dennis Bong, Chemistry; Co-Applicant: Stephen St. Martin, Horticulture and Crop Science

Novel active structure design exploiting 3D multi-functional materials

Lead: Steven Bechtel, Mechanical Engineering; Co-Applicants: Marcelo Dapino, Mechanical Engineering and Michael Mills, Materials Science and Engineering

Materials with magnetic ordering and low loss for new high frequency applications

Lead: Henk Verweij, Materials Science and Engineering; Co-Applicants: John Volakis, Electrical and Computer Engineering; Patrick Woodward, Chemistry

Physics-Based Multiscale Modeling Tools for Ultrastructural Evolution

Lead: Hamish Fraser, Materials Science and Engineering; Co-Applicants: Ju Li, Materials Science and Engineering; Yunzhi Wang, Materials Science and Engineering; Michael Mills, Materials Science and Engineering; Jim Williams, Materials Science and Engineering; Somnath Ghosh, Mechanical Engineering; John Wilkins, Physics; Parthasarathy Srinivasan, Computer Science and Engineering; Raghu Machiraju, Computer Science and Engineering; Kim Boyer, Electrical and Computer Engineering; Ashok Krishnamurthy, Electrical and Computer Engineering; William Carson, Surgery; Atom Sarkar, Neurological Surgery

Computational Modeling of Novel Multi-functional Materials

Lead: Nandini Trivedi, Physics; Co-Applicants: Mohit Randeria, Physics; Leonard Brillson, Electrical and Computer Engineering; Chris Hammel, Physics; Patrick Woodward, Chemistry

Assessing the physico-chemical properties of bio-based PLA-PEG films for food packaging applications

Lead: Yael Vodovotz, Food Science and Technology; Co-Applicant: Kurt Koelling, Chemical and Biomolecular Engineering

Interfacial engineering and scaling of hybrid biological-electrical biosensing architectures based on wide-bandgap semiconductor GaN

Lead: Wu Lu, Electrical and Computer Engineering; Co-Applicants: Leonard J. Brillson ; Electrical and Computer Engineering; Stephen C. Lee, Biomedical Engineering

Appendix II:

IMR Facility Grants Program Information

- 2009 Request for Proposals
- 2007-2009 Facility Grant Awards

INSTITUTE FOR MATERIALS RESEARCH (IMR)
REQUEST FOR PROPOSALS

IMR FACILITY GRANTS

The purpose of IMR Facility Grants is to make campus research facilities more accessible to researchers wishing to demonstrate materials-related research results with the goal of **strengthening near-term research proposals for external support**. Each Facility Grant provides **$2,000** to offset the cost of user access fees and related minor charges such as materials and supplies.

ELIGIBILITY

Applicants must be regular faculty of The Ohio State University *and* a member of the OSU Institute for Materials Research to be eligible to apply for an IMR Facility Grant. Proposed research already receiving IMR user facility support through existing cost-share mechanisms will not be eligible for this call for IMR Facility Grants.

DEADLINES

Facility Grant competition deadlines for fiscal year 2008-2009 are: **Wednesday, November 26, 2008** with an anticipated project start date of January 1, 2009; and **Friday, March 13, 2009** with an anticipated project start date of May 1, 2009.

APPLICATION INSTRUCTIONS

OSU faculty interested in applying for an IMR Facility Grant should submit a 1-2 page (maximum) application to the IMR office with the following information:

1. General Information: the names, titles, and departments of the Applicant and any Co-Applicants and contact information for the Lead Applicant only (mailing address, email, phone and fax numbers)
2. Project Description: a brief summary of the proposed research including the objective, scope of work, methodology, and research facilities that may be used to conduct the research
3. Relation to Planned External Proposal(s): a short statement listing the external agency(ies) and program(s) targeted by the Applicant with deadlines, if known, and how the Facility Grant is expected to strengthen the proposal
4. Budget Information: a listing of proposed expenses and a brief explanation of the proposed $2,000 budget. Applicants should detail their planned expenses in the grant application. Facility Grants are intended for facility user fees, materials, and supplies and *cannot* be used to pay for travel, personnel, or communications expenses.

All applications should use a minimum 11-point font size. All Facility Grants awarded will have a twelve-month project period and a total budget of $2,000. Applications longer than two pages or omitting information requested above will not be reviewed. Please submit your application as an email attachment in PDF or Microsoft Word format to Layla Manganaro, IMR Program Manager, at manganaro.4@osu.edu **by 5:00 PM on Wednesday, November 26, 2008 or Friday, March 13, 2009**.

TERMS AND CONDITIONS

1. IMR Facility Grants must be fully expended **within twelve (12) months** of award. Any unused funds at the end of the twelve-month award period must be returned to IMR.
2. A brief technical and financial report will be due at the end of the award cycle.
3. Facility Grant recipients will be expected to share their research findings at future IMR events, including seminars and workshops.
4. IMR requests that all researchers inform IMR of external proposals and/or awards the result from IMR-funded projects.
5. Recipients of IMR funds shall acknowledge IMR support in publications resulting from IMR-funded research projects. The acknowledgement shall read as follows: *This work was supported in part by The Ohio State University Institute for Materials Research.*
6. Submission of a proposal to this IMR Facility Grant competition constitutes an agreement to follow the above terms and conditions.

CONTACT INFORMATION

Potential applicants may contact Layla Manganaro, IMR Program Manager (manganaro.4@osu.edu or (614) 247-4685,) with any administrative or procedural questions. IMR Director Steven Ringel (ringel.5@osu.edu or (614) 688-3924) is the primary contact for technical questions related to potential research activities.

May 2009 Facility Grants
Awarded by the OSU Institute for Materials Research (IMR)

Eight new research projects were awarded by the IMR in May 2009, for a total investment of $16,000. The eight projects support 10 faculty researchers from four departments within the College of Engineering and the College of Biological, Mathematical and Physical Sciences.

