Fall 2013 IMR Facility Grants

Awarded by the OSU Institute for Materials Research (IMR)

Ten new research projects were awarded by the IMR in December 2013, for a total investment of $20,000 in nascent materials research. The ten projects support faculty researchers from seven different departments within the College of Engineering, College of Arts and Sciences, College of Medicine, and College of Food, Agricultural and Environmental Sciences.

Collagen Ultrastructure by AFM

Gunjan Agarwal, Biomedical Engineering

This project aims to employ atomic force microscopy (AFM) to understand ultrastructural differences between collagen fibers in the aorta from DDR1 knockout vs. wildtype mouse. In particular the depth of D-periodicity of collagen fibers will be analyzed using AFM, which is not possible by other microscopic techniques.

Nano-Textured Biomaterials for Enhanced Stem Cell Adhesion and Growth

Sheikh Akbar, Material Science and Engineering; Co-Investigator: Mahmood Khan, Department of Internal Medicine, Division of Cardiovascular Medicine

This project seeks to use a new, inexpensive and highly scalable nanowire growth technique to modify the surface of titanium bio-implant materials and study the interaction between bone-derived stem cells and the nano-textured environment. Mesenchymal stem cells (MSCs) can differentiate into several specific types of tissue and organ cells, and are typically cultured on a flat surface before injection into the body. These nano-textured surfaces will grow the MSCs in a 3D environment more similar to the body, likely increasing cell survival rate after injection. Additionally, increased cell adhesion to this textured surface should provide a firmer contact between a titanium implant and the surrounding environment. The optimal nano-textured morphology for cell growth and adhesion will be examined.

Identifying Nucleation Species for Microporous Materials

Nicholas Brunelli, Chemical & Biomolecular Engineering

The structure of microporous materials is intimately related to the resultant material properties. The mechanism through which these complex structures form is not well understood. This project will utilize the core facilities to identify key species responsible for the crystallization and growth of microporous materials.

Electroactive Thin Films for Energy Storage

Anne Co, Chemistry

The objective of this proposal is to create electroactive thin films that exhibit well-controlled current profiles which would allow for the systematic investigation of the lithiation mechanism of a Sn-based high capacity anode material for Li-ion battery applications. Specifically, the proposed study will focus on understanding the formation/removal mechanism of the solid electrolyte interface (SEI) on Sn during lithiation and delithiation processes using an in-situ electrochemical quartz crystal microbalance verified with vibrational spectroscopy. The outcome of this study will further our understanding of SEI formation and will strengthen the proposal to be submitted to DOE on a related topic.

Electrospinning Natural Rubber and Plastic Polymer Blends for the Creation of Nanofibers

Katrina Cornish, Horticulture and Crop Science

We are electrospinning natural rubber and plastic polymer blends to create nanofibers. We have prepared polymer blends while varying solution concentration and the ratio of polymers to determine how the resulting electrospun nanofibers differ in fiber morphology, mechanical properties, and thermal properties. These blended and spun materials will be microscopically analyzed and compared to our pure plastic and natural rubber nanofibers. Applications may include: 1) biological scaffolds, 2) drug delivery, 3) filtration, 4) nano-scale electronics, and 5) construction materials.

Phase-Change Materials (PCMs) for Millimeter-Wave and Terahertz Reconfigurable Devices

Nima Ghalichechian, ElectroScience Laboratory

Phase-change materials (PCMs) are a promising candidate for reconfigurable RF microsystems in which the electrical properties of the material are transformed at different temperatures. The change in resistivity and permittivity can be employed in realization of millimeter Wave (mmW) and terahertz reconfigurable filters, switches, antennas, and RF circuits used in sensing, imaging, wireless, and satellite communications. We propose to develop a thin-film growth fabrication process for vanadium dioxide PCM and study the material and electrical properties of the fabricated films.

Development of Electron Channeling Contrast Imaging

Tyler Grassman, Materials Science and Engineering

Transmission electron microscopy (TEM) based micro- and nano-scale structure and defect characterization is an integral aspect of advanced electronic materials development. However, due to the high degree of sample prep required by such techniques, as well as a number of experimental limitations, such characterization can also often lead to significant bottlenecks in research progress.

Electron channeling contrast imaging (ECCI), which utilizes relatively standard scanning electron microscopy (SEM) instrumentation to yield TEM-like results, but in a fraction of the time, is a promising technique for high-throughput defect and microstructure analysis. The project proposed here will serve to further the development and implementation of ECCI at OSU's CEMAS facility by working to both improve our understanding and execution of the technique and to explore its use in a wider range of experimental conditions and objectives.

A Multifunctional Scaffold System for Periodontal Tissue Regeneration

Jianjun Guan, Materials Science and Engineering

The goal of this project is to create a novel scaffold system that will simultaneously induce endogenous regeneration of multiple periodontal tissues that have inherent low regenerative potential. Periodontal tissues are critical tooth supporting structures. The created scaffold system will not only recruit endogenous cells to the periodontal defects, but also guide the recruited cells to regenerate alveolar bone, periodontal ligament (PDL) and gingiva. The proposed studies will generate broader impacts on endogenous regeneration of tissues for disease treatment.

Interfacing Cells with Nitride Semiconductors

Wu Lu, Electrical and Computer Engineering

Critical needs in the area of cell biology and engineering center on providing quantitative outputs of biological activities. In the rapidly expanding interface between engineering and medicine, device capabilities have outstripped the ability of traditional biological methods to keep pace. This IMR Facility Grant project is to establish an engineered platform on III-nitride semiconductors to study the electrophysiology activities of living cells in a non invasive manner for exploration of the interface of living and engineered systems.

The Self-Assembly of Nanostructured Redox Gradients for Light Harvesting

Jon Parquette, Chemistry

The goal of this work is to establish a reliable strategy for the self-assembly of small, molecular building blocks into multiscale, multifunctional superstructures that capture, transport and process energy. Specifically, we will create self-assembled nanostructures containing bicontinuous donor/acceptor (D/A) heterojunctions with multichromophore gradients in the electron transport channel. We would like to understand the relationship between the nature and type of intermolecular interactions within the nanostructures and the corresponding electronic properties, measured using ensemble and single-molecule femtosecond spectroscopic techniques via our collaborative efforts with Co-PI Prof. David Modarelli (University of Akron).