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Michigan Microscopy & Microanalysis Society conference. November 1, 2018

8:30 AM	8:55 AM	Registration	
8:55 AM	9:00 AM	Welcome	Vickie Kimler

9:00 AM	9:30 AM	Invited	Ji Hyun Lee
9:30 AM	10:20 AM	Keynote	Rhonda Stroud
10:20 AM	10:40 AM	Coffee Break	
10:40 AM	10:55 AM	Volunteered	Song Xu
10:55 AM	11:10 AM	Volunteered	Elizabeth Alessio
11:10 AM	11:55 AM	Invited	Vern Robertson
11:55 AM	2:10 PM	Lunch/Vendors/Posters	
2:10 PM	3:00 PM	Keynote	Emilio Mottillo
3:00 PM	3:30 PM	Invited	Aaron Taylor
3:30 PM	4:00 PM	Invited	Caroline Cencer
4:00 PM	4:30 PM	Invited	Corey Grice
4:30 PM	4:40 PM	Student Awards	?
4:40 PM	4:45 PM	Closing	
4:45 PM	5:30 PM	Post-meeting discussion	MMMS Board

Keynote 1

The Universe is my nano-fab: scanning transmission electron microscopy of carbonaceous nanomaterials

Author: Rhonda Stroud, Naval Research Laboratory; Washington, D.C.

Abstract:

Although nanoscience is a relatively new field of study, nanomaterials have existed for billions of years. Technologically important materials, such as graphene, nanodiamond, and SiC formed first not in clean-room fabrication facilities, but in the outflows of ancient dying stars. In the laboratory, the atomic-scale ordering, impurity and defect content of these materials can be optimized by manipulating the thermodynamic and kinetic growth conditions for specific optical, electrical or other properties. A better biocompatible quantum dot, for example, comes from careful incorporation of N or Si impurity atoms into nanodiamond. In space, the same thermodynamics and kinetics apply; the atomic-scale structure is a function of pressure, temperature, etc., But in this case the impurities are fortuitously incorporated, and serve as witness to the presolar origin rather than a commercial purpose. Aberration-corrected scanning transmission electron microscopy (AC-STEM) can reveal the structure of carbonaceous nanomaterials, often down to the individual impurity atom, whether from the lab or space. This talk will cover examples of the state-of-the-art in AC-STEM from both the natural and synthetic worlds of carbonaceous nanomaterials.

Dr. Rhonda Stroud is the Head of the Nanoscale Materials Section of the Materials Science and Technology Division of the Naval Research Laboratory in Washington, DC, where she oversees the DoD's most advanced electron microscope facility for nanoscale materials characterization. Her research interests span many classes of materials, from quasicrystals and oxide electronics to aerogel nanocomposites and nanoparticles formed in supernovae. She received her B.A. in physics from Cornell University in 1991, and her Ph.D. in physics from Washington University in St. Louis in 1996. She is a Fellow of the American Physical Society and the Meteoritical Society and was recently voted President-Elect of the Microanalysis Society of America.

Keynote 2

Illuminating fatty acid metabolism: Insights into fatty acid signaling and triacylglycerol metabolism

Author: Emilio P. Mottillo

Emilio P. Mottillo[1,2], Alexander Yang[1,2], Huamei Zhang[1,2], Li Zhou[1,2] and James G. Granneman[1,2].

[1]Center for Integrative Metabolic and Endocrine Research, [2]Center for Molecular Medicine and Genetics, Wayne State University School of Medicine, Detroit, MI, USA, 48202.

Abstract:

Fatty acid metabolism is thought to be compartmentalized, such that specific metabolites and signals can be generated within spatial domains and in a temporal fashion, however, we presently lack the tools to visualize lipid metabolism in live cells. Specifically, the regulation of triacylglycerol hydrolysis is mediated by dynamic protein-protein interaction that occur on the surface of lipid droplets (LDs). To begin to address these limitations, we have devised a series of genetically encoded sensors to detect and image the trafficking of fatty acids and their metabolites. Fluorescent confocal microscopy demonstrates that fatty acids can traffic from LDs to the nucleus where they mediate a transcriptional program involved in regulating gene expression. Furthermore, utilizing a FRET sensor, we are able to image intracellular acyl-CoAs, the immediate metabolite of fatty acids. In brown adipocytes, these lipolysis-derived acyl-CoAs are rapidly metabolized. Pharmacological manipulation of acyl-CoAs levels indicates that mitochondrial-derived acyl-CoAs function in a dynamic feedback system that rapidly balances fatty acid production and oxidation, lending further support for the concept of a metabolic synapse between LDs and mitochondria. Finally, utilizing protein complementation (PC) assays we are able to visualize the dynamic protein-protein interactions that occur on the surface of LDs and demonstrate novel interactions that are critical in regulating triacylglycerol metabolism. Overall, we anticipate that our developing toolkit of metabolic sensors and imaging approaches will be useful in illuminating the temporal and spatial dynamics of fatty acid metabolism and signaling and uncovering the mechanisms that regulated triacylglycerol hydrolysis and storage.

