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Dolan Science Center
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University Heights, Ohio

Joint Session I (Keynote)

Mineralization of the Verbebrate Skeleton and Teeth: A Possible Role for the Small, Non-Collagenous Protein, Osteocalcin, Deduced from Electron Microscopy and Immunocytochemistry

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Mineralization of vertebrate tissues such as bone, dentin, cementum, and calcifying tendon involves type I collagen, which has been proposed as a template for calcium and phosphate ion binding and subsequent nucleation of apatite crystals. Type I collagen thereby has been suggested to be responsible for the deposition of apatite mineral without the need for non-collagenous proteins or other extracellular matrix molecules. Based on studies in vitro, the small, non-collagenous protein, osteocalcin, is thought to mediate vertebrate mineralization associated with type I collagen. Osteocalcin, as possibly related to mineral deposition, has not been definitively localized in vivo. The presentation here identifies osteocalcin and its localization in the leg tendons of avian turkeys, a representative model of normal vertebrate mineralization. Immunocytochemistry of osteocalcin demonstrates its presence at the surface of, outside and within type I collagen fibrils. The association between osteocalcin and type I collagen structure is revealed optimally when calcium ions are added to the antibody solution in the immunocytochemical methodology. In this manner, osteocalcin is found specifically located along the a4–1, b1, c2 and d bands defining in part the hole and overlap zones within type I collagen. From these data, while type I collagen itself may be considered a stereochemical guide for intrafibrillar mineral nucleation and subsequent deposition, osteocalcin bound to type I collagen may also possibly mediate nucleation, growth and development of platelet-shaped apatite crystals. Osteocalcin immunolocalized at the surface of or outside type I collagen may also affect mineral deposition in these portions of the avian tendon. Possible direct involvement of osteocalcin with type I collagen is a novel role for this small protein in normal vertebrate mineralization events in vivo.

Presentation IA-1 (Invited)

Applications of *In Situ* Environmental Transmission Electron Microscopy in Catalysis

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The chemical reactions between gas and particles solid are important for many industrial applications such as catalysis, fuel reaction, gas sensing, etc. In this study, a redox reaction, that of hydrogen gas and ceria (CeO2) nanoparticles, has been studied in situ at the atomic level using an environmental transmission electron microscope. Real-time in situ electron microscopy techniques have been employed to make controlled microscopic observations of the reaction morphology, structure and chemistry of CeO2 nanoparticles during the redox processes by temporally and spatially resolved high-resolution imaging, diffraction, and spectroscopy. The dynamic in situ visualization are correlated with shape/size-reactivity macroscopic chemisorption characterization (temperature-programmed reduction, oxidation, and desorption) and activity test in a chemical reactor, for obtaining essential insights into reaction active sites, transient states, and reaction pathways.

Presentation IA-2

Early Stage Na_2SO_4-Induced Type II Hot Corrosion Behavior of Pt/Cr-Modified β-NiAl Alloys at 700°C

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Early-stage scaling behavior (up to 20 hours) of Ni-36Al alloys containing 5 at % additions of Cr or Pt undergoing Na_2SO_4-induced hot corrosion at 700°C was systematically studied using transmission electron microscopy (TEM). The model compositions studied are of relevance to β-NiAl coatings used in practice to protect Ni-based superalloys. The addition of the minor elements significantly changed the hot-corrosion behavior compared to that of the base alloy. The base alloy formed a dense Al_2O_3 scale, which failed locally, forming irregularly-spaced nodules. The Cr-containing alloy formed the most uniform corrosion products, but it also underwent severe sulfur attack to the extent that it had the poorest early-stage, hot corrosion resistance. The alloy containing 5 at % Pt formed a dense, comparatively thin Al_2O_3 oxide layer, and exhibited the best early-stage, hot corrosion resistance.

Presentation IA-3

Visualizing the True Structure of Materials with Quantitative 3D EDS Microanalysis

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Dual Beam focused ion beam instruments are now an industrially prevalent and important tool for the microanalytical characterization of materials. A wide variety of applications from subsurface defects in the semiconductor industry to a growing understanding of the three dimensional analysis of material structure are now commonly observed. Data collection routines facilitate large volume collection of serial sections, which now brings the focus of the work to analytical reconstruction of the data. Until now, only the images collected from elemental, phase or EBSD-orientation maps have been rendered into volumetric datacubes. With the latest technology, the serial dataset now becomes a full-spectrum 3D datacube. Using this format, analysts can now identify characteristics of interest (elements, energy ranges) and extract 3D volumetric points from the data cube for subsequent spectral and quantitative analysis. The result is a true quantitative analysis of the entire volume of a feature. In this presentation, multilayer solar films and rare earth inclusions in steel will be explored in depth.

Presentation IB-1 (Invited)

Vibrational Spectroscopy of Adsorbed CO_2 on the Surface of Nanostructured Sorbents

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Continuing increase in atmospheric CO_2 concentration and growing recognition of CO_2 impact on climate changes call for effective approaches in capture of CO_2 from coal/natural gas-fired power plants – the most significant sources of anthropogenic CO_2. We have been developing low cost nanostructured amine sorbents for CO_2 capture where CO_2 adsorbs on the sorbent at temperature below 50°C and desorbs above 100°C. Our infrared and Raman spectroscopic studies revealed that CO_2 adsorb on amine sorbents as carbamic acid and ammonium carbamate. The former is reversibly adsorbed/desorbed at temperatures below 50°C; the latter desorbed at temperatures above 50°C. In situ infrared studies further revealed that the density of amine functional group on the sorbent surface plays a critical role in controlling the diffusion of adsorbed CO_2 and its binding energy. This presentation will also discuss how the nature of adsorbed CO_2 and the nano/meso structure of the sorbents influence the overall cost of a CO_2 capture process.

Presentation IB-2

Nanoparticle Characterization Using spICP-Q-MS and FFF-ICP-Q-MS

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The use of nanoparticles in food, consumer products, and industrial process has been accelerating, and they are finding their way onto the environment. The toxicity of these nanoparticles in the environment has become a major scientific concern. This presentation will discuss the use of a sensitive ICP-MS as a detection system for these nanoparticles. Use of the characterization tools of both Field Flow Fractionation (FFF) ICP-MS and Single Particle (SP) ICP-MS will be presented. The utilization of the high sensitivity provided by the Thermo Scientific iCAP Q ICP-MS system will also be discussed as it applies to this specific application.

Presentation IB-3

Liquid Crystals Confined in Micro- and Nano-Channels

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Liquid crystals, characterized by long range orientational ordering, are sensitive to geometric confinements as mismatches between the boundary conditions and the orientation order in the bulk leads to frustration and formation of various defects. For chiral nematic liquid crystals, the interplays between cholesteric pitch, confinement size and the length scale determined by the ratio between elastic constants and anchoring strength make possible to control various defect structures by using confining geometries. We developed a simple and robust process for fabricating micro- and nano-channels with different sizes and aspect ratios, and study the behaviors of cholesteric liquid crystals in such micro and nano-channels. Liquid crystal cells with thickness down to 100nm are fabricated, and both homeotropic and planar alignment are realized with different methods. I will present experimental results of cholesteric liquid crystals confined in micro- and nano-channels with different confinement ratios.

Presentation IC-1

Shedding Light on Water and Ice Interactions With Solid Surfaces

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Ice adhesion on surfaces presents a myriad of problems to modern infrastructure. It hinders operation of wind turbines, ships, and HVAC system. Ice formation on airfoils and compression inlets of engines at about 9000-20000 ft. can cause airplanes to lose significant altitude when the airplane is bombarded with super-cooled water droplets. Because of these consequences, considerable effort has been devoted to developing icephobic materials. Despite these efforts, current methods of ice prevention are either cost intensive, ineffective or environmentally unfriendly. Due to this, it is imperative that in-depth molecular studies be performed to elucidate the underlying mechanism of ice nucleation on surfaces. We have performed the first molecular studies of ice formation using sum frequency generation (SFG) spectroscopy. SFG, a second-order non-linear technique; is able to collect information only at surfaces and interfaces. We have observed that the structure of water and ice molecules near surfaces is a function of pH and the surface charge. In this talk, the fundamental mechanism of how charges affect ice structure will be discussed. Moreover, the phase separation phenomenon of salt solution next to solid surfaces is elucidated. Our results offer novel insight on how the solid surface can influence ice formation and their implication on designing ice repellent or resistant materials.

Reference:

Emmanuel Anim-Danso, Yu Zhang, Azar Alizadeh, Ali Dhinojwala. *J. Am.Chem. Soc.* **2013,***135*, 2734-2740

Presentation IC-2

PolScope Made Easy, Inexpensive and Versatile

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Birefringence map imaging of both biological and liquid crystalline samples based on PolScope principles have been performed with the aid of an inexpensive technique. This easy method overcomes the current limitations of both optical and polarizing optical microscope in finding the alignment of molecular bonds, molecular order and detailed structural form. This instrument consistently generates a retardation map (in samples with known thicknesses also provides a birefringence map) whose pixels' colors are representing the local optical anisotropy within the specimen. Most biological, liquid crystalline and polymeric structures exhibit some or an entire degree of optical anisotropy. An existing polarizing optical microscope was equipped with a homemade liquid crystal device and a controller. The polarization optical parameters (birefringence and optical axis) could be obtained at all resolved points simultaneously. The computed retardance can provide analyses of dynamic processes. The device can be utilized at wide range of applications from biology to condensed matter physics.

