

IMS Associates Program Annual Meeting Schedule

May 27, 2009- All AM activities in IMS 20

9:00 - 9:15 Harris Marcus, IMS Director and Ed Kurz, IMS Associates Program Director

9:15 - 9:55 – Mark Aindow, Professor and Director of the Materials Science and Engineering Program, Overview of the Activities of the MS&E Program

9:55 -10:35 – Greg Sotzing, Associate Professor and Director of the Polymer Program, Overview of the Activities of the Polymer Program

10:35 - 10:50 Break

**10:50 – 11:15 Doug Adamson, Associate Professor, Chemistry
“Model polymers: synthesis, self-assembly, and nanofillers”**

Materials and structures at the nanometer length-scale, formed either by self-assembly or disassembly, will be presented. Self-assembled structures are produced using well-defined block copolymers as building blocks. These polymers are produced using anionic polymerization techniques in our lab. The structures and materials are typically bio-inspired and include vesicles, enzyme mimics, and ordered patterns for lithography at the nanometer scale. The disassembled materials are functionalized graphene sheets used as multifunctional nano-fillers to impart mechanical strength, barrier properties, and conductivity to polymer matrixes.

**11:15-11:40 Menka Jain, Assistant Professor, Institute of Materials Science and Department of Physics
“Functional Oxide Materials: Structure-Property Correlations”**

A wide variety of functional oxide materials in thin film form and powders are synthesized using chemical solution technique. With skilled chemical manipulation, metal-oxides with versatile perovskite structure can produce an incredibly wide array of phases with totally different functions such as ferroelectricity, ferromagnetism, metallic conductivity, etc. The physical properties, such as tunability, dielectric loss, magnetoresistance, and magnetic behavior, of these films highly depend on composition, grain size, crystalline quality, strain state of the film. Further, careful engineering of the nanostructured composites with multifunctional properties, which are unachievable in single phase materials, can lead to their applications in multifunctional devices.

11:40 – 12:05 Yao Lin, Assistant Professor, Chemistry
“Devising supramolecular architecture for medical and energy related applications”

Nanotechnology-based approaches are now poised to revolutionize biology and medicine, as nanotechnologies offer the means to study and control biological processes on the appropriate size scale. On the other hand, the biological world still has much to teach us about the synthesis and integration of functional complex nanomaterials. For example, biological systems are far more sophisticated in directing different biomolecular processes (e.g., self-assembly, molecular recognition, protein regulation and catalytic activities) in a dynamic and cooperative manner. My research interests are to establish material platforms that will bring in such biological characteristics for technology applications. Two examples will be given: 1) use polymer chains to artificially regulate proteins for biomedical applications; and 2) engineer catalytically superior enzyme-polymer complexes for economical conversion of cellulosic biomass to fuels.

All PM activities in Jorgensen Gallery

12:05-1:00 Lunch

1:00 -1:15 **Status of the Associates Program – Ed Kurz**

1:15- 2:15 –**Student research presentations**

Michael Invernale – “Electrochromic Polymers”

The Sotzing Group researches a broad range of electroactive materials for electrochromic applications. Synthetic monomer and polymer design forms the backbone of our research efforts, whether it be making new chromophores for optical applications or highly conductive polymers, like PT34bT, commercialized with Air Products and Chemicals. Many devices and device architectures have been developed by our group, including an Army Goggle program commercialized through Triton Systems. We are currently developing electrochromic textile applications, as well. This presentation and its movies gives a brief glimpse into the sorts of devices built and tested by our group.