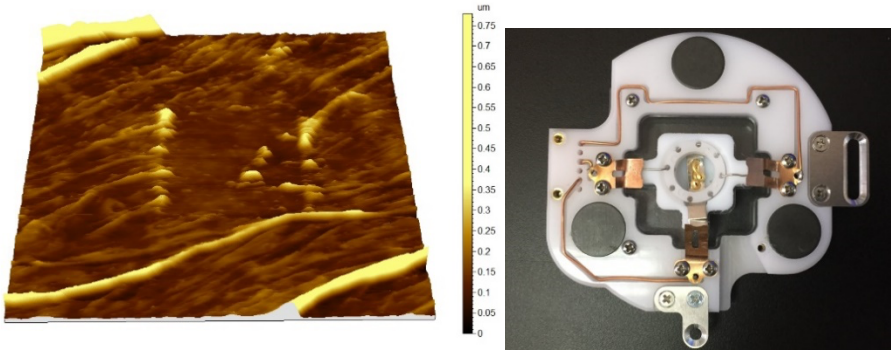
Author: Song Xu, PhD, Sr. Application Scientist

Email: song.xu@parksystems.com

Affiliation: Park AFM Systems Inc., Bloomfield Hills, MI

Title: 3D bench top manufacturing application in EC-AFM in-situ research in electrochemistry

Platform/Volunteer Speaker



Abstract:

EC-SPM combines two independent techniques: electrochemistry and SPM. The electrochemical unit includes a potentiostat and a 3-electrode cell that controls the electrochemical state of the working electrode (usually the sample). The SPM characterizes the surface of the solid electrode with a probe. The AFM cantilever acts as an inert probe that monitors the topographic changes of the electrode surface caused by electrochemical processes. The first part of this presentation focuses the research problems involving in-situ study of lithium SEI formation on electrode surface during charging and discharging circle of a lithium battery. There are many commercially available instruments that allows user to obtain high resolution with smart algorithms. However, when trying to adapt the instrument for unique research field, such as the lithium battery SEI in-situ observation, users often find it is not adequate to use the existing instrumentation hardware. Scientists often find problems that can only be solved by modifying the existing equipment and fabricating custom designed hardware. However, research groups often find graduate students' knowledge and training in chemistry, material science and biology does not cover this very useful know how. 3D Bench top manufacturing is often not part of the science education. The second part of the presentation will discuss the application of 3D benchtop manufacturing techniques and designs in developing a wide range of custom sample holding solutions, experimental accessories and instrument modification ideas in atomic force microscopy. We will specifically present an example of the observation of surface morphology evolution of an electrochemistry reaction and its application in lithium battery research.
Author: Corey R. Grice

Author Email: corey.grice@utoledo

Affiliation: Physics & Astronomy, The University of Toledo

Title: Structure & microscopy of thin film solar cells: the next generation of photovoltaics

Student Presentation, Invited Speaker

Abstract:

The direct conversion of solar energy into electricity using photovoltaic devices, commonly called solar cells, has long been proposed as a simple, scalable and easily distributable mechanism to meet the energy needs of modern society. However, these devices have only recently become relatively cost-effective and mass-produced for the purposes of terrestrial energy production. For much of the last 60+ years solar cells were almost exclusively fabricated from wafers of crystalline silicon, but the last few decades have also seen an explosion of interest in "thin film" solar cells, which typically consist of layers of materials with thicknesses on the order of microns or less deposited on a low-cost supporting substrate (although more complicated and multi-functional structures have also been fabricated). These devices have been demonstrated using a wide-range of materials as the photoactive absorber layer which also enables great flexibility in the methods used to fabricate them. Many incarnations of these thin-film solar cells have able to achieve laboratory-scale photoconversion efficiencies of over 23% under standard test conditions (mimicking normal sunlight), with commercialized large-scale devices approaching 20% conversion efficiency. This talk will discuss some of the fundamental features of solar cells, focusing on the structure and microscopy of the more common forms of thin-film solar cells currently being studied and manufactured, including some of the recent advances that have been achieved at the University of Toledo.

Author: Lacey D. Rzodkiewicz

Author Email: rzodk1ld@cmich.edu

Affiliation: Department of Biology, Central Michigan University

Title: Variation in reproductive physiology of male unionids (Eurynia dilatata and Lampsilis cardium) post-exposure to natural waters from an urban watershed (Milwaukee, WI)

Payer Email: wooln1d@cmich.edu

Student Presentation, Poster Session

Abstract:

Lacey D. Rzodkiewicz 1, Mandy Annis2 and Daelyn A. Woolnough1
1Department of Biology and Institute for Great Lakes Research, Central

Michigan University, Mt. Pleasant, MI, 48859. 2 US Fish & Wildlife Service, Michigan Ecological Services Field Office, 2651 Coolidge Road, Suite 101, East Lansing, MI, 48823.