Presentation IC-3 (Invited)

How do Animals Inherit Their Microtubule Organization Centers?

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Centrioles are conserved microtubule-based organelles that together with pericentriolar material (PCM) form the centrosome. During oogenesis in animals, the centrioles are eliminated, and, therefore, the ovum does not contribute centrioles to the zygote. Instead, centrioles are provided to the zygote by the sperm. However, compared to centrioles in somatic cells, in many animals, including Drosophila melanogaster, the spermatozoa centriole has a different structure and/or protein composition and the origin of the zygote centrosome is not clear. Recently, we showed that Drosophila spermatozoa provide, in addition to the giant centriole (GC), a centriole precursor, which we named the proximal centriole like (PCL). The PCL resembles a centriole precursor but lacks the centriole hallmark of microtubules. In the zygote, the GC and PCL recruit maternally contributed PCM and form a centrosome. This centrosome, which is found near the male pronucleus, forms astral microtubules that reach out to the female pronucleus. Then, the female pronucleus migrates along the astral microtubules until it fuses with the male pronucleus. Later, the GC and PCL duplicate and form the poles of the zygote's spindles. When males have abnormal PCL, their fertility is reduced which associates with two distinct phenotypes in the zygote: formation of monopolar spindles and delayed embryo development. These findings demonstrate PCL is essential for zygotic centrosome function.

Yeager Award Presentation

The Secret Life of DGPP: Physicochemical Properties and Function of an Enigmatic Signaling Lipid

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Diacyglycerol pyrophosphate (DGPP), an uncommon membrane lipid found in plants and yeast but never in mammals, is formed from phosphatidic acid (PA). Phosphatidic acid concentration in plants increases as a result of stress signaling. For example, changes in the salinity of soil, freezing temperatures, or pathogen attack activate protein signaling pathways via the formation of PA. The function of DGPP during stress signaling is unclear and the enzyme that makes DGPP from PA has not been identified. We therefore set out to investigate the physiochemical properties of DGPP, specifically the ionization of the head group. These properties can then be compared with those of PA, the phospholipid from which DGPP is formed, to elucidate the function of DGPP. In a previous investigation the ionization properties of DGPP in phosphatidylcholine (PC) and mixed membranes of PC and phosphatidyl-ethanolamine (PE) were investigated. We found that charge of DGPP is higher than that of PA at constant pH in the same membrane background. In other words, the pK_{a2} of DGPP is lower than that of PA. In this previous work only PA or DGPP were present in a matrix of PC or PC/PE, unlike the physiological situation. Here, we investigate the effect of the interaction of PA with DGPP and the resultant effect on the charge of both of these signaling lipids. The results are discussed in terms of the electrostatic-hydrogen bond switch model previously described for the ionization and protein interaction of PA.

Poster Session
Biological Sciences Section

Qing Yu UAkron Dept. of Polymer Science	A Tissue-Engineered Model of a Tendon-to-Bone Enthesis
Harry Scott CWRU Dept. of Pharmacology	Elucidating the Molecular Mechanism of Anthrax Pore Formation
Rania A Elrashidy CWRU Dept. of Urology	Characterization of Myocardial Remodeling in a Rat Model of Metabolic Syndrome Biochemical and Histological Study
Elliot Pawloski, Jacob Haller LCCC Dept. of Biology	Exploring Possible Gene Therapies for HIV
Lu Zou KSU Liquid Crystal Institute	Cryogenic Electron Microscopy Techniques for Soft-Matter Materials
Kyle Whiddon UAkron Dept. of Chemistry	Rapid Assessment of Intracytoplasmic Membranes
Chinthasagar Bastian Cleveland Clinic Foundation	Age-Dependent Modifications of Axons, Mitochondrial Dynamics and Calcium Homeostasis Underlie the Vulnerability of Aging White Matter to Ischemia
Aubrie Thompson. Christopher Kazee LCCC Dept. of Chemistry	GC-MS Analysis of the Flavor of Bourbon Whiskey Produced by a Novel Accelerated Aging Process
Roger Teppert Hitachi	New Preparation Method using Ionic Liquid for Rapid and Reliable SEM Observation of Uncoated Biological Specimens
Kyoung Ha Jo UToledo Dept. of Biological Sciences	Atypical Centriole During Fertilization
Jibin Abraham Punnoose KSU Dept. of Chemistry & Biochemistry	DNA Secondary Structures in the Full-Length 3' Telomeric Overhang
Tiyash Bose CSU Dept. of Chemistry	Ruthenium-Modified Sensitive NO Sensors: Quantifying Nitric Oxide in the Pathobiology
Gaurav Amarpuri UAkron Dept. of Polymer Science	Ubiquitous Distribution of Salts and Proteins in Spider Glue Enhances Spider Silk Adhesion
Brandon Gibbons KSU Dept. of Biological Sciences	A Microscopic Study of Cell Volume Dysregulation in Apoptosis: Evidence of the Involvement of Organic Cation Transporters (OCT)
Christopher Francy CWRU Department of Pharmacology	The Mechanoenzymatic Core of Dynamin-Related Protein 1 Comprises the Minimal Machinery Required for Membrane Constriction

Physical Sciences Section

Saide Tang CWRU Dept. of Macromolecular Sci. & Eng.	Three-Dimensional Self-Assembly of Mixed Poly(*tert*-butyl acrylate)/Polystyrene Brush-Grafted Silica Nanoparticles by ElectronTomography
Nathaniel Jurcago CWRU	Chia Seed Exudate used for Separation of Oil and Water
Natasha Eklund, Caroline Oehlerich Oberlin College Dept. of Chemistry	Simple Pyrolysis Gas Chromatography of Automotive Paints
Samantha Mock, Thomas Stoner YSU Department of Chemistry	Morphological Support Effects in Metal-CeO_2 Catalysts for CO Oxidation
Adam Patkin PerkinElmer	Improved Analysis of Petroleum Isomer Distribution Using Cold EI GC/MS
Haitham Kalil CSU Department of Chemistry	Metal-Decorated Graphene for Enhanced Detection of Peroxynitrite
Young-Ki Kim KSU Dept. of Chemical Engineering	Domain Walls and Anchoring Transitions Mimicking Nematic Biaxiality in the Bent-Core Liquid Crystal C7
Neetu M. Gulati CWRU Dept. of Pharmacology	Structural Characterization of Polyethylene Glycol on Viral Nanoparticle Surface
Dingqiang Li YSU Electron Microscopy Facility	Electron Microscopy Analysis on Nano Materials, Multi-Layer Films and Novel Ceramic Composites
Qiyi Chen CWRU Dept. of Macromolecular Sci. & Eng.	Inorganic-Organic Thiol-ene Coated Mesh for Oil/Water Separation
Al de Leon CWRU Dept. of Macromolecular Sci. & Eng.	Extruded Polymer Nanosheets: Toward Mass Production of Polymer Nanosheets
Paul Advincula CWRU Dept. of Macromolecular Sci. & Eng.	Grafted Carbazole – Assisted Electrodeposition of Graphene Oxide
Andrew Davis Cameca	Characterizing Modern Nanostructures with Atom Probe Tomography
Cassandra Pittman UToledo Dept. of Biological Sciences	Virtual Field Trip: How the University of Toledo Uses Cyber Access and Sophisticated Microscopes to Create a Unique Classroom Experience
Jennifer C. Espartero CWRU Dept. of Macromolecular Sci. & Eng.	Polymer/Clay Nanocomposite: A Viable Anti-Corrosion Coating for Geothermal Applications

Presentation IIA-1

Homogeneous Nucleation and Materials Analysis of Nanodiamonds Synthesized in an Atmospheric-Pressure Microplasma

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Nanodiamonds are nanoparticles of carbon that exhibit diamond-phase structure. They possess striking physical properties similar to those of bulk and microstructured diamond, including exceptional mechanical and chemical stability, low cytotoxicity, tunable active surface chemistry, and tunable photoluminescence-inducing color centers. Nanodiamonds have been synthesized at high pressure and high temperature either by conversion of graphite or by detonating carbon-containing explosives. Here, we introduce a novel atmospheric pressure plasma method to homogeneously nucleate nanodiamonds from C-H-O-containing vapor precursors. The nanodiamonds are less than 5 nm in size in a mixture containing non-diamond carbon, creating challenges for materials analysis. In this presentation, we will discuss our efforts to characterize the nanodiamond fraction by TEM and EELS, as well as separate or purify the nanodiamond product either *in situ* by gas-phase chemistry or post growth by solution etching, followed by materials analysis.

Presentation IIA-2 (Invited)

Applications of XPS in Polymer and Surface Science

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X-ray Photoelectron Spectroscopy (XPS) is an analytical technique finding numerous applications in science and industry for analysis of surfaces and interfaces. Its intrinsic depth resolution of up to 10 nm makes it the most used surface specific technique. In addition, the capabilities of determining chemical state of elements, and elemental depth profiling in a range from tens to hundreds of nanometers make it very attractive as a universal analytical tool.

The talk will review examples of XPS applications to study different materials and to help solving problems in science and nanotechnology. Possible subjects that will be covered are analysis of polymer blend thin films, surface functionalization of polymer films, nanoparticle catalysts, photovoltaic structures, corrosion layers, etc.