May 2009 IMR Facility Grant Awards

Characterization of TiO_2 Nanowires Grown by Thermal Oxidation on Titanium Alloys
Lead Investigator: Sheikh Akbar, Materials Science and Engineering; Co-Investigator: Suliman A. Dregia, Materials Science and Engineering

Ultra-high spatial resolution FeCNT probes for quantitative Magnetic Force Microscopy analysis of magnetic systems
Lead Investigator: P. Chris Hammel, Physics

A proposal to fabricate low loss ridge-type Ta_2O_5 optical waveguides using atomic layer deposition and electron beam lithography of SU-8
Lead Investigator: Gregory Lafyatis, Physics

High Resolution Electron Beam Lithography on Optically Transparent Substrates
Lead Investigator: Wu Lu, Electrical and Computer Engineering

Controlled Deposition of Nano-structured Metal Oxides on Micro Hotplate Devices for Gas Sensing
Lead Investigator: Patricia Morris, Materials Science and Engineering

Molecular beam epitaxy growth of GaN/AlN superlattice nanorods on Si (111)
Lead Investigator: Roberto Myers, Materials Science and Engineering

Simulation and Characterization on GDC Nano-islands
Lead Investigator: Yunzhi Wang, Materials Science and Engineering; Co-Investigator: Suliman Dregia, Materials Science and Engineering

Semiconductor Nanowire Synthesis by Metalorganic Chemical Vapor Deposition
Lead Investigator: Fengyuan Yang, Physics

January 2009 Facility Grants
Awarded by the OSU Institute for Materials Research (IMR)

Ten new research projects were awarded by the IMR in January 2009, for a total investment of $20,000. The ten projects support 13 faculty researchers from seven departments within the College of Engineering and the College of Biological, Mathematical and Physical Sciences.

January 2009 IMR Facility Grant Awards

Magnetic Force Microscopy of Magnetic Nanoparticles in Biological Systems
Lead Investigator: Gunjan Agarwal, Biomedical Engineering ; Co-Investigator: Chris Hammel, Physics

Strong NDR from Metal-Oxide/Conjugated Polymer Interfaces Enabling Low-Power, Plastic Logic, Memory and Wireless Datalinks
Lead Investigator: Paul Berger, Electrical and Computer Engineering

Characterization of Multivalent Ionic Liquids for Nanolubrication
Lead Investigator: Bharat Bhushan, Mechanical Engineering

Enhance Program on Spintronic Phenomena in Organic-based Materials
Lead Investigator: Arthur Epstein, Physics; Co-Investigators: Deniz Duman and Mark Murphey, Graduate Students

Development of a Mechanically Robust Stem Cell Delivery System for Myocardial Injection
Lead Investigator: Jianjun Guan, Materials Science and Engineering

Nanoscale Modification of Diamond surface Conductivity
Lead Investigator: Jay Gupta, Physics

Development/Evaluation of Molecular Materials for Spintronics
Lead Investigator: Ezekiel Johnston-Halperin, Physics; Co-Investigator: Malcolm Chisholm, Chemistry

Fabricating Magnetic Traps to Manipulate Nanoparticles and Biological Cells
Lead Investigator: R. Sooryakumar, Physics; Co-Investigator: Jessica Winter, Chemical and Biomolecular Engineering

Development of A Hybrid Microcantilever for Bi-directional Sensing and Actuating at the Small Scale
Lead Investigator: Yi Zhao, Biomedical Engineering

Innovative Micro and Nano Channels for Signal Transmission in Ion Transmission Lines
Lead Investigator: Yuan Zheng, Electrical and Computer Engineering

IMR Facility Grant Awards, February 2008

Photomodulation of Carbon Nanosponges
Lead: Vish Subramaniam, Mechanical Engineering; Co-Applicant: R. Sooryakumar, Physics

Fabrication of Essential Experimental Components for Magnetic Resonance Force Microscopy (MRFM)
Lead: Chris Hammel, Physics

Enhance Program on Spintronic Phenomena in Organic-based Materials
Lead: Arthur Epstein, Physics; Co-Applicants: Deniz Duman and Mark Murphey, Graduate Students

Preparation and Characterization of Ultrasharp Tips for sub-10nm Resolution Optical Microscopy and Spectroscopy
Lead: Jay Gupta, Physics; Co-Applicants: Arthur Epstein, Physics; Terry Gustafson, Chemistry

Surface Acoustic Wave Sensor Development
Lead: Erik Walton, ElectroScience Laboratory; Co-Applicant: Yakup Bayram, ElectroScience Laboratory

Spin Transport in Semiconductor Nanowires
Lead: Fengyuan Yang, Physics

Fabrication of Si Microhotplate Arrays
Lead: Patricia Morris, Materials Science and Engineering

Facility Support for Chemical and Conformational Analysis of AlGaN Biosensors
Lead: Leonard Brillson, Electrical and Computer Engineering; Co-Applicants: Wu Lu, Electrical and Computer Engineering; Stephen Lee, Biomedical Engineering

Fabrication of Ultra-Dense Spin-Torque Oscillators (STOs)
Lead: Ezekiel Johnston-Halperin, Physics; Co-Applicant: Fengyuan Yang, Physics

nm-resolution studies of metal contacts to semiconducting nanowires
Lead: Jonathan Pelz, Physics

Lorentz-Force Based MEMS Device for Controllable Mechanical Loading on Single Cell
Lead: Yi Zhao, Biomedical Engineering

Measuring Cell Deformating Using Bioscope Dual AFM/fluorescence integrated miscroscope in the AFM Core of DHLRI
Lead: Nicanor Moldovan, Internal Medicine and Biomedical Engineering

Site Specific Stamping of Graphene
Lead: Nitin Padture, Materials Science and Engineering; Co-Applicant: Wolfgang Windl, Materials Science and Engineering

The Self-Assembly of Peptide-Dendron Hybrids
Lead: Jon Parquette, Chemistry

Simultaneously assemble of cardiac patch comprising of stem cells, growth factors and elastic nanofibers for congestive heart failure