Jacquelynn K. McGuinness Garofano – “Characterization of microstructural effects in percussion laser-drilled powder metallurgy (P/M) Ni-based superalloy IN100”

Percussion laser drilling is a well-established technique for drilling cooling holes in gas turbine engine components and airfoils. Laser machining can, however, lead to a range of complex metallurgical effects particularly in the recast layer and heat-affected zone (HAZ) that may surround the drilled hole. It is important to understand these effects since the recast and HAZ could have a deleterious effect upon the mechanical properties of laser-drilled components. High-resolution electron microscopy techniques have been used to characterize the microstructural changes that occur during percussion laser drilling of powder metallurgy (P/M) IN100, a Ni-based superalloy. For holes drilled using typical conditions, there is a recast layer 10 – 25 μ m in thickness on the hole walls, the interface between the recast layer and base metal is abrupt, and there is no discernable heat-affected zone in the base metal. The recast layer exhibits a dendritic FCC structure with microsegregation of Al and Ti, but no L12 ordering.

Darlington Abanulo - “Facile Chirality Separation of Single Wall Carbon Nanotubes”

The chirality of single-walled carbon nanotubes (SWNTs) affects many of their physical and electronic properties. Current growth methods result in nanotubes of mixed chiralities, so facile separation of specific chiralities of SWNTs is a challenging and important step in their effective utilization. Recently, we reported that flavin mononucleotide (FMN), the phosphorylated form of vitamin B₂, imparts an effective helical wrapping around SWNTs (*Nature Nanotech.*, 3, 356-362 (2008)). Despite its low molecular weight, the isoalloxazine ring of FMN enables it to cooperatively bond with adjacent isoalloxazine moieties and form a helical ribbon, which organizes around SWNTs through concentric π - π interactions between FMN and the underlying graphene structure of carbon nanotubes. This unique interaction ultimately leads to an 85% chirality enrichment of (8,6)-single-walled carbon nanotubes using a simple surfactant replacement and salt-out precipitation process. In this paper, we briefly introduce the current state-of-art in nanotube separation and contrast it with the flavin-based enrichment method. The stability of the flavin helical assemblies will be addressed using molecular simulation, as well as related to the unique optical spectra of the resulting nanotube suspensions. Current research direction to separate different chirality using various surfactants will be also discussed. Last but not least, recent efforts to disperse nanotubes in organic media will be addressed in order to expand the versatility of the flavin-based assembly to new directions. Financial Support from AFOSR is kindly acknowledged.

Fei Peng, Mei Wei - "Hydroxyapatite/Polymer Scaffolds for Bone Repair".

Human bone is a hybrid of hydroxyapatite (HA) nanoparticles and type I collagen nanofibers, which assembles into a highly porous structure with interconnected pores. The lamellae of HA nanoparticles are aligned along the long axis of collagen fiber and contribute to strong mechanical properties of bone. Therefore, much attention has been directed at preparing porous HA/polymer scaffolds as a prospective candidate for bone tissue engineering. In our group, an HA/Poly(L-lactide) (PLLA) scaffold with 3D interconnected porous structures and dual-scale alignments, including a nano-scale HA alignment within fiber matrix and a micro-scale fiber alignment, was fabricated using the electrospinning technique. Both of the nano- or microsized HA particles and the two alignments were found to significantly enhance the mechanical strength of the composite scaffolds. The rat osteosarcoma cell culture results indicated that the scaffolds not only have good cytocompatibility but also good cell signaling properties. A fluorescein isothiocyanate labeled bovine serum albumin (FITC-BSA) was used as a model protein and incorporated into the scaffold by a one-step biomimetic apatite coating method. Its release profile through an 8-week period demonstrated that the scaffolds with the protein/apatite coating were effective carriers for sustained release of proteins. Moreover, a highly porous HA/type I collagen scaffold with interconnected pores was prepared using a one-step in situ co-precipitation technique at a mild temperature. Its cytocompatibility was evaluated by *in vitro* cell culture carried out using mouse calvaria osteoblast (mCOB). After 5-day culture, more mCOB cells were observed attaching and proliferating on the surface of the scaffold instead of on that of the culture dish. After 10-day culture, cells were found growing into the top layer of the scaffold. The bone forming property of the scaffold was evaluated in a novel mouse calvaria model. After a 28-day implantation period, new bone was formed in the defects with both Healos® as the control and the test scaffolds.

2:30 IMS Tour