Presentation IIA-3

Effects of Structural Phase Transitions on the 2D Conductivity at the Interface of Perovskite Oxides

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Conductivity at the interface of perovskite oxides such as LaAlO3/SrTiO3 is a wildly growing area of research. These interfaces are rich in phenomena including superconductivity, large negative in-plane magnetoresistance, giant persistent photoconductivity, and ferromagnetism. Although this field has seen rapid growth in the recent decade, there is yet to be a systematic study on what effect structural phase transitions in strontium titanate play on the interface. It is well understood that strontium titanate transitions from a cubic to tetragonal phase most notably at 105K, but how this effects oxide interface conductivity has yet to be reported on. Through transport measurements, we observe evidence of structural phase transitions in LaAlO3/SrTiO3 and Al2O3/SrTiO3 interfaces at 80K and 200K. These effects are enhanced when the scale of the devices is reduced to a few microns.

Presentation IIA-4

Compositional and Thickness Measurements of Thin Films in the Scanning Electron Microscope

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Thin films of various types are used as industrial and optical coatings, in biomedical research and semi-conductor devices. Different techniques from Ellipsometry to SIMS are used to determine thickness and/or composition of these films. One method, analysis of an energy dispersive x-ray spectrum generated in a Scanning Electron Microscope (SEM) or Microprobe, has been applied to thin film measurement for many years but has not been widely adopted. Previously, accurate SEM-EDS thin film measurements required expert knowledge in EDS analysis to determine proper analytical conditions and interpret results; however, development in software tools to aid the user in setting experimental parameters has now made thin film analysis in the SEM routine.

This talk gives an overview of the basic principles of SEM-EDS thin film analysis, new software tools, as well as the advantages and limitations compared to other techniques. Various applications will also be presented.

Presentation IIB-1 (Invited)

An Overview of Forensic DNA Technology

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Over the past decade, DNA testing in forensic casework has become more prevalent in a variety of cases. The sample types and surfaces from which forensic scientists are able to obtain a DNA profile continues to grow as new technologies become available. When once a large biological stain may have been required to obtain a profile, now only a few skin cells may be all that is needed. The methodology employed in forensic DNA testing involves four processes: extraction, quantitation, amplification, and analysis. Extraction may be manual, semi-automated or fully automated. Human DNA quantitation is carried out by Real-Time PCR analysis. Commercially available amplification kits allow DNA scientists to amplify the genetic locations (loci) of forensic interest using Polymerase Chain Reaction. Post amplification, data is generated using capillary gel electrophoresis. Profiles generated in a case may qualify for entry into the FBI's Combined DNA Index System (CODIS) database. The DNA Department at the Cuyahoga County Regional Forensic Science Laboratory employs the latest forensic methods in processing a variety of casework samples submitted in fatal, non-fatal, and sexual assault cases. This talk will discuss the methods used in-house, provide an overview of a homicide case, and discuss the utility of the CODIS database.

Presentation IIB-2 (Invited)

Drugs: The Underbelly of Our Society

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Forensic Drug Chemistry is the application of the various techniques and science of chemistry to the detection and confirmation of controlled substances in suspected drug evidence. A brief overview of the field of Forensic Drug Chemistry shall be presented including a synopsis of the technologies currently being utilized by the Cuyahoga County Medical Examiner's Drug Chemistry lab. The case study shall be presented showing how these technologies were applied and how drug chemistry analyses can assist law enforcement, the courts, and also enhance the operation of the office of Medical Examiner.

Presentation IIB-3 (Invited)

Trace Evidence at the Cuyahoga County Medical Examiner's Office

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After attending this presentation, attendees will understand the definition of trace evidence as well as the methodology used at the Cuyahoga County Medical Examiner's Office for its collection, preservation, examination, and characterization. Special focus will be given to the instrumentation (e.g. microscopy, spectroscopy) used on a daily basis in the forensic laboratory. This presentation will introduce Locard's Theory of Exchange and will detail examples of its occurrence and its inherent importance to forensic science. There are a large number of subdisciplines of trace evidence (e.g. fibers, hair, paint, adhesive tape, gunshot residue, etc.), and it would be difficult to comprehensively discuss all of them in a limited amount of time. Therefore, a single case study of fiber evidence in a motor vehicle versus pedestrian collision will be presented. Attendees will learn about the process of forensic fiber comparison and the unique challenges encountered during the work performed on the case.

Presentation IIB-4 (Invited)

The Use of Mass Spectrometry in Analytical Forensic Toxicology – Approaching the Black Box

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The role of mass spectrometry in a typical forensic toxicology laboratory will be presented. The evolution of mass spectrometry has significantly impacted analytical forensic toxicology. Gas Chromatography/Mass Spectrometry (GC/MS) improved the way toxicologists identified and quantified hundreds of illicit drugs and prescription medications. Advances in the interface between High Performance Liquid Chromatography (HPLC) and MS and subsequent improvements in LC have resulted in many forensic toxicology laboratories transitioning away from GC/MS to using LC/MS. More recently, tandem techniques such as GC/MS/MS and LC/MS/MS have provided the forensic toxicologist increased sensitivity and specificity to detect extremely low concentrations of drugs of abuse which are analytically very challenging. The future of High Resolution Accurate Mass (HR/AM) and Direct Analysis in Real Time (DART) mass spectrometers are paving the way toward the proverbial black box.

Presentation IIC-1 (Invited)

Ecological and Economic Importance of Lake Erie: The Impacts of Harmful Algal Blooms and Current Research Efforts

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Attendees will learn about harmful algal blooms including causes and impacts. This discussion will include: (1) economic importance of Lake Erie, (2) a history of Lake Erie's environmental successes and failures, (3) a description of Lake Erie's shape and land use that make it an likely candidate for harmful algal blooms, (4) a discussion about climate changes impact on harmful algal blooms, (5) a discussion about what actions can and should be taken to resolve the current harmful blooms, and (6) what research is currently being conducted.

Presentation IIC-2 (Invited)

Controlling Infectious Diseases at the Source

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Infectious disease is predicated on (1) the number of organisms that gain access to the human host, and (2) their genetic ability to compete at the cellular level (also known as their virulence). Virulence can be a function of microbial size, toxin production, exploitation of normal host structures or processes, etc. Here we examine the ultrastructure of several microorganisms to reveal structure-function (virulence) relationships. In the case of the *f*d bacteriophage virus (predator of *E. coli*), we find that self-assembly of the helical filaments, a driver of virus replication, is a function of the bent core structure, and its 30 nm layer modulation, of the major coat protein, g8p. This is similar to that of concentric smectic bent core materials. In the case of bacteria, the ability to form spores is a major virulence factor. This multi-layered structure confers UV- and disinfectant-resistance, permitting survival for thousands of years. Our studies show that disruption of key surface proteins or deposition of reactive oxygen/nitrogen species (RONS) results in decreased viability of spores. Lastly, a substantial virulence factor in bacteria is the ability to form exopolysaccharide biofilms. These materials protect bacteria from harsh conditions. Deposition of RONS on biofilm eradicates the biofilm. Thus our studies reveal new targets for control of infectious disease.

Presentation IIC-3

Characterizing Multi-layered Food Packaging with Molecular Spectroscopy

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Food packaging containers are complex multi-component structures that are designed to fulfill many requirements. The packaging must be durable enough to permit products to be transported great distances. They must block the ingress of moisture, ultraviolet radiation, microbes, and gases to prevent product spoilage and contamination. The packaging must also facilitate the sale of the product through compatibility with the printing processes deployed to inform and attract the consumer of the product. FTIR, FTIR Microscopy, and Confocal Raman Microscopy techniques were used to characterize the packaging materials of different products in order to determine the identity and thickness of the individual layers comprising the packaging. Six multi-layered packaging samples were analyzed for this study. The results of the FTIR were useful in identifying the outer layers of the packaging materials, yielded some information on inner layers but did not provide information regarding individual layer thickness. The FTIR Microscopy technique successfully identified the individual layers of the six multi-layered samples in this study and determined the approximate thickness of the layers. Confocal Raman Microscopy successfully identified and determined the thickness of the layers for the two samples attempted in the study. This paper will present the benefits and weaknesses of these methods including the hardware and software tools needed to characterize these materials. Guidance on which technique is the most appropriate for different analysis scenarios will be presented.

Presentation IIC-4

Tracing Lipids and their Association with Keratin in the Adhesive Gecko Setae by NMR Spectroscopy

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The gecko toe is one of the intriguing examples of adhesion in nature. Based on a complex structure of hairy features known as 'setae', the toe is composed primarily of keratinous material. Recently however, lipids have been found to be associated with the structure of the adhesive setae. However, the organization and the molecular-level behavior of lipids and keratin in the setae is still not known. Here, we demonstrate the use of Solid and Solution State NMR spectroscopy to detect lipids and understand their association with keratin in the molts termed as 'sheds' from the toe pad and the non-adhesive regions of the epidermal skin. Our results show a distribution of similar lipids in both the skin and toe shed but with different dynamics at a molecular level. The study has implications in understanding the organization of materials in nature and provides insight to improve fabrication for synthetic adhesives.