Lead: Jianjun Guan, Materials Science and Engineering

Electrohydrodynamic jet printing of biological materials with micro/nano structural features for biomedical and nanobiotechnological applications

Lead: Edward Eteshola, Biomedical Engineering; Co-Applicant: Suwan Jayasinghe, University College London

Development of Nanowire Arrays for Biosensing

Lead: Wu Lu, Electrical and Computer Engineering

Characterize high quality coupling gratings for Ta2O5 optical waveguides using electron beam lithography of SU-8

Lead: Gregory Lafyatis, Physics; Co-Applicant: Aimee Bross, IMR

Microchannel Chromatographic Systems for Chip-Based Monitoring of Therapeutic Windows and for Early-Stage Cancer Monitoring

Lead: Susan Olesik, Chemistry

Characterization of Self Assembled Ceramic Nano-Arrays

Lead: Suliman Dregia, Materials Science and Engineering; Co-Applicant: L. James Lee, Chemical and Biomolecular Engineering

IMR Facility Grants Awards, February 2007

Manufacture of Non-Photodefinable Polymer Nanostructures Using Pressure-Assisted Nanopatterning

Lead: Yi Zhao, Biomedical Engineering

Superconductivity and Ferromagnetism: Proximity Effects

Lead: Thomas Lemberger, Physics; Co-Applicants: Fengyuan Yang, Physics; Julia Myer, Physics; R. Sooryakumar, Physics

Passive Millimeter-Wave Camera Using Monolithic Si-Based Square-Law Detectors for Inclement Weather Piloting and Security Screening

Lead: Paul Berger, Electrical and Computer Engineering

Request for IMR Facility Grant to Enhance Program on Spintronic Phenomena in Organic-Based Materials

Lead: Arthur Epstein, Physics; Co-Applicants: Jeremy Bergeson (Postdoctoral Researcher); Deniz Duman and Mark Murphey (Graduate Students)

A Proposal to Devlop High Quality Coupling Gratings for Ta2O5 Optical Waveguides Using Electron Beam Lithography

Lead: Gregory Lafyatis, Physics

Development of Ultra-Short T-Gates for High Speed Electronics

Lead: Wu Lu, Electrical and Computer Engineering

Facility Support for Structural Analysis of Multifunctional Oxide Interfaces

Lead: Leonard Brillson, Electrical and Computer Engineering; Co-Applicants: Fengyuan Yang, Physics; Patrick Woodward, Chemistry

Preparation and Characterization of Ultrasharp Tips for Sub-10nm Resolution Optical Microscopy and Spectroscopy

Lead: Jay Gupta, Physics; Co-Applicants: Arthur Epstein, Physics; Terry Gustafson, Chemistry

Support for 2 projects: Nanometer-resolution studies of gate-field-modified Schottky-Barrier devices and Nanoscale studies of metal-molecule-Si Schottky-Barrier devices

Lead: Jonathan Pelz, Physics

Reliability of Single Sensor DTA in Determining Phase Transformations and Structural Changes in Advanced Structural Alloys

Lead: John Lippold, Industrial, Welding, and Systems Engineering; Co-Applicant: Boian Alexandrov (Research Scientist)

Materials Science of Photo-reversible Semiconducting Glass States

Lead: R. Sooryakumar, Physics; Co-Applicant: Ronald Reano, Electrical and Computer Engineering

Request for an IMR Facility Grant

Lead: Sheikh Akbar, Materials Science and Engineering; Co-Applicants: Derek Hansford, Biomedical Engineering

Multi-Cation Oxides for Cye-Sensitized Solar Cells
Lead: Yiying Wu, Chemistry

Semiconductor Nanowires for Spintronics
Lead: Fengyuan Yang, Physics

Sub-Lithographic Patterning of Magnetic Nanowires
Lead: Ezekiel Johnston-Halperin, Physics; Co-Applicant: Fengyuan Yang, Physics

Application for IMR Facility Grant
Lead: P. Chris Hammel, Physics

Appendix III:

List of IMR Members and Affiliations

Members of the Institute for Materials Research (IMR) August 2009

Sudha Agarwal, Orthopedics

Gunjan Agarwal, Biomedical Engineering

Sheikh Akbar, Materials Science and Engineering

Boian Alexandrov, Industrial, Welding and Systems Engineering

Betty Lise Anderson, Electrical and Computer Engineering

Sudarsanam Suresh Babu, Industrial, Welding and Systems Engineering

Yakup Bayram, Electroscience Lab

Thomas Bean, Food, Agricultural and Biological Engineering

Jim Beatty, Physics

Stephen Bechtel, Mechanical Engineering

Paul Berger, Electrical and Computer Engineering

Bharat Bhushan, Mechanical Engineering

Thomas Blue, Mechanical Engineering

Dennis Bong, Chemistry

Leonard Brillson, Electrical and Computer Engineering

Aimee Bross, Institute for Materials Research

Rudy Buchheit, Materials Science and Engineering

Ralf Bundschuh, Physics

John Carlin, Institute for Materials Research

Malcolm Chisholm, Chemistry

William Clark, Materials Science and Engineering

James Coe, Chemistry

Edward Collings, Materials Science and Engineering

Terry Conlisk, Mechanical Engineering

Stuart Cooper, Chemical and Biomolecular Engineering

Glen Daehn, Materials Science and Engineering

Marcelo Dapino, Mechanical Engineering

Robert Davis, Institute for Materials Research

Suliman Dregia, Materials Science and Engineering

Charles Drummond, Materials Science and Engineering

Prabir Dutta, Chemistry

Arthur Epstein, Physics

Edward Eteshola, Biomedical Engineering

Liang-Shih Fan, Chemical and Biomolecular Engineering

Katharine Flores, Materials Science and Engineering

Gerald Frankel, Materials Science and Engineering

Hamish Fraser, Materials Science and Engineering

Richard Freeman, Physics

Somnath Ghosh, Mechanical Engineering

Jianjun Guan, Materials Science and Engineering

Yann Guezennec, Mechanical Engineering

Jay Gupta, Physics

Prabhat Gupta, Materials Science and Engineering

Terry Gustafson, Chemistry

Nathan Hall, Radiology

P. Chris Hammel, Physics

Derek Hansford, Biomedical Engineering

Richard Hart, Biomedical Engineering

Joseph Heremans, Mechanical Engineering

Anton Heyns, Chemistry

Julia Higle, Integrated Systems Engineering

George Hinkle, Pharmacy Practice and Radiology

W.S. Winston Ho, Chemical and Biomolecular Engineering

Ezekiel Johnston-Halperin, Physics

Matt Kleinhenz, Horticulture and Crop Science

Kurt Koelling, Chemical and Biomolecular Engineering

Ashok Krishnamurthy, Electrical and Computer Engineering

Gregory Lafyatis, Physics

John Lannutti, Materials Science and Engineering

Robert Lee, Electrical and Computer Engineering

L. James Lee, Chemical and Biomolecular Engineering

Stephen Lee, Biomedical Engineering

Robert J. Lee, Pharmacy

Thomas Lemberger, Physics

Yebo Li, Food, Agricultural and Biological Engineering

John Lippold, Industrial, Welding and Systems Engineering

Wu Lu, Electrical and Computer Engineering

Edward Martin Jr., Surgery Oncology

Jeffery McNeal, Math and Physical Science Admin

Carolyn Merry, Civil, Environmental Eng and Geodetic Science

Julia Meyer, Physics

Fred Michel Jr., Food, Agricultural and Biological Engineering

Sharell Mikesell, NSEC-Polymer Biomedical

Terry Miller, Chemistry

Michael Mills, Materials Science and Engineering

Nicanor Moldovan, Opthamology/ Heart and Lung Institute

John Morral, Materials Science and Engineering

Patricia Morris, Materials Science and Engineering

Randy Moses, Electrical and Computer Engineering

Stephen Myers, Ohio BioProducts

Roberto Myers, Materials Science and Engineering

Susan Olesik, Chemistry

Michael Ostrowski, Molecular and Cellular Biochemistry

Umit Ozkan, Chemical and Biomolecular Engineering

Nitin Padture, Materials Science and Engineering

Jon Parquette, Chemistry

Srinivasan Parthasarathy, Computer Science and Engineering

Michael Paulaitis, Chemical and Biomolecular Engineering

Denis Pelekhov, Institute for Materials Research

Jonathan Pelz, Physics

Matthew Platz, Chemistry

Michael Poirier, Physics

Stephen Povoski, Surgery Oncology

Heather Powell, Materials Science and Engineering

Siddarth Rajan, Electrical and Computer Engineering

Mohit Randeria, Physics

Bill Ravlin, Ohio Agricultural Research and Development Center

Ronald Reano, Electrical and Computer Engineering

David Rigney, Materials Science and Engineering

Matthew Ringel, Molecular Virology, Immunology & Medical Genetics

Steven Ringel, Electrical and Computer Engineering

Giorgio Rizzoni, Mechanical Engineering

Patrick Roblin, Electrical and Computer Engineering

Thomas Rosol, Surgery Oncology

Yogeshwar Sahai, Materials Science and Engineering

Sherwin Singer, Chemistry

Ratnasingham Sooryakumar, Physics

Krishnaswamy Srinivasan, Mechanical Engineering

Stephen St. Martin, Horticulture and Crop Science

Doru Stefanescu, Materials Science and Engineering

David Stroud, Physics

Vishwanath Subramaniam, Mechanical Engineering

Michael Sumption, Materials Science and Engineering

Nandini Trivedi, Physics

Claudia Turro, Chemistry

George Valco, Electrical and Computer Engineering

Hendrik Verweij, Materials Science and Engineering

John Volakis, Electrical and Computer Engineering

Robert Wagoner, Materials Science and Engineering

Eric Walton, Electroscience Lab

Yunzhi Wang, Materials Science and Engineering

Gregory Washington, Mechanical Engineering

Janet Weisenberger, Research Administration

John Wilkins, Physics

James Williams, Materials Science and Engineering

Wolfgang Windl, Materials Science and Engineering

Jessica Winter, Chemical and Biomolecular Engineering

Patrick Woodward, Chemistry

Yiying Wu, Chemistry

Ronald Xu, Biomedical Engineering

Fengyuan Yang, Physics

Yi Zhao, Biomedical Engineering

Ji-Cheng Zhao, Materials Science and Engineering

Yuan Zheng, Electrical and Computer Engineering

Appendix IV:

List of Known Publications and Presentations Directly Attributable to Awarded IMR Funds

List of Known Publications and Presentations Directly Attributable to Awarded IMR Funds

Provided below is a list of known publications and presentations directly attributed to funding from IMR Interdisciplinary Materials Research Grants and Facility Grants. It should be noted that these are only self-reported by faculty members and this list will be significantly smaller than actuality as a result. Nevertheless the list is provided to demonstrate yet other forms of impact.

Known Publications and Conference Proceedings Directly Related to IMR-Funded Internal Research Projects

M. Rauscher, S. A. Dregia, A. Boyne, and S. A. Akbar, "Self-Assembly of Pseudo-Periodic Arrays of Nano-Islands on YSZ-(001)" Advanced Materials, 20[9], 1699-1705 (2008).