Chemical profiles of river water represent complex mixtures of contaminants based on anthropogenic influence through surrounding land use. The Milwaukee River watershed is considered to be surrounded by urban land use. Many of the toxicants in the watershed are considered contaminants of emerging concern (CECs), a classification of pollutants that are under evaluation for their effects on aquatic life. Freshwater mussels (family: Unionidae) are highly imperiled throughout North America, and are thus at great risk for population loss if contaminants influence reproductive traits such as gametogenesis or gonad development. Male Eurynia dilatata and Lampsilis cardium were exposed to river water samples from 6 sites throughout the Milwaukee River watershed, representing a variety of CEC mixtures, for a total of 21 days in May 2017. At the conclusion of exposures, tissues were excised for histological analysis of gonad development and sperm counts using light microscopy. Sperm counts differed significantly among sites for L. cardium ($p < 0.05$), though they were not statistically different among E. dilatata ($p = 0.07$). Preliminary data suggests changes to gonadal development for both unionid species and the CEC profile found in the exposure water may be responsible for changes in spermatogenesis for both species though sensitivities to CECs may vary between the taxa. Management efforts may vary among watersheds to best address the sensitivities of molluscs present rather than a widespread focus to minimize inputs of any particular group of toxicants.

Author: Matthew Buccilli

Author Email: bucci1mj@cmich.edu

Affiliation: Department of Biology, Central Michigan University

Title: Investigation of the function of Copine C in *Dictyostelium*

Student Presentation, Poster Session

Abstract:

Copines are a family of conserved calcium-dependent membrane binding proteins found throughout many examples of eukaryotic life, ranging from the microscopic to plants and mammals. The conservation of copines suggests that the role that copines have within the cell is an important one, but their exact function is still being investigated. We are studying copines

in the model organism Dictyostelium discoideum, which has six copine genes, cpnA-cpnF. To study the function of these genes, we are creating knockout mutants and studying their phenotypes. Previous experiments with cpnA- cells have shown they have defects in cytokinesis, contractile vacuole function, chemotaxis, and development. We have recently created a cpnC- cell line and have begun to characterize its phenotype. When placed in water, cpnA- cells make abnormally large contractile vacuoles. When cpnC- cells were placed in water and imaged with DIC microscopy, the size of the contractile vacuoles appeared to be similar those in wild-type cells. cpnA- cells exhibited several developmental defects in aggregation, slug size, and culmination. When cpnC- cells were developed on agar plates and monitored with a dissecting microscope, they appeared to develop normally with similar timing as wild-type cells. This preliminary data indicates that cpnA- and cpnC- cells have very different phenotypes and suggests that cpnC has a distinct function from cpnA in Dictyostelium.

Author: Prabodha Balapuwaduge a , Swati Naik b , Liang Hong c , Robert Klie c and Gabriel Caruntu a,b a

Email: mendi1cm@cmich.edu

Affiliation: Department of Chemistry and Biochemistry, Central Michigan University, Mount Pleasant, MI. USA b Science of Advanced Materials (SAM), Central Michigan University, Mount Pleasant, MI, USA c Department of Physics, University of Illinois at Chicago, Chicago, IL, USA

Title: Soft-solution processing of novel dielectric and photocatalytic nanomaterials by a sacrificial template method

Student Presentation, Poster Session

Abstract:

SrTiO3 has a well-known perovskite crystalline structure and exhibits excellent dielectric, electrooptic and catalytic properties, being the leading candidate in many cutting-edge technological applications. We report here on the rational synthesis of SrTiO3/TiO2 nanodimensional heterostructures by using TiO2 colloidal nanocrystals as sacrificial templates under different reaction conditions, with the main goal of achieving control over the morphology (size, shape), internal structure and surface composition of the resulting nanoparticles. Both the synthesis of TiO2 nanocrystals and their subsequent conversion into SrTiO3 were performed using a hydrothermal method. These nanostructures were characterized by powder X-ray diffraction (XRD), transmission electron microscopy (TEM), high resolution transmission microscopy (HRTEM), energy dispersive X-ray spectroscopy (EDS), vibrational spectroscopy

(Fourier transform infrared spectroscopy (FT-IR) and Raman spectroscopy) and optical absorption measurements. Various reaction parameters have been finely tuned in order to optimize the reaction conditions. A detailed characterization of the dielectric properties of these nanopowders was carried, revealing that dielectric permittivity has a value around 120 at room temperature with a low loss, which make these nanomaterials desirable for applications in energy storage and as dielectrics. Moreover, the photocatalytic properties of SrTiO3-TiO2 heterostructures were analyzed by using dye degradation method under ultraviolet light. An enhanced photocatalytic activity was observed, which can be ascribed to the improved charge separation between photogenerated electrons and holes in conduction and valence bands of SrTiO3 and TiO2. Thus, this synthesis strategy of nanoscale heterostructures is useful to develop functional materials with superior efficiency for implementation into functional electrical devices, as well as photocatalysts.