Presentation IIIA-1 (Invited)

Flexible Organic Transistors – Challenges and Prospects

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Organic field effect transistors (OFETs) are flexible, lightweight, and can be processed on large areas by low-cost methods. These unique properties will allow for exciting applications such as flexible and foldable displays, wearable electronics, artificial skin, or implantable electronics.

However, the commercialization of OFETs is still hindered by two disadvantages of OFETs. First of all, the switching speed of OFETs is limited by the rather low charge carrier mobility of organic semiconductors. Furthermore, controlling and stabilizing the threshold voltage of OFETs is challenging, which poses severe limits on the use of OFETs in driving electronics for flexible displays or analogue organic circuits.

Here, I will discuss approaches to address these challenges. I will show that doping the organic semiconductor leads to more stable organic transistors and allows for a precise control of the threshold voltage. Furthermore, I will present novel vertical organic transistors that show exceptional large driving currents and have the potential to push the transit frequency of organic transistors into the very high frequency regime.

Presentation IIIA-2 (Invited)

Microscopic Analysis of Space Solar Array Degradation

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Solar arrays structures, solar cells, and their components degrade over time in space due to their environmental conditions. These include radiation, temperature variations, ultraviolet light, and bombardment by micrometeoroids to name a few. This presentation will show examples of how microscopic analysis of these materials aids in improving the lifetime of space solar arrays.

Presentation IIIA-3

A Modified Two-step Sequential Deposition Method with Addition of Quaternary Ammonium Salts for Planar-Architectured Perovskite Solar Cells

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Lead-based organic-inorganic hybrid perovskites have recently attracted much attention as superior light harvesting materials. To achieve high power conversion efficiency, morphology control of perovskite film has been considered as one of the most important factors. A two-step sequential deposition method has been developed to gain better crystal growth. However, the difficulty of this method is to get balance between complete conversion of PbI_2 to $CH_3NH_3PbI_3$ and good surface morphology by controlling immersion time. Therefore, it is crucial to improve the conversion rate of PbI_2 to $CH_3NH_3PbI_3$. Recent publications have addressed this problem mainly by solvent engineering, for instance, substituting DMSO for DMF to control the crystal size of PbI_2. However, solvent effect is more complicated and different to manipulate. Herein, we developed a modified two-step sequential deposition method by employing quaternary ammonium salts as additives in PbI_2-DMF solution. Strong electrostatic attractive force between the positive charged ammonium group in quaternary ammonium salts and the negative charged Pb-I clusters can retard the crystallization of PbI_2. Thus it makes accessibility of methylammonium iodide much easier, which leads to complete conversion of PbI_2 to perovskite. Correspondingly, device performance has been improved. Structural and optical properties have been studied to analyze the origin of higher power conversion efficiency. It provided a new path to control crystal growth of PbI_2 and improve film morphology in the two-step sequential deposition method.

Presentation IIIB-1

A Novel Correlation Method for Hyperspectral Image Analysis

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Advances in technology have made hyperspectral imaging a routine analytical method. The ability to rapidly generate chemical-based image contrast from hyperspectral image data is a fundamental challenge that is necessary to process the large amounts of data in hyperspectral image data. We have developed a fully-automated method called reduction of spectral angle symmetry (ROSAS), which is effective in differentiating spectral shapes at different locations in a hyperspectral image. ROSAS removes the degeneracies caused by angular symmetry, can be done rapidly, requires no training datasets or *a priori* information about the dataset, and takes advantage of the full color space that modern RGB displays can handle when displaying the resultant image. A full theoretical description of the method is given along with performance metrics. The description has been generalized to work with any number of wavelength dimensions and spectra. A concise protocol is put forth that will enable other researchers to utilize this method by following a short, simple list of steps.

Presentation IIIB-2 (Invited)

Aberration-Corrected Electron Microscopy and its Applications in Materials Research

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During the past decade, great achievement has been made in the development of aberration-corrected electron microscope (ACEM). TEMs working in aberration corrected conditions have been installed in most TEM labs worldwide. In the Electron Microbeam Analysis Laboratory (EMAL) at the University of Michigan two ACEMs, a JEOL JEM 2100F equipped with a probe Cs-corrector and a JEOL JEM 3100R05 equipped with both a probe and a TEM Cs-correctors have been installed since 2009. This talk firstly introduces the two ACEMs including their performances and functions. Then several example studies on the characterization of some advanced materials using the two ACEMs are followed.

Presentation IIIB-3

Soft X-Ray Emission Spectroscopy-Coupled with New Field Emission SEM Technology, Coming Close to Doing the Impossible

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Recent advances in Field Emission SEMs, new large area SDD EDS detectors allow analysts to perform very low voltage, high spatial resolution microanalysis. This is further augmented by the commercialization of a soft X-Ray emission, variable grating, WDS spectrometer. Initially available only on EPMAs, this technology is now available on both EPMA and FEG SEMs. This new type of spectrometer not only can see very low energy lines (50ev-200ev) with high spectral resolution (0.3ev) and high sensitivity (<10ppm), it has the capability of detecting Li and at very low levels which has been the unattainable holy grail of many micro analysts. Its other key advantage is that it also provides chemical state analysis once only the realm of XPS, scanning Auger or Synchrotron. Applications examples and comparisons to existing technologies will be discussed.

Presentation IIIC-1 (Invited)

Use of Serial Blockface Imaging to Study Synaptopathy in Glaucoma

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Functional axonal transport deficits and aberrant neuronal signaling have been implicated as some of the earliest injuries in neurodegenerative conditions. In glaucoma, we have found that retinal ganglion cell synaptic boutons in the brain persist after transport loss, yet little is known as to how functional and connected these terminals are. We used serial blockface scanning electron microscopy (SBSEM) to characterize synaptic morphology in a common model of glaucoma: the DBA/2J mouse. With age, these mice exhibit elevated intraocular pressure and retinal pathology that mimics the presentation of human glaucoma. We assayed axonal transport in 9-14 mo. DBA/2J mice and controls using intravitreal injections of the neuronal tracer cholera toxin-B and microdissected regions of the superior colliculus (SC; the main retinal target in rodents) with varying levels of tracer signal. Samples underwent SBSEM and all synaptic boutons in two 125 cubic micron volumes of the retinorecipient collicular neuropil were traced and analyzed. We found that densities of retinal ganglion cell terminals did not differ between control, CTB-positive, or CTB-negative portions of the SC in DBA/2J mice. However, CTB-positive regions of SC in our glaucomatous mice exhibited larger bouton and mitochondrial volumes than control colliculi. We found that CTB-negative glaucomatous terminals were smaller and had less mitochondrial volume than either controls or CTB-positive DBA/2J colliculi. In addition, these terminals also had fewer and smaller active zones. We believe these subtle, pre-degenerative changes may underlie signaling defects in the retinal projection and likely contribute to the eventual distal axonopathy seen in this disorder.

Presentation IIIC-2

3-Dimensional Characterization of Resin-Embedded Biological Samples Using SBF-SEM and MEDSEM

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3-dimensional characterization of resin-embedded tissue samples in SEM or DualBeam FIB-SEM has demonstrated results equaling traditional 120 keV S/TEM tomography. With a continued interest in larger and larger tissue volumes, there has been a considerable advancement in SEM-based methods for imaging and 3-dimensional reconstruction in the past several years. Serial Block-Face SEM (SBF-SEM) involves combination of imaging and in-situ sectioning of resin-embedded tissue within the SEM, allowing for automated imaging and subsequent reconstruction of volumes of tissue. To mitigate charge in what is generally a non-conductive specimen, low energy electrons or the use of low vacuum is employed. In 2014, FEI introduced and launched Teneo VolumeScope (VS), an SEM with integrated SBF and multi-energy deconvolution (MED-SEM). MED-SEM is a non-destructive technique that allows high-resolution imaging and reconstruction of the top layers of a sample. With multi-energy deconvolution one can overcome the traditional resolution limits set by mechanical slicing. After cutting a thin layer of the block face using a diamond knife, freshly exposed tissue is imaged several times using various accelerating voltages. These images are subsequently used for deconvolving the information into several virtual subsurface layers. This cycle of physical and virtual sectioning offers isotropic data sets with excellent z-resolution and can be fully integrated and automated. This method will be presented as technique for isotropic 3-dimensional characterization of resin-embedded tissue specimens.

Presentation IIIC-3

Study of Endosome Trafficking by Scanning Electron Microscopy (SEM)

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Endocytosis is the process by which cells internalize extracellular fluid, particles, transmembrane receptors, and receptor-bound ligands. Other workers hypothesize that a bias toward endocytic or exocytotic activity, respectively, drives repulsive or attractive turning of the axon growth cone. On haptotactic gradients, epithelial cells rely on filopodia to detect the gradient of adhesiveness across the width of the cell. Filopodia act as the cell's GPS and are more prevalent on the adhesive side of the cell. According to the hypothesis, net retraction of filopodia on the less adhesive side would mean more endocytosis on that side. We used SEM to detect endocytic compartments and test the possibility of localizing endosomes. We allowed cells to become polarized on gradients, then introduced horseradish peroxidase into the cultures at 1 mg/ml for 30 minutes. When cells were fixed and exposed to 3,3'-diaminobenzidine and H_2O_2, osmium tetroxide was reduced by the reaction product and yielded a signal for backscatter detection. The results suggested polarized endocytic activity in some cells, but it was likely that signals were missed due to the cell thickness. Monte Carlo simulations confirmed that backscatter was attenuated on account of thickness. Other means of investigating filopodia stability and regulation are being explored.