S. C. Nagpure, B. Bhushan, S. Babu, G. Rizzioni. "Scanning Spreading Resistance Characterization of Aged Li-Ion Batteries Using Atomic Force Microscopy". Scripta Materialia 60 (2009) 933-936

S.Piratla, S.E. Bechtel, M. Dapino, "Thermodynamic potentials for fully-coupled characterization of thermo-electro-magneto-mechanical materials," Acta Materials, in preparation

M. Mahboob, C. Kagarise, K. Koelling and S.E. Bechtel, "Quantitative 3D Measurement of the Nanostructural Features that Dictate Mesoscale Performance Properties of Nanocomposites," Composites Science and Technology. Polymer Composites, to appear

P. Evans and M.J. Dapino, "Effect of stress and anisotropy on the magnetic susceptibility of single-crystal Galfenol,'' Journal of Physics D: Applied Physics, in review

P. Evans and M.J. Dapino, "Efficient model for field-induced magnetization and magnetostriction of Galfenol," Journal of Applied Physics. Vol. 44, Issue 7, Part 1, pp. 1711-1720, July 2008

P.G. Evans and M.J. Dapino, "State-space constitutive model for magnetization and magnetostriction of Galfenol alloys," IEEE Transactions on Magnetics, Vol. 44, Issue 7, Part 1, pp.1711-1720, July 2008

S. Piratla, S.E. Bechtel, and M.J. Dapino, "Application of thermodynamics for optimal design of Galfenol devices," International Journal of Structural Changes in Solids Mechanics and Applications, in preparation

S. Y. Park, R. Yu, S. Y. Chung, P. R. Berger, P. E. Thompson, and P. Fay,"Sensitivity of SI-Based Zero-Bias Backward Diodes for Microwave Detection", Electronics Letters, 43, pp.53-54, 2007

Oscar Torres, Denis Yuksel, Matt Bernardina, Krishna Kumar and Dennis Bong. "Peptide tertiary structure nucleation by sidechain crosslinking with metal complexation and double "click" cycloaddition." ChemBioChem 2008, 9, 1701-1705

Mingming Ma, Angel Paredes and Dennis Bong. "Intra and intermembrane pairwise molecular recognition between synthetic hydrogen-bonding phospholipids." J. Am. Chem. Soc. 2008, 130, 14456-14458

O. Torres, D. Yüksel, M. Bernardina, K. Kumar and D. Bong. “Peptide tertiary structure nucleation by sidechain crosslinking with metal complexation and double “click” cycloaddition.” ChemBioChem, 2008, 9 1701-1705

M. Ma, A. Paredes and D. Bong. "Intra and intermembrane pairwise molecular recognition between synthetic hydrogen-bonding phospholipids." J. Am. Chem. Soc. 2008, 130, 14456-14458

T. L. Gustafson, M. L. Ho, Malcolm H. Chisholm, Pi-Tai Chou, Yi-Hsuan Chou, Yagnaseni Ghosh, "Preparations and Photophysical Properties of Fused and Non-Fused Thienyl Bridged MM (M = Mo or W) Quadruply Bonded Complexes", Inorganic Chemistry, 47, 3415-3425 (2008)

W. J. Yoon and P. R. Berger, "4.8% Efficient Poly(3-hexylthiophene)-Fullerene (1:0.8) Bulk Heterojunction Photovoltaic Devices with Plasma Treated AgOx/ITO Anode Modification", Applied Physics Letters, 92, 013306 (January 7, 2008). Additionally, selected for republication in the January 21, 2008 issue of Virtual Journal of Nanoscale Science & Technology

B. T. Burdzinski, Malcolm H. Chisholm, P.-T. Chou, Y.-H. Chou, Florian Feil, Judith C. Gallucci, Yagnaseni Ghosh, Terry L. Gustafson, M.-L. Ho, Y. Liu, R. Ramnauth and Claudia Turro, “The Remarkable Influence of M2δ to Thienyl π Conjugation in Oligothiophenes Incorporating MM Quadruple Bonds.” Proc. Natl. Acad. Sci., 105(40), 15247-15252 (2008)

Brian G. Alberding, Malcolm H. Chisholm, Yagnaseni Ghosh, Terry L. Gustafson, Y. Liu and Claudia Turro, “Sexithiophenes Mediated by MM Quadruple Bonds: MM = Mo2, MoW and W2.” Inorg. Chem., 2009, in press

Woo-Jun Yoon, Scott B. Orlove, Robert L. Olmon, and Paul R. Berger, “Enhanced Emission using Thin Li-Halide Cathodic Interlayers for Improved Injection into Poly(p-phenylene vinylene) Derivative PLEDs.” Electrochemical and Solid-State Letters, 11, pp. J76-J78 (2008)

Dhiman Bhattacharyya, Woo-Jun Yoon, Paul R. Berger and Richard B. Timmons, “Plasma Polymerized Multistacked Organic Bipolar Films: A New Approach to Flexible High k-Dielectrics.” Advanced Materials, 20, pp. 2383-2388 (June 18, 2008)

Woo-Jun Yoon and Paul R. Berger, “4.4% Efficient Poly(3-hexylthiophene)-Fullerene Bulk Heterojunction Photovoltaics With Optimized LiF Interlayer Thickness and Post-Annealing Temperature.” submitted to Electronics Letters

Woo-Jun Yoon and Paul R. Berger, “Atomic layer deposited HfO2 gate dielectrics for low-voltage operating, high-performance poly-(3-hexythiophene) organic thin-film transistors.” submitted to Organic Electronics

Woo-Jun Yoon, Kyung-Young Jung, Jiwen Liu, Thirumalai Duraisamy, Rao Revur, Fernando L. Teixeira, Suvankar Sengupta and Paul R. Berger, “Plasmon-enhanced optical absorption and photocurrent in organic bulk heterojunction photovoltaic devices using self-assembled layer of silver nanoparticles.” submitted to Solar Energy Materials & Solar Cells

Bergeson, et al., “Iron nanoparticle driven spin-valve behavior in aligned carbon nanotube arrays”, Applied Physics Letters 93 172505 (2008)

F. Wang, Z. Li, J. Guan, "Rapid Fabrication of Growth Factor Releasing, Anisotropic and Flexible Scaffolds", Submitted to Acta Biomaterials

F. Wang, Z. Li, J. Lannutti, W. R. Wagner, J. Guan, "Synthesis, Characterization and Surface Modification of Low Moduli Polyurethanes for Soft Tissue Engineering". Submitted to Biomaterials