Author: Omolade Ademuyiwa

Author Email: omolada@bgsu.edu

Affiliation: Center for Microscopy & Microanalysis, Bowling Green State University

Title: Cation flux through TRP channels affects filopodia dynamics

Student Presentation, Poster Session

Abstract:

Filopodia are projections on cells that help them sense their environment. They act as the global positioning system (GPS) navigation system of migrating cells in developmental contexts such as angiogenic sprouting in endothelial cells and axon pathfinding in neurons. There is a controversy about how cells regulate filopodial dynamics. In neuronal growth cones, the amplitude and timing of calcium transients are considered important. However, the directional gradient of calcium in the cytoplasm could also be important. The filopodia in the nerve growth cone are specialized for steering the protrusion. We have studied a simpler system in which the filopodia dynamics are not responding to chemotactic or haptotactic signals. Using cyclopiozonic acid, which prevents re-uptake of calcium into the endoplasmic reticulum (ER), and eliminating calcium in the medium, we activated net calcium efflux. This elevated cytoplasmic calcium levels reported by calcium orange fluorescence but reduced filopodia. Thus, filopodia were not dependent strictly on calcium concentration. Subsequent restoration of calcium increased the filopodia. The increase depended on the transient receptor potential cation (TRPC) transporter, because it was inhibited by SKF96365. TPRC was localized on the filopodia tip. On the contrary, enhancement was not inhibited by

nifedipin, a blocker of L-type voltage-gated calcium channels (VGCCs). Depolarizing the cells during calcium re-uptake, however, inhibited filopodia. Because VGCCs are opened transiently by depolarization, there is a discrepancy between the effects on VGCCs, which remains unresolved. We conclude that filopodia dynamics are not responding to the exact cytoplasmic calcium concentration but to calcium trafficking through channels.

Author: Khaleel I. Quasem

Email: kquasem@emich.edu

Affiliation: Neuroscience, Eastern Michigan University

Title: Tyrosine hydroxylase within the mouse glomerular neuropil following peripheral insult

Student Presentation, Poster Session

Abstract:

Olfactory nerve damage reduces olfactory bulb (OB) dopamine production. Dopamine (DA) is proposed to participate in gain control and lateral inhibition during OB odor processing. This has been difficult to prove since olfactory nerve damage makes odorant processing impossible. However, previous studies suggest that intranasal lavage with dilute detergent solution reduces OB dopamine content without damaging the olfactory nerve. Thus, peripheral lavage may be a model to study olfactory bulb processing without dopamine. However, DA recovery following intranasal lavage has not been studied. In this study, we quantify tyrosine hydroxylase (TH) expressing fibers within the glomerular neuropil 24, 48, and 120 hours following lavage via fluorescent microscopy. TH expression within olfactory neuropil was reduced in the 24 hours following detergent treatment compared to sham-treated animals.

Author: Suporna Paul, Benard D. Kavey and Gabriel Caruntu

Email: paul1s@cmich.edu

Affiliation: Department of Chemistry and Biochemistry, Central Michigan University

Title: Fabrication and characterization of BaTiO3/styrene-butadiene stretchable thin film nanocomposites for flexible electronics

Student Presentation, Poster Session

Abstract:

The development of stretchable, bendable inorganic/polymer nanocomposite dielectric thin films has been of significant technological interest in flexible electronics because of their relatively low fabrication costs, high power energy density and fast charge-discharge ability in energy transfer applications. Polymer ceramic nanocomposites exhibit performance characteristics superior to those of the parent materials as they harness the mechanical properties (flexibility, bendability, etc.) of the polymer and the dielectric properties (high dielectric constant) of the ceramic, respectively. However, the rational design of flexible high-k dielectric nanocomposites with high filler loading is still challenging as the increase of the ceramic content deteriorates the mechanical properties of the material, despite the increase of the dielectric constant of the nanocomposites. In this project, we investigated the fabrication of flexible modern electronics by dispersing monodisperse, surface functionalized $BaTiO_3$ (BTO) colloidal nanocrystals with various sizes (10-15 nm) into a styrene-butadiene-styrene matrix followed by casting the mixtures onto various substrates, both rigid and flexible. The resulting polymer-ceramic nanocomposite films contain up to 50% (wt.) ceramic fillers and possess high energy density values along with excellent mechanical properties. In this work, we report on an increase in dielectric constant of the polymer by a factor of 4 as the concentration of BTO content increases while maintaining the mechanical properties of the thin film. Also, the assembly of the BTO nanocubes in the polymer matrix has been investigated using atomic force and scanning electron microscopy.

Author: Austin Tetmeyer, Alphonsa Thomas, Farid Badar, Yang Xia

Email: adtetmeyer@oakland.edu

Affiliation: Department of Physics, Oakland University

Title: Quantitative study of chondrocyte and collagen structure in articular cartilage degradation by polarized light microscopy

Student Presentation, Poster Session

Abstract:

Polarized light microscopy (PLM) is an optical quantitative tool used in a variety of biological and material science studies. Articular cartilage is a heterogeneous tissue at end of bone in synovial joints, histologically divided into three histological zones (superficial SZ, transitional TZ, radial RZ) based on the orientation of collagen fibers. This work aims to quantify the depth dependent orientations of the collagen fibers and the chondrocytes in healthy and Osteoarthritic (OA) cartilage when loaded in an unconfined manner. Using an orientation fitting equation, ø(r)= a(tanh[((r-r0))⁄(b])+c), the relative histological zone thickness was calculated for all tissue slices using the collagen matrix and the cell orientations. The cell area and aspect ratio were also averaged across each zone to show the cell changes per zone, disease and strain (%). With an applied load, the morphological changes of collagen and chondrocytes due to the external loading were demonstrated. These changes are studied across different strains and disease stages, showing linear relationships between strain and relative zone thickness. Quantitative measurement of collagen and chondrocyte morphology at 0.5μm pixel resolution showed changes in cartilage from healthy to OA, and under different external loading. This study is aimed to find a critical marker in the progression of OA by the measurement of chondrocytes and collagen deformation.