Morley Lecture

Catalytic Metallodrugs – Toward a New Therapeutic Paradigm

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The introduction of metal ions affords many opportunities to design new families of drugs with novel mechanisms of action against specific therapeutic targets. This lecture will review recent progress in our laboratory on the design and study of catalytic metallodrugs against nucleic acid, protein and carbohydrate targets of biomedical interest. Structural, mechanistic, and cellular studies provide a glimpse of the therapeutic potential of such molecules, and suggest pathways for improved in vitro and in vivo performance. These advances will be illustrated through selected studies of metallodrugs designed against viral, bacterial, cancer, and cardiovascular disease targets.

Poster Number One

A Tissue-Engineered Model of a Tendon-to-Bone Enthesis

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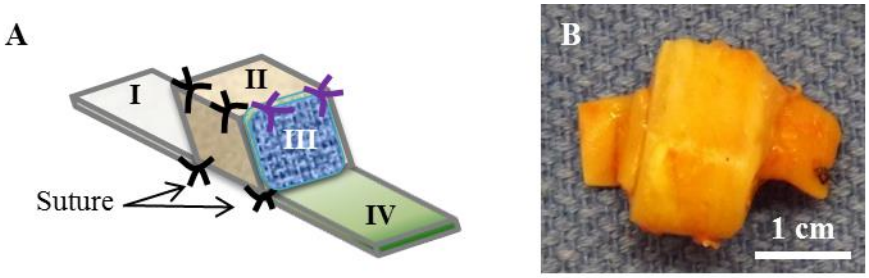

Figure A. A schematic of a fabricated enthesis model. I: poly(caprolactone-co-L-lactic acid) (PCL/PLLA), II: fresh (< 24 hr old) cadaveric human periosteum wrapped about human allograft bone, III: poly(glycolic acid) seeded with human chondrocytes, and IV: PCL/PLLA seeded with human tenocytes. Figure B. Image of an enthesis construct after implantation in an athymic mouse for 20 weeks.

The tendon-to-bone enthesis has a four-zone gradation of connective tissue that includes tendon followed by uncalcified cartilage, calcified cartilage, and bone. The loss of the tendon-to-bone attachment is a common and difficult problem in orthopedic injuries of the hand, elbow, shoulder, knee, heel and foot. These injuries may be treated surgically by repair, reconstruction or grafting methods, processes that may be beneficial to the patient but may also lead to complications such as adhesion formation, tenolysis, persistent tears and sub-optimal function.

This study develops a tissue-engineering approach to generate a functional tendon-to-bone insertion site (an 'enthesis'), utilizing a phalanx model well characterized previously. This complete tissue-engineering process included fabrication of tendon-to-bone constructs, culture of constructs for 1-2 weeks, implantation of constructs in nude mice serving as bioreactors in vivo, construct harvest from mice, and retrieved construct immunohistological and biomechanical assessments. Preliminary data from a recently harvested 20-week construct demonstrated that the fabricated cell-seeded enthesis (II-IV, Fig. A) was viable and possessed stiffness three times greater than its non-seeded aspect (I, Fig. A). Subsequent studies will compare morphology, immunohistochemical markers, and additional biomechanical properties of fabricated entheses to the normal tendon-to-bone attachment of cadaveric or non-cadaveric adult surgical specimens of the human phalanx. Methods developed here could be applied in a broad translational sense for treatment and repair of isolated tendon injuries such as tears of the flexor tendon, Achilles tendon, and rotator cuff.

Poster Number Two

Elucidating the Molecular Mechanism of Anthrax Pore Formation

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The anthrax bacterial species (*Bacillus anthracis*) exhibits a high degree of lethality upon mammalian infection and has been studied for decades. However, the molecular mechanism of the events associated with anthrax toxicity are poorly understood. Anthrax imparts its toxicity via a tripartite toxin system consisting of Protective Antigen (PA_{83}), lethal factor (LF), and edema factor (EF). PA_{83} is an 83 kDa peptide that is proteolytically activated to PA_{63}, which then forms a heptameric prepore species. After endocytosis and acidification of the endosome, the prepore converts to a pore through which the other two bacterial toxins can pass to the cytosol. LF disrupts MAP kinase signaling and EF disrupts cAMP signaling which leads to cell death and immune evasion. The crystal structure of the prepore and the recent cryo-EM model of the mature pore provide the static conformations of these two states in atomic detail. Consequently, it still remains unclear how the maturation process is orchestrated. Pore maturation requires large-scale conformational changes and reorganization of protein domains. A single point mutation (D425A) halts pore maturation at an early stage and, thus, provides a unique intermediate to study the initial stages of anthrax pore formation. Cryo-EM and single particle image analysis was used to elucidate this structural intermediate at ~11 Å. The structure displays a region of density at the base of the complex, which is consistent with the initial stages of β-barrel formation at low pH.

Poster Number Three

Characterization of Myocardial Remodeling in a Rat Model of Metabolic Syndrome Biochemical and Histological Study

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Introduction: Metabolic syndrome (MetS) is a cluster of metabolic abnormalities, including obesity, dyslipidemia, glucose intolerance and hypertension that serve as risk factors for cardiovascular diseases. Although growing evidence showed the association between MetS and myocardial remodeling, the underlying mechanisms are poorly understood. This study aimed to investigate the molecular mechanisms of MetS-induced myocardial remodeling.

Methods: Male rats were fed high fat and high fructose diet to induce MetS, and compared with age matched rats fed with standard chow, as controls. After 42 weeks, insulin resistance was assessed by oral glucose tolerance test. Fibrosis and apoptosis-related proteins as well as nitrotyrosine (oxidative stress (OS) marker) were examined by immunoblotting. TNF-α was measured by ELISA. Collagen deposition was evaluated by Masson's Trichrome staining.

Results: High fat and high fructose diet induced a marked hyperglycemia and insulin resistance, along with altered lipid profile and hypertension, however, no overt obesity was observed. This was associated with a dramatic increase in serum levels of TNF-α, compared with control rats. Higher expression of nitrotyrosine was observed in hearts of MetS rats than in controls. There were significant increases in the expression of collagen I, III, transforming growth factor-beta 1 (TGF-β1), matrix mettaloproteinase-1 (MMP-1) and its tissue inhibitor (TIMP-1) in cardiac tissues of MetS rats, compared with control rats. A significant upregulation of pro-apoptotic Bax, associated with downregulation of anti-apoptotic Bcl-2 was found in cardiac tissues of MetS rats, compared with their controls. The deposition of collagen fibers was more abundant in hearts of MetS rats than in controls.

Conclusion: Our findings suggest that OS and inflammation play a key role in myocardial fibrosis and apoptosis, associated with MetS. TGF-β1-induced extracellular matrix remodeling is critically implicated in this process.

Poster Number Four

Exploring Possible Gene Therapies for HIV

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CCR5 is a receptor that lies on the membrane of normal human white blood cells, typically facilitating inflammatory responses. CCR5 along with CXCR4 serve as a secondary receptor for HIV. A mutation called CCR5Δ32 confers resistance to HIV infectivity as well as *Yersenia pestis*. A man by the name of Timothy Ray Brown was cured of HIV through a bone marrow transplant from a donor who was homozygous Δ32/Δ32. In addition to Δ32 a novel mutation in the ccr5 gene (TG5) was found in a member of an African American family who was exposed to HIV but was not infected. The gene was inserted into a pcDNA expression vector, and transfected into the human T-cell line H9. The gene expression of cells containing this gene and the relative infectivity of these cells will be examined. Additionally, this gene, as well as, Δ32 will be cloned into the retroviral shuttle vectors pLNCX2 and used to create retroviral particles. These particles will be used to test the effect of alleles of CCR5 on the expression of wild type CCR5 and CXCR4. If CCR5 Δ32 and CCR5 TG5 can block expression of the wild type proteins then a gene therapy for HIV is attainable.

Authors: Norah Ali, Darla Balawender, Virgina Ford, Jacob Haller, Brandon Holcomb, Austyn Lilly, Briana Long, Keira Magdos, Steve Mares, Carson Moen, Michelle Neudeck, Elliott Pawloski, Nicholas Reed, Jared Repas, Nya Washington, L. Beth Weir, Amanda Worcester, India Worthy, Kayla Zamborsky; Advisor: Harry W. Kestler

Poster Number Five

Cryogenic Electron Microscopy Techniques for Soft-Matter Materials

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In this poster, we present an overview of cryogenic electron microscopy (cryo-EM) techniques for soft-matter materials (e.g., bio-materials, liquid crystals, oils, and polymers). These materials often impose great challenges for electron microscopy studies due to the weak contrast, difficulties in specimen preparation and radiation damage. As *in situ* electron microscopy techniques are still not practical at the current stage, cryo-EM techniques are often considered to be a desired choice for many soft-matter materials. Several steps are involved in cryo-EM, including sample freezing (thin film or bulk samples), thinning process (to obtain electron-transparent specimens), and EM observation. We demonstrate that plunge-freezing is an efficient technique for solution samples with small particles (< a few hundreds of nanometers), for example, lipid vesicles. High pressure freezing is another widely used freezing technique for biological tissue samples or those with strong surface effect (e.g., lyotropic liquid crystals). The frozen thick samples need to undergo a thinning process (e.g., cryo-ultramicrotomy and cryo-FIB) to obtain electron transparent specimens for cryo-EM. Another alternative is to fracture the frozen thick sample and replicate the fracture surface morphology by depositing heavy metal and carbon films (freeze fracture technique).