K.C. Fong, Y. Che, P. Banerjee, Yu. Obukhov, D.V. Pelekhov and P.C. Hammel, "Manipulating Spins by Cantilever Synchronized Frequency Modulation: A Variable Resolution Magnetic Resonance Force Microscope," Manuscript in preparation (to be submitted to APL)

R. B. Sears, J. Heremans, D. Sun, E. Martin Jr., C. Turro "Selective Detection of Cancer Cells by Antibody-Near-IR Dye Conjugates" J. Med. Chem., in preparation

E. Ben-Dor, A.L. Bross, G. Lafyatis, R. Hardman, J. Golden, P. R. Berger "High Sensitivity SU-8 Resist for EBL using Zero Photoacid Generator"

B. Alexandrov, and J. C. Lippold, "Non-equilibrium Phase Diagrams for Engineering Alloys", 50th Annual Assembly of IIW, Dubrovnik, Croatia, July 2007, IIW. Doc. II-A-181-07

B. Alexandrov, and J.C. Lippold, "Non-equilibrium Phase Diagrams in Advanced Engineering Alloys", to be published in Trends in Welding Research, Pain Mountain, Georgia, June 2008

B. Alexandrov, J.C. Lippold, "Non-equilibrium Phase Transitions in Ni-Base Super Alloys", to be published in Superalloys 2008, Pittsburgh, PA, September 2008 NSF Abstract

S. Gupta, M. Elias, X. Wen, J. Shapiro, L. Brillson, W. Luc, S. C. Lee, "Detection of clinically relevant levels of protein analyte under physiologic buffer using planar field effect transistors", Biosensors and Bioelectronics journal homepage: www.elsevier.com/locate/bios

J. Song and W. Lu, "Operation of Pt/AlGaN/GaN-Heterojunction Field-Effect-Transistor Hydrogen Sensors With Low Detection Limit and High Sensitivity", IEEE Electron Devices Letters, VOL. 29, NO. 11, November 2008 1193

M. Schuette and W. Lu, "Highly-selective zero-bias plasma etching of GaN over AlGaN", Journal of Vacuum Science and Technology B, vol. 25, pp.1870-1874, 2007

H. Kim, M. Schuette, J. Lee, W. Lu, and J.C. Mabon, "Passivation of Surface and Interface States in AlGaN/GaN HEMT Structures by Annealing", Journal of Electronic Materials, vol. 36, pp. 1149-1155, 2007

D. Liu, M. Hudait, Y. Lin, H. Kim, S. A. Ringel, and W. Lu, "Gate legnth scaling study of InAlAs/InGaAs/InAsP composite channel HEMTs", Solid State Electronics, vol.51, pp. 838-841, 2007

H. Kim and W. Lu, "A simple model for extraction of effective trap density and gate legnth in A1GaN/GaN high-electron mobility transistors based on pulse I-V characteristics", submitted to Applied Physics Letters

D. Liu, M.udait, Y. Lin, H. Kim, S. A. Ringel, and W. Lu, "80nm InAlA/InGaAs/InAsP Composite Channel HEMTs with an f[symbol] of 280 GHz", Submitted to Solid State Electronics

X. Wen, S. Wang, L. J. Lee, and W. Lu, "AlGaB/GaN heterostructure field-effect transistors for label-free detection of DNA hybridization," IEEE Sensors Journal (Submitted, in revision)

M. Schuette and W. Lu, "Highly-selective zero-bias plasma etching of GaN over AlGaN", Journal of Vacuum Science Technology B, vol. 25, pp. 1870-1874, 2007

S. Gupta, M. Elias, X. Wen, J. Shapiro, L. Brillson, W. Lu, and S. Lee, "AlGaN heterojunction field effect transistors for detection of clinically relevant MIG concentrations at physiological salt concentrations", Biosensors and Bioelectronics

X. Wen, J. Song, W. Lu, "Responses of AlGaN/GaN Heterojunction Field Effect Transistors to DNAs", Journal of Science and Technology B, Accepted

X. Wen, S. Wang, L. J. Lee, and W. Lu, "AlGaN/GaN Heterostructure Field Transistor for Label Free Detection of DNA Hybridization", Biosensors and Bioelectronics, submitted

D. Li, W. Windl, and N.P. Padture, "Towards Site-Specific Stamping of Graphene," Advanced Materials, 21 [12] 1243-1246 (2009)

J. Parquette, H. Shao. "Controllable Peptide-Dendron Self-Assembly: Interconversion of Nanotubes and Fibrillar Nanostructures". Angew. Chem. Int. Ed. 2009, 48. 1-5

W. Zhou, R.P. Tiwari, R. Annamalai, R. Sooryakumar, V. Subramaniam, D. Stroud, "Sounds Propogation in light-modulated carbon nanosponge suspensions", Physical Review B79, 104204 (2009)

T.B. Shrestha, J. Melin, Y. Liu, O. Dolgounitcheva, V.G. Zakrzewski, M. R. Pokhrel, E. Gogritchiani, J. V.Ortiz, C. Turro, S. H.Bossmann, Photochem."New insights in the photochromic spiro-dihydroindolizine/betaine-system". Photobiol. Sci. 2008, 7, 1449-1456

Yao Liu, David B. Turner, Tanya N. Singh, Abdelatif Chouai, Kim R. Dunbar, and Claudia Turro, "Ultrafast Ligand Exchange: Detection of a Pentacoordinate Ru(II) Intermediate and Product Formation" J. Am. Chem. Soc. 2009, 131, 26-27

Yao Liu, Richard Hammitt, Daniel A. Lutterman, Joyce, L. E.; Randolph P. Thummel, Claudia Turro, "Ru(II) Complexes of New Tridentate Ligands: DNA Photocleavage and Unexpected High Yield of Sensitized 1O2", Inorg. Chem. 2009, 48, 375-385