Author: Benard D. Kavey and Gabriel Caruntu

Email: kavey1bd@cmich.edu

Affiliation: Science of Advanced Materials, Department of Chemistry and Biochemistry, Central Michigan University

Title: Synthesis, microscopy and spectroscopic characterizations of rare earth-doped BaTiO3 nanocubes for optical and ferroelectric applications

Student Presentation, Poster Session

Abstract:

Rare-earth doped $BaTiO_3$ nanocubes have been synthesized using a highly versatile and energy-efficient solvothermal route at temperatures as low as 150 ^oC. Transmission electron microscopy images of the as-synthesized $Ba_{1-x}Ln_xTiO_3$ ($0.01 \leq x \leq 0.09$; Ln = La^{3+}, Ce^{3+}, Nd^{3+}, Sm^{3+}, Gd^{3+}, Dy^{3+}) showed highly monodisperse and self-assembled nanocubes with a mean particle size of 20 ± 2 nm for all nominal dopant compositions. High resolution transmission electron microscopy was used to explore in detail the atomic planes, polarization direction, distribution of individual dipoles and the ferroelectric domains within a single nanocube. Also, piezoelectric force microscopy and lithography techniques were employed to further understand the ferroelectric behavior of the $Ba_{1-x}Ln_xTiO_3$ nanocubes. It was determined that all $Ba_{1-x}Ln_xTiO_3$ nanocrystals present a ferroelectric behavior at room temperature with maximum values of the permittivity around the Curie temperature. Dielectric spectroscopy measurements were performed by using vacuum sintered pellets of the as-synthesized nanocubes and measured at both the megahertz and terahertz electric field frequencies. We observed significantly higher dielectric constant values up to 6000 for lower Ln^{3+} dopant concentrations. The insulating properties of the $Ba_{1-x}Ln_xTiO_3$ was further determined using diffuse reflectance spectroscopy and the Kubelka-Munk theory of reflectance. The band gaps of the as-synthesized $Ba_{1-x}Ln_xTiO_3$ nanocubes were determined for all different Ln^{3+}dopants and various concentrations.

Author: Roshan Timilsina and Chunqi Qian

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Department: Department of Physics, Oakland University; Department of Radiology, Michigan State University

Title: Signal sensitivity enhancement of high-spatial-resolution MR imaging with a concatenated cylindrical parametric RF-resonator array

Student Presentation, Poster Session

Abstract:

Objective: The purpose of this study is to demonstrate Wireless Amplified Nuclear magnetic resonance Detection (WAND) for high-spatial-resolution MR imaging using cylindrical shaped concatenated detector arrays. Methods: A cylindrically symmetric quadruple frequency resonator concatenated with a

double frequency resonator was designed and fabricated to improve MR detection sensitivity. Both resonators work on the principle of parametric amplification; the weak MR-signal is amplified through exchanging energy with the strong pumping signal provided wirelessly. Results: Concatenated RF resonators have good sensitivity with larger longitudinal field-of-view (FOV) than the previously designed double frequency resonators. Conclusion: Each detector can be individually activated and manipulated to enlarge the sensitivity-enhanced region without sacrificing their individual performance. Significance: Quadruple frequency detectors offer more flexibility in their design when compared with the double frequency detectors, enabling multi-element concatenation over an extended FOV.

Author: Kasun Gamage

Email: gamag1kk@cmich.edu

Affiliation: Department of Physics, Central Michigan University

Title: Large magnetoresistance in layered ferromagnetic Cr0.29TaS2

Student Presentation, Poster Session

Abstract:

Transition metal dichalcogenides (TMD) intercalated with transition metal ions show a wide range of physical properties of metals, insulators, semiconductors and semimetals. Owing to their extremely thin layered homogenous structures they are very promising candidates in many technological applications. Unusual and fascinating properties of superconductivity, charge density waves (CDW), anisotropic (AMR) and giant (GMR) magnetoresistance, anomalous Hall effect and spintronic effects are observed in these materials. Here we report the study of the magneto-transport properties of the transition metal intercalated TMD, Cr0.29TaS2 single crystals. Careful analysis of the magnetization (M) has been measured as a function of temperature and applied magnetic field (H) in the directions of H // c and H // ab, c and ab denoting the crystallographic directions. Further, the analysis of magnetoresistance and Hall conductivity has been done for the same crystallographic directions with respect to temperature as well as H.

