Spring/Summer 2012 IMR Facility Grants

Awarded by the OSU Institute for Materials Research (IMR)

Six new research projects were awarded by the IMR in June 2012, for a total investment of $12,000 in nascent materials research. The six projects support faculty researchers from five different departments within the College of Engineering and the Division of Natural and Mathematical Sciences.

Study of Fast Neutron Irradiation Effects on GaN using Depth-resolved Cathodoluminescence Spectroscopy

Lei (Raymond) Cao, Mechanical and Aerospace Engineering

Gallium Nitride (GaN) is a radiation hard material that has unexplored potentials to be used as a neutron detector in harsh radiation environment. In this study, we will investigate the effects of radiation on semi-insulating (SI) and undoped GaN using depth-resolved cathodoluminescence spectroscopy (DRCLS) to measure the lattice defects due to neutron irradiation. The relationship between two main defects, termed "yellow line" (YL) and "blue line" (BL) band will be investigated with different annealing temperature to determine the evolution of the irradiation-induced defects in GaN. In addition to the specified goals to be achieved in this project, the research also aims to obtain preliminary data that could enhance proposals to meet high priority goals of several federal agencies.

In-situ detection of CO_2 reduction intermediates

Anne Co, Chemistry

The detection of reaction intermediates for identifying the mechanistic pathway of a chemical reaction is crucial in the development of more selective heterogenous catalysts. In this work, our goal is to utilize surface enhancing nanoporous copper foams as an ideal substrate for identifying the reaction intermediates of the electroreduction of CO_2.

Single- and Few-layer transport measurements of Group 14 Graphane Analogues

Joshua Goldberger, Chemistry

Graphene's success has shown that it is not only possible to create stable, single-atom thick sheets of a layered material, but that these materials can have fundamentally different electronic structures than their parent that are significantly influenced by the environment. With this IMR facilities grant, we will develop the capabilities of measuring the transport properties of single-atom and few-layer thick Group 14 graphane analogues, with a particular emphasis on H- and organic-terminated germananes. We have successfully synthesized H-terminated germanane and have shown that it has a 1.55 eV direct band gap, that can be tuned from 1.3-1.6 eV depending on the surface functionalization, which is in sharp contrast to the 0.67 eV indirect gap of bulk Ge. These electronic measurements will allow us to understand the extent to which we can manipulate the band structure with surface termination.

Single Cell Culture Wells (SiCCWells) for combinatorial approaches to cell biology

Derek Hansford Biomedical Engineering

It is proposed to fabricate and evaluate microdevice platforms that allow combinatorial culture of individual cells or clusters of cells for biological studies. This application is for the facilities access and materials to fabricate prototype single cell culture wells (SiCCWells) to produce preliminary results for proposals to the NIH. Studies showing the controlled dosage of toxin to individual cells on multiple platform devices will demonstrate the uniformity of devices and their ability to dose a known amount of chemical to each cell.

Development and characterization of a novel direct patterning technique for graphene using Dip-Pen Nanolithography

Ezekiel Johnston-Halperin, Physics

Since its experimental discovery by Geim and Novoselov in 2004, the single atomic layer of graphite known as graphene has proved to be an extremely promising material for next-generation technology due to a high electron mobility, large thermal conductivity, durability, and long spin lifetime. Since graphene is only one atomic layer thick, its properties are strongly influenced by any materials it comes into contact with. While this can prove useful in many situations, it also makes it difficult to pattern graphene using typical forms of lithography such as photo- and electron beam-lithography, which tend to leave damaging resist residues on the surface. We propose the development of a direct patterning technique known as Dip-Pen Nanolithography where the fine tip of an Atomic Force Microscope cantilever is used as a pen to transfer a solution the polar solution of $CoCl_2$ in agarose to the graphene surface. This direct patterning will act as a non-volatile electrostatic gate, restricting the flow of electrons to channels, allowing the study of nano- and micro- scale charge and spin interaction in graphene.

Using Nanostructured Aerogel Films for Improved Performance of Metal Oxide Gas Sensors

Patricia Morris, Materials Science & Engineering

The objective of this project is to use a continuous aerogel film as a gas sensing element, which has never before been reported. Aerogels are ultra-lightweight materials synthesized by sol-gel chemistry and are generally composed of metal oxides which exhibit high porosity and extremely high surface area, a critical characteristic in gas sensor performance. By using existing in-house deposition systems, this work seeks to create an aerogel-structured gas sensor with a two- or three-fold increase in usable surface area over current sensing oxide structures. Once proof of concept has been established, this work can use the highly-customizable aerogel chemistries to create devices optimized for applications as dictated by external funding agencies.