Alberding, Brian; Chisholm, Malcolm; Chou, Yi-Hsuan; Ghosh, Yagnaseni; Gustafson, T. L.; Turro, Claudia; Reed, Carly; Patmore, Nathan; Gallucci, Judith, "Quadruply Bonded Dimetal Units Supported by 2,4,6-triisopropylbenzoates (MM = Mo2, MoW and W2): Preparations and Photophysical Properties", Inorg. Chem., in press

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McClure, Beth; Mockus, Nicholas; Butcher, Dennis; Lutterman, Daniel A.; Turro, Claudia; Petersen, Jeffrey; Rack, Jeffrey, "Photochromic Ruthenium Sulfoxide Complexes: Evidence for Isomerization through a Conical Intersection" Inorg. Chem., in press

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Y. Zhao and H. Zheng. "Fabricating Freeform Polymer Microstructures for Micromechanical and Microfluidic Applications", Sensors and Actuators B: Chemical, 2009, Journal Paper under 1st revision

Known Invited Talks Directly Attributable to IMR-Funded Internal Research Projects

S.E. Bechtel, “Measurement of the Nanostructural Features in Polymer Nanocomposites”, Society of Engineering Science 45th Annual Technical Meeting, Urbana-Champaign, Il, October 12-15 2008

M.J. Dapino, “Constitutive modeling for design and control of magnetostrictive Galfenol devices,'' CIMTEC's Third International Conference Smart Materials, Structures & Systems, Acireale, Sicily, Italy, 10 June 2008

M.J. Dapino, "Smaller, simpler, faster, lighter: Can smart materials drive the development of next-generation vehicle systems?'' presented at Michigan State University, East Lansing, Michigan, 25 Oct. 2007

Woo-Jun Yoon, Kyung-Young Jung, Fernando L. Teixeira and Paul R. Berger, Jiwen Liu, Thirumalai Duraisamy, Rao Revur and Suvankar Sengupta, “Efficient Poly(3-hexylthiophene)-Fullerene Derivative Bulk Heterojunction Photovoltaic Devices using Unique Self-assembled Layer of Ag Nanoparticles with Controllable Particle-to-particle Spacing.” 34th IEEE Photovoltaic Specialists Conference, Philadelphia, PA, June 2009.

Woo-Jun Yoon and Paul R. Berger, Yagnaseni Ghosh, Yi-Hsuan Chou, Carly Reed and Malcolm Chisholm, “Efficient Organic Bulk Heterojunction Solar Cells through Near Infrared Absorbing Metallated Thiophene Complexes.” 34th IEEE Photovoltaic Specialists Conference, Philadelphia, PA, June 2009. Runner-up Best Poster Award.

Woo-Jun Yoon and Paul R. Berger, “Surface Modifications to the Indium Tin Oxide (ITO) Anodes Through Plasma Oxidized Silver for Efficient P3HT:PCBM (1:0.8) Bulk Heterojunction Photovoltaic Devices.” 33rd IEEE Photovoltaic Specialists Conference, San Diego, CA, May 2008. Honorable Mention Award.

Woo-Jun Yoon and Paul R. Berger, “Polymer-Fullerene Bulk Heterojunction Photovoltaic Devices for Efficient Solar Energy Conversion on a Low-Cost, Flexible Substrate.” University Clean Energy Alliance of Ohio (UCEAO) Workshop, April 24, 2008.

Malcolm H. Chisholm, “Oligothiophenes Incorporating MM Quadruple Bonds (MM = Mo2, MoW and W2). A Chemical Approach to Photon Harvesting and Spectral Expansion.” 34th IEEE Photovoltaic Specialist Conference, Philadelphia, PA, June 2009.

Alberding, B. G.; Chisholm, M. H. "Photophysics of Paddlewheel Complexes Involving Molybdenum and Tungsten Quadruple Bonds Supported by Amidinate and Carboxylate Ligands", The International Symposium on Molecular Spectroscopy, Columbus, OH, June 2009

Reed, C. R.; Chisholm, M. H.; Turro, C. "The Photophysical Properties of Quadruply Bonded M2 Arylethynylcarboxylate Complexes." The International Molecular Spectroscopy Symposium, Columbus, OH, June 2009.

Ghosh, Y.; Chisholm, M. H.; Liu, Y.; Alberding, B. G.; Turro, C.; Gustafson, T. L. "Metallo-Thiophenes with Novel Electronic and Optical Properties: Photoharvestors in Solar Cells." Central Regional Meeting of the American Chemical Society, Cleveland, OH, May 2009.

Reed, C. R.; Chisholm, M. H.; Turro, C. " Incorporation of Ethynylaryl Carboxylates into Quadruply Bonded M2 Complexes." 237th ACS National Meeting, Salt Lake City, UT, March 2009.

Chisholm, M. H. "Sexithiophenes Mediated by MM Quadruple Bonds: MM = Mo2, MoW and W2." 237th ACS National Meeting, Salt Lake City, UT, March 2009.

Reed, C. R.; Chisholm, M. H.; Turro, C. "Synthesis and Photophysical Properties of Triply Bonded Dirhenium(II,II) Complexes." 40th Central Regional Meeting of the American Chemical Society, Columbus, OH, June 2008.

Chisholm, M. H.; Patmore, N. J.; Singh, N. Synthetic, "Electronic and Spectroscopic Studies of Molecular Assemblies with Quadruply Bonded Molybdenum Units." 40th Central Regional Meeting of the American Chemical Society, Columbus, OH, June 2008.

Burdzinski, G.; Chisholm, M. H.; Chou, P.-T.; Chou, Y.-H.; Ghosh, Y.; Gustafson, T. L.; Ho, M.-L.; Liu, Y.; Ramnauth, R.; Turro, C. "Syntheses and Photophysical Properties of Thiophenes Incorporating Quadruply Bonded Metal-Metal Complexes." 40th Central Regional Meeting of the American Chemical Society, Columbus, OH, June 2008.