Author: Mohanad Ahmad, Shivani Dabadi, Sanela Martic and Colin Wu

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Affiliation: Department of Chemistry, Oakland University

Title: Amyloidogenic fragments of gelsolin: spectroscopic and microscopic analysis of peptide aggregation

Student Presentation, Poster Session

Abstract:

Amyloidosis is a group of diseases characterized by tissue deposition of insoluble fibrils, formed by misfolded proteins, in an anti-parallel β-sheet fashion. Gelsolin, an actin-binding protein, plays a major role in regulation of the actin cytoskeleton through calcium binding . When aspartate residue 187 is mutated to either an asparagine or tyrosine, the gelsolin protein is cleaved into two fragments . While both of these gelsolin fragments are prone to amyloidosis, it is unclear which peptide sequences facilitate aggregation. Hence, we investigated the aggregation propensities of the following gelsolin fragments: RLFQVKG, NNGDCFILDL, and CFILDL. Peptide aggregation was monitored as a function of concentration and incubation time (0 to 8 days) with a fluorescence assay. In this approach, an increase in fluorescence intensity was correlated with the aggregation of the peptide. High fluorescence was observed for RLFQVKG and CFILDL but not NNGDCFILDL, even at high concentrations. None of the peptides aggregated below a critical threshold concentration which was required for nucleation. Additionally, the aggregation propensity did not increase over time. Consistent with the results of the fluorescence aggregation assays, TEM imaging studies of all three gelsolin peptide fragments showed extensive fibril formation for NNGDCFILDL and CFILDL, while RLFQVKG fragment form similar fibrils.

Author: Tommaso Costanzo and Gabriel Caruntu

Email: costa1t@cmich.edu

Affiliation: Science of Advanced Materials, Central Michigan University

Title: Study of multiferroic properties of BaTiO3 nanocrystals by D-PFM and VSM

Student Presentation, Poster Session

Abstract:

Multiferroic materials are characterized by the coexistence of two or more ferroic properties, such as ferroelectricity, ferromagnetism and ferroelasticity. Exploiting the coupling between various ferroic order parameters in multiferroics holds great promise for the development of high performance memories, energy harvesting/storage and sensing devices. As nanostructuring is an efficient way to improve the performance characteristics of materials, the strict control over size and shape of nanoparticles is key for the integration of nanoscale multiferroics into functional devices. Here, we report on the characterization of single crystalline, monodiperse BaFe1-xTixO3 colloidal cube-like nanocrystals (0<x<0.6) with sizes varying from 15 nm to 65 nm. The ferromagnetic properties have been investigated by vibrating sample magnetometer (VSM) measurements, while the ferroelectric behaviour was studied by dynamic piezoresponse force microscopy (D-PFM). The analysis of the multidimensional D-PFM dataset was carried out with a novel machine learning approach that allows a rapid quantitative visualization of the tip responses. Similar to the parent material, transition metal-doped BaTiO3 nanocrystals possess an acentric structure associated with ferroelectricity that can be detected by the PFM tip. By increasing the Fe concentration the piezoresponse decreases, and at 4% the signal is very weak with a distorted hysteresis loop, which is indicative of a very weak or quasi-absent ferroelectricity. On the other hand, the VSM measurements have shown that the magnetic moment increases up to a 4% of Fe content, which however, starts decreasing when the concentration increases past 4% due to the antiferromagnetic coupling of nearest Fe3+ ions.[1] The analysis of PFM data revealed a strong dependency of the tip response to the size of the nanocrystals. Specifically, when the edge length of the nanocubes increases from 15 to 25 nm, the hysteresis loop becomes sharper (e.g. switching in a narrow range of voltages) and showing higher remanent

responses, indicative of better ferroelectric properties. In contrast, in nanocrystals with sizes of 45 and 65 nm the PFM response shows anomalous hysteresis loops. Moreover, the time dependency of the PFM amplitude suggests a bigger relaxation compared to that of the undoped materials. Furthermore, the relaxation has been also observed at voltage pulses smaller than the coercive voltage, which suggests the existence of a strain generated from mechanisms other than ferroelectricity (i.e. oxidation/reduction of Fe ions). These results suggest that multiferroism can be achieved only in BaFe1-xTixO3 (0<x<0.2) nanocrystals with size below 45 nm. These findings unambiguously demonstrate that the control of the nanocrystals size is crucial for the development of room temperature multiferroic BaTiO3.

[1] L. Yang, H. Qiu, L. Pan, Z. Guo, M. Xu, J. Yin and X. Zhao, J. Magn. Magn. Mater., 2014, 350, 1–5.

or…

[1] Yang, L. *et al.* Magnetic properties of BaTiO3 and BaTi1−xMxO3 (M=Co, Fe) nanocrystals by hydrothermal method. *Journal of Magnetism and Magnetic Materials* **350,** 1–5 (2014).