Poster Number Six

Rapid Assessment of Intracytoplasmic Membranes in Bacteria by Fluorescence Microscopy

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Intracytoplasmic membranes (ICMs) are known to play an important biological role in bacteria, but many details about these membrane systems remain unclear. The primary tool for observing these ICMs has been electron microscopy, which limited data collection due to preparation times and the inability to look at dynamic membrane changes. Here we describe a method to rapidly analyze intracytoplasmic membrane structures on a single-cell level using fluorescence microscopy and lipophilic dyes on live cells. This allows us to rapidly track the ICM growth of multiple single cells over time to elucidate the mechanisms by which these membranes are gained or lost with time. Growth conditions can also be altered during imaging to observe immediate cellular reactions under varying conditions. This technique can be coupled to the use of other fluorescence imaging techniques such as protein localization via fluorescent protein fusions. We primarily apply these methods to methanotropic bacteria, such as *Methylomicrobium alcaliphilum 20z* and *Methylosinus trichosporium OB3b*, which can use single carbon molecules, as their sole energy and carbon source. These methanotrophs produce the membrane bound enzyme, particulate methane monooxygenase (pMMO) which is capable of oxidizing C-H bonds. Our goal is to understand the dynamic relationship between ICMs and pMMO.

Poster Number Seven

Age-Dependent Modifications of Axons, Mitochondrial Dynamics and Calcium Homeostasis Underlie the Vulnerability of Aging White Matter to Ischemia

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Aging white matter (WM) is increasingly susceptible to neurodegenerative diseases and stroke. Among others, changes in Ca^{+2} homeostasis, ATP production, and mitochondrial dynamics contribute to increased susceptibility of aging WM to stroke.

We utilized a pure white matter tract, mouse optic nerve (MON), obtained from 2- and 12-month old mice to quantify axon structure and function using immunoblots, ATP assays, electrophysiology and 3D-EM. Functionally, aging axons recovered less after ischemia compared to young axons. Structurally, aging axons became thicker with lower G ratios, as well as increased internodal distances and nodal lengths. Aging axonal mitochondria were larger and thicker with lower incidence of SER association. A mismatch of mitochondrial shaping proteins with aging resulted in aggregation of mitochondria and together with lower ATP levels suggesting mitochondrial dysfunction.

Our results suggest that aging alters axonal mitochondrial structure and function leading to reduced ATP production that may disrupt Ca^{+2} homeostasis to underlie the increased vulnerability of aging WM to ischemia and neurodegenerative diseases.

Poster Number Eight

GC-MS Analysis of the Flavor of Bourbon Whiskey Produced by a Novel Accelerated Aging Process

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Gas Chromatography-Mass Spectroscopy (GC-MS) can be readily used to generate an analytical profile of the flavor compounds for whiskey. This analytical method has been applied to samples of bourbon whiskey produced by a novel process which uses pressure to accelerate the aging of the whiskey. As such, GC-MS information yields insights into the process parameters for the novel accelerated aging technique. Pragmatically, GC-MS data can be used in product design to tune the process parameters for the production of a desired target product.

Poster Number Nine

New Preparation Method using Ionic Liquid for Rapid and Reliable SEM Observation of Uncoated Biological Specimens

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For observation in an electron microscope (EM), biological specimens require various preparation methods to preserve their shape under vacuum, but they can be very time-consuming. Ionic liquids are unique materials because of their natural incombustibility, non-volatility, and high ionic conductivity. Our particular ionic liquid was designed specifically for EM sample preparation, where unfixed specimens are immersed with our ionic liquid and observed without dehydrating. The results indicate that this method for biological sample preparation greatly reduces preparation time, and is additionally better at preserving the specimen's original shape while imaging in the SEM environment. Nano-porous structures were also treated with our ionic liquid and also showed promising results in the SEM environment.

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Poster Number Ten

Atypical Centriole During Fertilization

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During fertilization, centrosomes, the major microtubule-organizing center, are essential in forming astral microtubules and mediating male and female pronuclei congression. Failure to do so, leads to infertility. It has been thought that the insects only have one centriole in the sperm and only that centriole is inherited to the oocyte. However, we discovered a second centriole structure named the “Proximal Centriole-Like (PCL),” in *Drosophila*. We found that the PCL along with the previously known centriole, the Giant centriole (GC), are inherited to the oocyte and functions as the first centrosome in the zygote. In addition, the PCL does not have microtubules and the GC lose most of centrosome proteins during spermiogensis. Therefore, we hypothesize that PCL and GC are atypcial centrioles that perform normal centrosome functions in the zygote. This suggests that atypical centrioles are essential for fertilization and it could be conserved in fertilization of the other animals.

Poster Number Eleven

DNA Secondary Structures in the Full-length 3' Telomeric Overhang

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The telomere 3' overhang in the chromosomes of eukaryotes consists of Guanine (G)-rich tandem repeats of nucleotides. These G-repeats can self-assemble into DNA secondary structures like G-quadruplex, G-triplex and higher-order structures in the presence of monovalent cations like K+. These structures are potential targets for cancer treatment since they inhibit the activity of telomerase-an enzyme over-expressed in most of the cancer cells. Thus, structural information of the non-B DNA structures present in the 3' telomeric overhang is vital for designing highly specific cancer therapeutic agents. Most of the current studies are focused on telomeric DNA with four TTAGGG repeats that can only host one G-quadruplex unit. However, such a system oversimplifies the physiological context in which a telomere overhang may contain ~20-50 G-repeats. We used a dual-trap optical tweezer for single molecule force ramping analysis in place of ensemble-averaged methods using NMR or X-ray techniques to study the telomere DNA having up to 24 G-repeats. This technique allows to resolving the minor species formed in the construct approaching full-length of telomere overhang. From our force-extension experiments, we were able to conclude that G-quadruplex is the most abundant species (80%) present in telomere followed by G-triplex (15%) and Higher-order structure (5%).

Poster Number Twelve

Ruthenium-Modified Sensitive NO Sensors: Quantifying Nitric Oxide in the Pathobiology

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This is a preliminary work towards preparing a device capable to measure nitric oxide levels in a cystic fibrosis cell line model. It has been found that exhaled NO levels remains unchanged or reduced in cystic fibrosis patients unlike other inflammatory lung diseases like asthma where it increases. However, it is not clear whether the lower NO levels in cystic fibrosis correlate with lowered production of this metabolite in the bronchial epithelium. We will present preliminary results of our ruthenium oxide-modified, combined electrodes and how they can be applied to the study of cystic fibrosis at the cellular level.

In this work, we explore the performance of combined reference/working electrodes modified with ruthenium oxide and Poly(3,4-ethylenedioxythiophene) (PEDOT) in the detection of nitric oxide with the goal to measure nitric oxide at the level of single or collective cultured cells. The synergistic effect of the electrocatalytic activity of ruthenium oxide and the enhanced surface area for catalytic activity provided by the polymer greatly enhanced the analytical performance of our sensors in terms of sensitivity, selectivity, and stability. With the incorporation of a layer by layer method of electrodeposition, we attained a sensitivity of ~ 17 pA/nM towards NO and a detection limit in the vicinity of 500 pM. In order to improve the selectivity of our sensors we coated the surface with nafion and lowered the applied potential. We attained ~86% and ~81% decrease in response to nitrite and ascorbic acid respectively after nafion coating.

Poster Number Thirteen

Ubiquitous Distribution of Salts and Proteins in Spider Glue Enhances Spider Silk Adhesion

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Modern orb weaving spiders use micron-sized glue droplets on their viscid silk to retain prey in webs. A combination of low molecular weight salts and proteins makes the glue viscoelastic and humidity responsive in a way not easily achieved by synthetic adhesives. Optically, the glue droplet shows a heterogeneous structure, but the spatial arrangement of its chemical components is poorly understood. Here, we use optical and confocal Raman microscopy to show that salts and proteins are present ubiquitously throughout the droplet. The distribution of adhesive proteins in the peripheral region explains the superior prey capture performance of orb webs as it enables the entire surface area of the glue droplet to act as a site for prey capture. The presence of salts throughout the droplet explains the recent Solid-State NMR results that show salts directly facilitate protein mobility. Understanding the function of individual glue components and the role of the droplet's macro-structure can help in designing better synthetic adhesives for humid environments.

Poster Number Fourteen

A Microscopic Study of Cell Volume Dysregulation in Apoptosis: Evidence of the Involvement of Organic Cation Transporters (OCT)

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The two main types of cell death are apoptosis and necrosis. Necrotic cells accumulate water, which leads to cell rupture and inflammation; conversely, apoptosis is characterized by water expulsion, shrinkage and elimination of affected cells without causing inflammation. In some cases, however, a temporary volume increase occurs in apoptotic cells prior to shrinkage. In HeLa cells treated by actinomycin D or camptothecin, swelling coincides with membrane blebbing and the loss of mitochondrial potential. In this study we used confocal and wide-field fluorescence, along with transmission-through-dye microscopy (a technique for cell volume measurements previously developed in our lab), to understand the apoptotic swelling phenomenon. First, we additionally validated volume measurements on cells with irregular shapes and/or with reduced water content, as are typical during apoptosis. Next, we show that blebbing and swelling can occur independently of each other. In a sodium-containing medium, cell swelling is accompanied by accumulation of sodium and can be prevented by sodium channel blockers. Unexpectedly, some of sodium-free media supports apoptotic swelling as well, apparently through activation of OCT. Independent evidence for OCT involvement comes from cell staining by a potentiometric dye ASP that may utilize these channels for cell entry: the staining pattern changes from mitochondrial to membrane prior to any other observable apoptotic changes. Our current hypothesis is that OCT shut down either early in apoptosis or just in response to stress and become reactivated during membrane blebbing; further work will elucidate the nature of this potentially important phenomenon.

