Winter 2016 IMR Facility Grants Awards

Six new research projects were awarded by the IMR in January 2016, for a total investment of $12,000 in nascent materials research. The six projects support eleven faculty researchers from five different departments within the College of Engineering, College of Arts and Sciences, and College of Medicine.

Analytical TEM for Physiological vs. Pathological Iron Core

Gunjan Agarwal, Biomedical Engineering; Co-Investigators: David McComb, Materials Science and Engineering; Dana McTigue, Neuroscience

This project aims to use analytical electron microscopy techniques to evaluate the mineral composition of ferritin iron core in mammalian tissue(s) under pathological versus physiological conditions.

LIPSS and SIPSS: Novel Surface Patterning Processes for Materials

Sheikh Akbar, Materials Science and Engineering; Co-Investigator: Enam Chowdhury, Physics

The proposed work involves an interdisciplinary study of two novel techniques (LIPSS and SIPSS) that can lead to the spontaneous formation of surface patterns. These two processes take place in very different time scales (femtoseconds for LIPSS, hours for SIPSS), however, can result in very similar features. The main objective of the proposed work is to fill gaps in the current mechanistic understanding of LIPSS formation by performing careful materials characterization. The role of stress in the LIPSS formation will also be examined by strain mapping and annealing experiments to test our hypothesis that LIPSS is a type of laser-activated SIPSS.

A Micro/Nanofabricated Platform for Enhanced Gene Delivery: Applications in Cell-based Therapies

Daniel Gallego Perez, Surgery; Co-Investigator: Savita Khanna, Surgery

The proposed research focuses on the development and fabrication of silicon-based platforms for non-viral transduction of genes into cells in a controlled and benign manner. Such genes will be delivered with the intent to induce directed cell reprogramming of fibroblasts into excitatory neurons that could potentially be used in regenerative medicine applications. These platforms will be tested within the context of stroke research, where gene-transduced cells will be stereotactically-implanted into the brains of stroked mice. Brain tissue repair and/or remodeling in response to cell delivery will be characterized via immunofluorescence microscopy.

Development of Photonic Crystals for the Investigation of Magneto-Optical Properties in 2D Materials

Ezekiel Johnston-Halperin, Physics

This project will focus on the development of successful fabrication strategies for the creating of photonic crystal structures in SiOx and SiNx substrates. These photonic structures will be coupled to various 2D materials by exfoliation and transfer, enabling both higher fidelity measurement of their optical properties and the inclusion of active optical functionality (such as gain and chirality selection) in the integrated photonic structures.

Quantification of the Effect of Active Beta Phase Grain Boundary Coverage on Fatigue in Simulated Marine Environments

Jenifer S. Locke, Materials Science and Engineering

Al-Mg alloys, identified as 5xxx alloys, are used in naval applications and susceptible to a process called sensitization, which leads to greatly reduced resistance to intergranular corrosion and corrosion fatigue. Sensitization is a process by which unsuitable combinations of time and temperature cause precipitation of a detrimental beta (β) phase on grain boundaries of Al-Mg alloys. Preliminary work is being conducted which establishes that time spent at elevated temperatures accelerates corrosion fatigue crack growth, but the link between crack growth and sensitization needs to be verified. This work proposed here aims to conduct scanning electron microscopy on intergranular surfaces to quantify the percent grain boundary area occupied by β phase and correlate it with the measured resistance to corrosion fatigue.

Sample Fabrication for BEEM Studies of Contacts to 2D Materials

Jonathan Pelz, Physics; Co-Investigator: Roland Kawakami, Physics

The research team will use the NanoSystems Laboratory (NSL) facilities to fabricate Au/MoS2/graphene samples for nm-resolution studies of Au/MoS2 Schottky contacts using Ballistic Electron Emission Microscopy (BEEM). Large local variations in contact properties can significantly alter performance of devices made from 2D semiconductors such as MoS2, produced by factors such as local variations in 2D film thickness, local defects or disorder in the 2D film, or defects in the device substrate. BEEM should allow direct measurement of such local variations, which has not been possible in prior studies. These proof-of-principle measurements will be critical for future proposals to the NSF to study contact effects in 2D material device structures.