Author: Caroline Cencer

Email: caroline.s.cencer@vanderbilt.edu

Affiliation: Department of Cell and Developmental Biology, Vanderbilt University

Title: An apical symphony: the formation of the intestinal brush border

Student Presentation, Invited Speaker

Abstract:

The intestine is lined with finger-like membrane protrusions called villi important for both nutrient absorption and defense against pathogens. Intestinal cells, called enterocytes, line the length of a villus and have smaller protrusions on their apical surface, known as microvilli. Packed tightly together and of uniform length, microvilli appear like bristles on a brush and therefore make up the “brush border”. Enterocytes of the brush border

are constantly renewing, migrating up the villus and shedding off at the tip by apoptosis. The source of these renewing enterocytes are stem cell crypts between adjacent villi. Immature enterocytes in the crypt have few, disorganized microvilli on their surface. However, as the enterocytes move out of the crypt the microvilli then become uniform and pack together. The intermicrovillar adhesion complex (IMAC) is known to be important for the transition to the brush border state. Included in the IMAC are motor proteins, scaffolding proteins and the adhesion proteins protocadherin-24 (CDHR2) and mucin-like protocadherin (CDHR5). Preliminary data suggests that CDHR2 and CDHR5 form apical adhesion complexes of varying strength, strong or weak, to link adjacent microvilli and promote brush border formation. Understanding this clustering behavior of microvilli will fill a critical gap in the mechanism of brush border formation. Since the brush border is necessary for proper gut function, this study will have further implications for intestinal disorders such as microvillus inclusion disease and inflammatory bowel disease.

Author: Prabodha Balapuwaduge, Swati Naik, Liang Hong, Robert Klie and Gabriel Caruntu

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Affiliation: 1)Department of Chemistry and Biochemistry, Central Michigan University, Mount Pleasant, MI. USA, 2)Science of Advanced Materials (SAM), Central Michigan University, Mount Pleasant, MI, USA 3)Department of Physics, University of Illinois at Chicago, Chicago, IL, USA

Title: Soft-solution processing of novel dielectric and photocatalytic nanomaterials by a sacrificial template method

Student Presentation, Poster Session

Abstract:

SrTiO3 has a well-known perovskite crystalline structure and exhibits excellent dielectric, electro-optic and catalytic properties, being the leading candidate in many cutting-edge technological applications. We report here on

the rational synthesis of SrTiO3/TiO2 nanodimensional heterostructures by using TiO2 colloidal nanocrystals as sacrificial templates under different reaction conditions, with the main goal of achieving control over the morphology (size, shape), internal structure and surface composition of the resulting nanoparticles. Both the synthesis of TiO2 nanocrystals and their subsequent conversion into SrTiO3 were performed using a hydrothermal method. These nanostructures were characterized by powder X-ray diffraction (XRD), transmission electron microscopy (TEM), vibrational spectroscopy (Fourier transform infrared spectroscopy (FT-IR) and Raman spectroscopy) and optical absorption measurements. Various reaction parameters have been finely tuned in order to optimize the reaction conditions. A detailed characterization of the dielectric properties of these nanopowders was carried, revealing that dielectric permittivity has a value around 120 at room temperature with a low loss, which make these nanomaterials desirable for applications in energy storage and as dielectrics. Moreover, the photocatalytic properties of SrTiO3-TiO2 heterostructures were analyzed by using dye degradation method under ultraviolet light. An enhanced photocatalytic activity was observed, which can be ascribed to the improved charge separation between photogenerated electrons and holes in conduction and valence bands of SrTiO3 and TiO2. Thus, this synthesis strategy of nanoscale heterostructures is useful to develop functional materials with superior efficiency for implementation into functional electrical devices, as well as photocatalysts.

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Affiliation: BRCF Microscopy Core, University of Michigan

Title: An overview of the Michigan medicine BRCF microscopy core

Plenary Presentation

Abstract:

The Michigan Medicine Microscopy Core is a campus wide light and electron microscopy core. Our light microscopy capabilities include laser scanning and spinning disk confocal microscopy, multiphoton microscopy, fluorescence life time imaging, and

structured illumination microscopy. We offer advice on sample preparation and staining choices, as well as tissue clearing and expansion microscopy on a fee for service basis. We hope to acquire light sheet microscopes in the near future. For electron microscopy, we offer fee-for-service sample preparation (including for CLEM workflows) as well as transmission and scanning electron microscopes. MIL users can also access MC2 electron microscopes in some cases (in Engineering). We hope to acquire high-pressure freezing and freeze substitution capabilities in the near future. We offer full support for quantitative image and data analysis, including on image data sets that were not acquired in the facility. We can also provide fee-for-service training or troubleshooting on your own microscope systems.

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Title: Recent advances in SEM ultralow kV imaging and microanalysis; some amazing data (doing the almost impossible) and some words of caution

Plenary Presentation

Abstract:

There has been a quantum leap in the ability of the scanning electron microscopes (SEMs and EPMAs) to observe and chemically analyze a wider variety of materials. FEG SEMs provide: a very small probe diameter (high-resolution imaging) at very low kVs (high-resolution microanalysis) with high beam currents required for microanalysis and with reduced beam specimen interaction in a bulk sample with previously unattainable nanometer scale resolution at kVs as low as 10V on nonconductive materials both for imaging and analysis with surface sensitive information. These extremely low voltages require different sample preparation and handling procedures. Advances in X-ray spectroscopy, both in EDS and a new novel Wavelength Dispersive Spectrometer (WDS) have also pushed the boundaries to higher mag, lower voltage and lower X-ray energy (soft X-ray) analysis creating new methodologies for specimen observation and analysis. We are also seeing other accessories being integrated into the everyday operation of the electron microscopes. These new state-of-the-art microscopes, detectors and

spectrometers overcome many of the historical limitations. Case studies and examples of the good things (and some of the bad) that can result from ultralow kV imaging and analysis will be presented. Ultralow kV and or ultra-high spatial resolution is a VERY POWERFUL tool, and as with all powerful tools, it needs to be used with caution (keeping an eye out for the non-intuitive). Examples of previously “impossible tasks” will highlight how these new generations of microscopes & spectrometers have pushed the boundaries of electron microscopy for basic research and failure analysis.