Poster Number Fifteen

The Mechanoenzymatic Core of Dynamin-Related Protein 1 Comprises the Minimal Machinery Required for Membrane Constriction*

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Mitochondria are dynamic organelles that continually undergo cycles of fission and fusion. Many neurodegenerative diseases, including Alzheimer's, Parkinson's and Huntington's display increased levels of mitochondrial fission. Dynamin-related protein 1 (Drp1), a large GTPase of the dynamin superfamily, is the main mediator of mitochondrial fission. Like prototypical dynamin, Drp1 is composed of a mechanochemical core consisting of the GTPase, middle and GED regions. In place of the pleckstrin homology (PH) domain in dynamin, however, Drp1 contains an unstructured variable domain (VD), whose function is not yet fully resolved. Here, using time-resolved EM and rigorous statistical analyses, we establish the ability of full length Drp1 to constrict lipid bilayers through a GTP hydrolysis dependent mechanism. We also show the variable domain limits premature Drp1 assembly in solution and promotes membrane curvature. Furthermore, the mechanochemical core of Drp1, absent of the variable domain, is sufficient to mediate GTP hydrolysis-dependent membrane constriction. Characterization of the mechanoenzymatic properties of Drp1 will advance our understanding of the mitochondrial fission process.

Poster Number Sixteen

Three-Dimensional Self-Assembly of Mixed Poly(*tert*-butyl acrylate)/Polystyrene Brush-Grafted Silica Nanoparticles by Electron Tomography

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Three-dimensional (3D), self-assembly of poly (*tert*-butyl acrylate) (P*t*BA)/ polystyrene (PS) mixed brushes grafted on 67 nm silica nanoparticles was investigated by transmission electron tomography (3D TEM). The number average molecular weights for P*t*BA and PS are 22.2 and 23.4 kDa, and their grafting densities are 0.54 and 0.31 chains/nm^2, respectively. When particles cast from chloroform solution, monolayer particle film formed through strong brush-brush interaction. Clear bicontinuous phase separation of P*t*BA and PS brush domains were presented in both 2D and 3D TEM images. Uniformly collapsed mixed brush particles prepared by the emulsion method exhibited both isolated and short worm-like PS domains. Environmentally responsive self-assembly of mixed brush-grafted silica nanoparticles was studied by imbedding particles in P*t*BA and poly(cyclohexyl methacrylate)(PCHMA) homopolymer matrices, which are miscible with PtBA and PS brushes, respectively. Using tomography, the 3D morphology of phase separated mixed brushes on single particles was reconstructed. The inverted phase separation of the mixed brushes was observed in the two systems. When the molecular weights of the matrices increased, the minor brush phase gradually changed from protruded islands to bicontinuous morphology. Furthermore, the diameter of the single particle decreased with increasing of molecular weights of polymer matrices. This responsive behavior can be explained by wet-brush/dry-brush theory.

Poster Number Seventeen

Chia Seed Exudate used for Separation of Oil and Water

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Using extracted Chia Seed gel as an oleophobic organic hydrogel to coat mesh and strain/extract oils and alcohols from water. Wire mesh is coated with the hydrogel and expected to let water pass through while retaining any oil substance. This is done by testing the contact angles of different oils and alcohols on the coated mesh. The ability to strain water and retain oil will be tested by sealing oil onto the mesh so that it does not roll off and then pouring water onto that mesh to let gravity strain the water through the mesh. Relevant and prominent uses are to be a cheaper and more easily produced alternative to other oleophilic coatings.

Poster Number Eighteen

Simple Pyrolysis Gas Chromatography of Automotive Paints

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Pyrolysis gas chromatography (Py-GC-MS) is often used to characterize automobile paint in the crime laboratory. Pyrolysis refers to the breakdown of polymers into small molecules under high heat in an inert environment. Identifying the pyrolysis products enables the determination of the original polymer. Commercial pyrolyzers that attach to a GC-MS instrument provide automated and reproducible pyrolysis and injection of the gaseous products, but they are very costly (>$20,000). This makes Py-GC-MS inaccessible for many laboratories, particularly academic labs. Therefore, we developed a simpler, more cost-effective method. The polymeric sample (~0.2 mg) is placed in a bent glass pipet, with the tip of the pipet in ice-cold dichloromethane. With N_2 gas flowing through the pipet, the sample is heated with a natural gas-air flame. Pyrolysis products are collected in the cold solvent, and the resulting solution is analyzed by GC-MS. Several commercial plastics (#1-6) were tested and produced chromatograms and pyrograms (summed mass spectra) that matched well to those in a chromatogram/spectral library of known polymers. Clearcoats and electrocoats of automobile paints that were distinguishable by IR spectrophotometry were also distinguishable by this method. Paint layers that appeared to be indistinguishable by IR can be differentiated by this method.

Poster Number Nineteen

Morphological Support Effects in Metal-CeO_2 Catalysts for CO Oxidation

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Surface facet orientation of CeO_2 Nanoparticles plays a vital role in the oxygen vacancy formation/elimination under reducing/oxidizing conditions. These formations and eliminations of oxygen vacancies directly correlate to the Oxygen Storage Capacity (OSC) and the catalytic activity of CeO_2-supported metal catalysts. Reported is a detailed kinetic behavior study of the effect that metal has on the catalytic activity of CeO_2 catalysts with well-defined CeO_2 surface planes. Shape- and size-controlled CeO_2 nanocrystals were prepared by facile hydrothermal reactions. The metal was then impregnated, and the catalytic activity was characterized. The catalytic activity of CeO_2 supported metals is believed to depend on the number of perimeter metal atoms and the metal-CeO_2 interaction at the interface. In this study, the catalytic activity of the impregnated catalysts was compared using various metals (Mn, Fe, Co, Ni, and Ag) on the same shape of CeO_2 nanocrystal supports using numerous instruments and techniques (TEM, XRD, Raman, BET, TPR, and catalytic activity characterization). This allows for a better understanding of the detailed metal-CeO_2 interaction and its effect on low temperature CO oxidation reactions.

Poster Number Twenty

Improved Analysis of Petroleum Isomer Distribution Using Cold EI GC/MS

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The hydrocarbon isomer distribution in petrochemicals contributes to many commercially important petrochemical characteristics such as boiling and melting points, octane number, combustion efficiency, flash point, viscosity, lubricity, solubility, and solvation power.

Electron Ionization Gas Chromatography / Mass Spectrometry (EI GC/MS) is a powerful and information-rich technique for qualitative characterization and quantitative analysis of the compounds in a petrochemical mixture. One of its most valuable functions is to provide the molecular weight of a compound. However, for high molecular weight or highly branched compounds, this important ion may be small or absent because of energetic instability relative to its fragment ions. In that case, analyte confirmation is more dependent upon measured retention time and comparison with established standards.

In contrast, Cold Electron Ionization GC/MS (Cold EI GC/MS) can improve petroleum isomer distribution analysis by substantially increasing the molecular ion peak intensity of a compound while retaining the EI fragmentation pattern for spectral library searching without modification to established GC methodologies. Enhanced molecular ion abundance allows plotting the molecular ion chromatogram for easy determination of isomer distribution, even for isomers with a high degree of branching and small or no molecular ion in conventional EI.

When used in a novel q-TOF configuration, the enhanced molecular ion in Cold EI provides enhanced selectivity and valuable information on the isomeric content and distribution of petrochemical fluids.

Poster Number Twenty One

Metal-Decorated Graphene for Enhanced Detection of Peroxynitrite

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Recent clinical research indicates that the cytotoxicity role of peroxynitrite ($ONOO^-$) plays an essential role in several cardiovascular dysfunctions and other diseases triggered by oxidative stress. Peroxynitrite (PON) is a strong oxidizing agent produced from the diffusion-controlled reaction between nitric oxide radical ($^\bullet NO$) and superoxide anion-radical ($^\bullet O_2^-$). PON attacks vital components inside the body and initiates deleterious effects via direct and indirect interactions. It reacts directly with lipids, DNA, and proteins and indirectly serves as a trigger of radical chain reactions.

Previously, we have shown that hemin and hemin-modified graphene can be used as catalytic platforms for electrochemical detection and quantification of peroxynitrite. In this work we prepare metal-decorated, graphene-based composite materials as potential catalytic interfaces for sensitive electrochemical determination of PON. We first describe the method of preparation of metal-modified graphene materials. We characterize the hybrid materials using a number of methods including scanning electron microscopy (SEM), atomic force microscopy (AFM), raman, and x-ray photoelectron spectroscopy (XPS). The modified metal-graphene composite is then tested on carbon electrodes for PON detection and quantification using voltammetry and dose-response amperometry. We compare and contrast the performance of the new metal-graphene materials with hemin-only based electrodes as well as bare graphene based electrodes.