Mier, L. M.; Ghosh, Y.; Carter, A. R.; Chisholm, M. H.; Epstein, A. J.; Gustafson, T. L. "Electron Transfer Dynamics Between 9-Anthracenecarboxylic Acid and TiO2 Nanoparticles with Applications for Novel Photovoltaic Devices." 40th Central Regional Meeting of the American Chemical Society, Columbus, OH, June 2008.

Chisholm, M. H. "Electron Delocalization in Ground-, Photoexcited- and Redox States Involving M2 Delta - Organic Pi Systems." 235th ACS National Meeting, New Orleans, LA, April 2008.

R. Bryan Sears, Claudia Turro, Joseph Heremans, Duxin Sun, Edward Martin Jr. "Development of An Intra-Operative Probe for near-IR Detection of Occult Cancer Tissue". Central Regional Meeting of the American Chemical Society, Columbus, OH, June 2008.

P.A. Truitt, R. Talwar, E. Johnston- Halperin, N. Abdullah, C. Reed, N. Singh, C. Chatterjee, M. Chisholm, "Magnetic and Surface Studies of Transition Metal Complexes for Molecular Spintronics," March 2009, March meeting of the American Physical Society, Pittsburgh, USA.

S. Parks, "Structural Characterization of Spin-Torque Osciallators,"March 2009, March meeting of the American Physical Society, Pittsburgh, USA.

Ke Li. "Sub-lithographic Patterning of Extended Arrays of Graphene Nanostructures," March 2009, March meeting of the American Physical Society, Pittsburgh, USA.

P.A. Truitt, S. Parks, K. Li, A. Hauser, J. Ciraldo, J. emerick, F.Y. Yang, E. Johnston-Halperin, “Structural Characterization of Spin-Torque Oscillators and Arrays” September 2008, Joint European Magnetic Symposia 2008, Dublin, Ireland.

E. Johnston-Halperin, J. Pelz, “Evaluating Materials for Molecular Spintronics Applications” September 2008, Gordon Research Conference on Magnetic Nanostructures, Aussois, France.

S. Parks, “Characterization of Spin-Torque Oscillators and Arrays” September 2008, Gordon Research Conference on Magnetic Nanostructures, Aussois, France.

W. Lu, “Surface Functionalization of III-Nitride Semiconductors for Biosensor Applications,” 2007 International Workshop on Semiconductor Surface Passivation.

X. Wen, S. Wang, L.J. Lee, and W. Lu, “AlGaN/GaN heterostructure field effect transistors for label free detection of DNA hybridization”, 2007 Nanoelectronic Devices for Defense and Security.

X. Wen, M. A. Elias, J. P. Shapiro, L. Mosbacker, S. K. Gupta, S.C. Lee, L.J. Brillson, and W. Lu,”Surface Functionalization of AlGaN for Biosensor Applications”, 2007 Electronic Materials Conference.

J. P. Shapiro, S. Gupta, E. Eteshola, M. Elias, L. Brillson, X. Wen, W. Lu, S. C. Lee, “Challenges in Optimization of Nanobiothechnological Devices Illustrated by Partial Optimization of a Protein Sensor”, The 2nd International congress on nanobiotechnology and nanomedicine, 2007.

N. Padture, “Carbon Nanotubes and Graphene,” International Workshop on Mechanics-Based Design of Advanced Materials, Composites and Coatings, Perth, Australia, July 2008.

N. Padture, W. Windl, Structural and Functional Nanocomposites with Hierarchical Structures in 1-D, 2-D, and 3-D,” MS&T ’08, Pittsburgh, PA, October 2008.

N. Padture, W. Windl, “Center for Emergent Materials, A NSF-Funded Materials Research Science and Engineering Center at the Ohio State University,” NSF MRSEC Director’s Meeting, Arlington, VA, October 2008.

N. Padture, W. Windl, “Towards Rational Tailoring of Functional and Structural Nanomaterials: Nanowires (1-D), Graphene (2-D), and Nanocomposites (3-D),” Northwestern University, Evanston, IL, November 2008.

N. Padture, W. Windl, “Towards Rational Tailoring of Functional and Structural Nanomaterials: Nanowires (1-D), Graphene (2-D), and Nanocomposites (3-D),” University of Michigan, Ann Arbor, MI, January 2009.

N. Padture, W. Windl, “Novel Concepts in Structural Ceramics: Thermal Barrier Coatings and Contact-Damage-Resistant Ceramic Nanocomposites,” Case Western Reserve University, Cleveland, OH, February 2009.

N. Padture, W. Windl, “Towards Rational Tailoring of Functional and Structural Nanomaterials: Nanowires (1-D), Graphene (2-D), and Nanocomposites (3-D),” University of Seville, Seville, Spain, March 2009.

N. Padture, W. Windl, “Towards Rational Tailoring of Functional and Structural Nanomaterials: Nanowires (1-D), Graphene (2-D), and Nanocomposites (3-D),” University of Extremadura, Badajoz, Spain March 2009

V. Subramaniam. "Sound propagation in light-modulated carbon nanosponge suspensions", European Materials Research Society Meeting held in Warsaw, Poland in September 2008.

C. Turro, PACIFICHEM, symposium on Metal-Nucleic Acid Interactions, January 2010, Hawaii.

C. Turro, “Intra-Operative Fluorescence for Cancer Detection”, Massachusetts Institute of Technology, Department of Chemistry, June 2009.

C. Turro, “Intra-Operative Fluorescence for Cancer Detection”, Rice University, Department of Chemistry, April 2009.

C. Turro, R. Bryan Sears, “Intra-Operative Fluorescence for Cancer Detection”, Central Regional Meeting of the American Chemical Society, Columbus, Ohio, June 2008.

C. Turro, “Intra-Operative Fluorescence for Cancer Detection”, Kansas State University, May 2008.

S. Modi, K. Koelling, and Y. Vodovotz, "Thermal and Rheological Properties of PHB Synthesized with Various Hydroxyvalerate Content for Potential Use in Food Packaging", Antec Conference Proceeding in May 2009