Poster Number Twenty Two

Domain Walls and Anchoring Transitions Mimicking Nematic Biaxiality in the Bent-Core Liquid Crystal C7

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We investigate the origin of ‘‘secondary disclinations’’ that were recently described as new evidence of a biaxial nematic in a liquid crystal C7. Using various optical microscopic techniques such as polarizing optical microscopy, LC PolScope, and fluorescence confocal polarizing microscopy, we demonstrate that the secondary disclinations represent domain walls formed in a uniaxial nematic during the anchoring transition, in which the director orientation changes from tangential (parallel to substrates) to tilted. Each domain wall separates two regions with the director tilted in opposite directions. At the center of the wall, the director remains parallel to substrates. The domain walls can be removed by an electric field. The anchoring transition is explained by the balance of (a) the intrinsic perpendicular anchoring produced by the aligning layer and (b) tangential alignment caused by ionic impurities forming electric double layers. It is supported by the fact that the anchoring transition temperature decreases as the cell thickness and the concentration of impurities increases. We also demonstrate that the alignment is affected by thermal degradation of the samples. This study shows that C7 exhibits only a uniaxial nematic and demonstrates yet another mechanism by which a uniaxial nematic can mimic a biaxial nematic.

Poster Number Twenty Three

Structural Characterization of Polyethylene Glycol on Viral Nanoparticle Surface

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High molecular weight polymers, such as polyethylene glycol (PEG), are commonly used to coat nanoparticles and drug formulations for improved pharmacokinetics and therapeutic outcomes. PEGylation induces 'stealth effect', where the drug or nanoparticle (loaded with drugs or contrast agents) is shielded from the immune system enabling evasion of mononuclear phagocyte system clearance. Stealth properties are a function of PEG chain length, molecular weight, and conformation. While modeling allows one to estimate nanoparticle surface coverage and PEG conformation, e.g. brush vs. mushroom; these calculations are only an approximation. It is imperative that novel methods be devised to study the PEG coating on nanoparticles. Here, we visualize PEG on the surface of tobacco mosaic virus (TMV)-based nanoparticles using cryo-electron microscopy and tomography; the goals are to provide detailed information about the morphology of PEG on the nanoparticle surface. We compare differently-sized PEG polymers with various grafting densities on the surface of the TMV nanoparticles. Future studies will set out to correlate the structure-function relationship of the PEG conformation and its pharmacokinetic properties.

Poster Number Twenty Four

Electron Microscopy Analysis on Nano Materials, Multi-Layer Films and Novel Ceramic Composites

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The Youngstown State University Electron Microscope Facility (YSU-EMF) has four electron microscopies and its affiliated sample preparation laboratory. It is an instruction and research unit of the YSU College of Science, Technology, Engineering and Mathematics (STEM). It serves not only the YSU Campus and academic community, but also industry and manufacturing at large. It provides three basic types of service: education and training; equipment access for trained users and full service microscopy for pilot studies. The whole facility is available to anyone with an interest in electron microscopy: graduate and undergraduate students, post-doctoral researchers, faculty, staff and non-YSU users including collaborators and other external users.

The YSU-EMF can offer various equipment and techniques to meet general and most specific requirements of EM specimen preparation and analysis. It has a JEOL JEM-2100 analytic TEM, a JEOL JIB-4500 SEM/FIB dual beam system, a JEOL JSM-7600 Field Emission High Resolution SEM and a JEOL JSM-IT300LV Variable Pressure SEM. It has an ultrasonic disk cutter, dimpling grinder, low angle ion milling and polishing system, twin-jet electropolisher and plasma cleaner, etc. It can offer specialized techniques to prepare different tough EM specimens and also conduct EM analyses with advanced EM techniques. In this poster, electron microscopy analysis on three typical advanced hard materials will be presented. Powerful functions and high capability of the YSU-EMF therefore will be introduced.

Poster Number Twenty Five

Inorganic−Organic Thiol-ene Coated Mesh for Oil/Water Separation

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A highly efficient water/oil separation mesh was fabricated by using a superhydrophobic and superolephilic coating of thiol-ene hybrid, consisting of pentaerythritol tetra (3-mercaptopropionate) (PETMP), 2,4,6,8-tetramethyl-2,4,6,8-tetravinylcyclotetrasiloxane (TMTVSi), and hydrophobic fumed silica nanoparticles, via a simple two-step fabrication process. Spray deposition, and UV curing photopolymerization were sequentially performed during which solvent evaporation provides micro-scale roughness while nanoparticle aggregation forms nano-scale roughness, and this hierarchical morphologies were stabilized after UV curing photopolymerization. High contact (>160) and low roll-off angle (< 5) were achieved due to the multi-scale roughness structure of the hierarchical morphologies. These coatings also have excellent chemical resistance, temperature and ph stability after curing. The water/oil separation efficiency and rate can be varied by controlling coating thickness and mesh openings.

Poster Number Twenty Six

Extruded Polymer Nanosheets: Toward Mass Production of Polymer Nanosheets

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Polymer nanosheets have found several applications as adhesive plaster, drug delivery, and separation membrane. However, the major thing that limits its industrial application is that existing fabrication techniques can only fabricate it one at a time. This study investigates the applicability of the CLiPS technology to mass produce polymer nanosheets by co-extruding a water insoluble polymer and a water soluble polymer into a multilayer film. The dissolution of one of the layers will exfoliate the polymer nanosheets. It has been found that the extruded polymer nanosheets have higher mechanical property than the conventional spin-casted polymer nanosheet.

Poster Number Twenty Seven

Grafted Carbazole - Assisted Electrodeposition of Graphene Oxide

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A simple preparation of graphene oxide (GO) nanosheets that can be electrodeposited readily is presented herein. This is based on the electro-polymerization and electrodeposition of covalently linked Cbz units when a potential is applied. During the electrochemical process, the Cbz groups electro-polymerize and carry the GO nanosheets as it electro-deposits on the substrate. Moreover, the GO-Cbz sheets selectively deposit only on conducting regions of the substrate, demonstrating its promise for the fabrication of electro-patterned graphene-based devices. Spectroscopic techniques such as UV-Vis, Fluorescence, FT-IR, Raman and XPS were utilized to characterize the resulting material. For visualization, SEM, TEM and AFM imaging were also employed.

Poster Number Twenty Eight

Characterizing Modern Nanostructures with Atom Probe Tomography

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Atom probe tomography (APT) provides 3D compositional characterization of buried nanostructures with near-atomic sensitivity and, when combined with the structural and property information produced by conventional techniques, yields the opportunity for development of new understanding. Here we will present a review of the technique with pertinent examples which highlight the unique measurement capabilities (statistical, chemical, and spatial) of APT methods. These will include: a) III-V-based heterojunctions, b) grain boundary segregation, c) fine-scale precipitate formation and c) nano-scale cluster identification. The combination of APT data with that obtained from other techniques will also be discussed. For example, pairing high-resolution transmission electron back scattering diffraction (t-EBSD) analysis and APT data acquired from the same volume of material enables grain-boundary-specific targeting as well as *direct correlation* – achieved in a routine manner-- of grain boundary chemistries to grain mis-orientations.

Poster Number Twenty Nine

Virtual Field Trip: How the University of Toledo Uses Cyber Access and Sophisticated Microscopes to Create a Unique Classroom Experience

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With the United States falling behind globally in education, garnering interest in the STEM (Science, Technology, Engineering and Mathematics) subjects is becoming increasingly important. However, funding for extracurricular schools has decreased, leading to fewer field trips and hands-on activities. The College of Natural Sciences and Mathematics at the University of Toledo has developed an aid to solve that problem. In 2010, the SCOPE (Scientists Changing Our Pre-college Education) program was created. This program employs a scanning electron microscope (SEM) and a confocal fluorescent light microscope. Both microscopes are capable of being controlled remotely, allowing students to experience real-life research equipment without ever having to leave the classroom. The program is flexible both in accessibility and subject matter, as students from elementary school through college have been able to utilize SCOPE. Best of all, this program is 100% free for any school that wishes to participate.

Poster Number Thirty

Polymer/Clay Nanocomposite: A Viable Anti-Corrosion Coating for Geothermal Applications

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Geothermal technology has gained wide attention as a new source of renewable energy that would decrease the dependence on fossil fuels and is more environment friendly. Its optimum utilization, however, is limited by accelerated corrosion. Solutions for this problem in the geothermal industry are often reactive such as regular preventive maintenance and material replacement. A proactive way to solve this problem is by utilizing polymers designed for geothermal brine chemistry. In this study, a polymer-clay nanocomposite was synthesized and evaluated for the corrosion protection of carbon steel in acidic geothermal brine. Various characterization techniques such as Scanning Electron Microscopy (SEM), X-ray Photoelectron Spectroscopy(XPS), Fourier Transform-Infrared (FT-IR) spectroscopy, and X-ray Diffraction (XRD) were done to determine the applicability and effect of these polymers to carbon steel immersed in simulated acidic geothermal brine. The anti-corrosion property of both the inhibitor and the coating was further tested using the weight loss method, EIS, potentiodynamic polarization scan (PPS) and open-circuit potential (OCP) measurements.