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Title: MRI and CT can detect multiorgan failure in the nonhuman primate model of Ebola virus disease

Plenary Presentation

Abstract:

This report describes MRI and CT imaging findings in nine rhesus macaques with 1000 pfu Ebola virus (EBOV) inoculation. CT and MRI were performed at baseline, and after inoculation on day2, day5, and terminal days. MRI was performed with a hepatocyte-specific contrast agent (gadoxetate). Laboratory assays, physical examinations and necropsy were performed. MRI and CT images at baseline and on day2 were normal. On day5, CT showed axillary lymphadenopathy and early lymphedema ipsilateral to the inoculation site, and MRI showed decreased enhancement and mildly decreased biliary function. On terminal days, both showed fulminant hepatic failure and edema, T2 signal loss in the spleen, extensive left axillary adenopathy with chest wall extension, and small bowel dysfunction. Qualitative inspection of MR data revealed time-dependent enhancement in the liver and biliary tract that decreased with disease progression. Laboratory abnormalities include increases in liver enzyme tests that paralleled the imaging findings; bilirubin also increased but severity lagged the imaging findings. Necropsy confirmed the imaging findings by showing extensive hepatic and splenic necrosis and congestion. These cases are illustrative and typical of the clinical course of

Ebola virus infection in this NHP-EBOV model, and faithfully recapitulates the course in humans. MRI and CT in a case of acute EBOV infection demonstrated fulminant multiorgan failure. MRI and CT in a BSL-4 setting can be accomplished and demonstrated diagnostic findings that correlated well with the laboratory, clinical, and necropsy findings. The findings may be diagnostic and may have therapeutic and prognostic implications.

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Title: Distribution of glutamate receptor subtypes on dopamine releasing neurons in the mouse retina

Student Presentation, Platform Session

Glutamate is well known as the primary excitatory neurotransmitter of a synapse, an ultra-connection between pre- and post-synaptic neurons, in the brain as well as in the vertebrate retina. Specifically, the activity of dopamine-releasing neurons in the retina is mediated by glutamate released by pre-synaptic neurons via activation of glutamate receptors. NMDA and AMPA receptors are two distinct subtypes of glutamate receptors. However, the distribution of these two subtypes on dopamine neurons in unclear. Here, we used immunohistochemistry (IHC), an immunofluorescence staining technique, in combination with confocal microscopy to determine the distribution of glutamate receptor subtypes on dopamine neurons in the mouse retina. Four primary antibodies were used for the IHC. An antibody against tyrosine hydroxylase was used to label dopamine neurons. A post-synaptic marker protein (PSD-95) was used to identify post-synaptic sites on dopamine neurons. Antibodies against GluR2 and NR2A were used to reveal AMPA and NMDA receptors, respectively. Z-stacked confocal images were taken and analyzed. We found that dopamine neurons express both subtypes of glutamate receptors, and these NMDA and AMPA receptors are expressed primarily in post-synaptic sites on dopamine neurons. Our results suggest that both AMPA and NMDA receptors are involved in mediating synaptic transmission to dopamine neurons. This synaptic activation of dopamine neurons results in the release of dopamine, which is vital for a wide range of visual functions.

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Title: Transfection of cultured human lens epithelial cells with the gene for αA 66-80

Status: I am a student

Student Presentation, Poster Presentation

Abstract:

The human lens contains αA- and αB-crystallin proteins that function like chaperones to maintain the transparency. With aging, αA-crystallin undergoes various post-translational modifications including oxidation, which leads to degradation, especially the long-lived αA-crystallin within the lens nucleus. Among that αA-crystallin, 66-80 fragmentation occurs due to aging and exposure to high levels of oxygen. Our earlier in vitro studies confirm that the fragment has high affinity to bind to with αA-crystallin, causing the formation of aggregates and nuclear cataract. The purpose of this study is to investigate the role of alpha-A crystallin derived peptide (66-80) in lens protein aggregation by in vitro analysis. To determine the role of αA (66-80) peptide in vitro, cultured human SRA 01/04 lens epithelial cells (LECs) were transfected with a plasmid containing the DNA sequence for αA(66-80) peptide and a GFP tag, at a concentration of 50 µg/mL, along with a plasmid for V72P as a control. LECs were incubated at various time points and analyzed for the production of reactive oxygen species (ROS) by fluorescence staining. Evidence of binding of αA(66-80) peptide was visualized through co-localization of αA(66-80) peptide with αA-crystallin fluorescent stains. The results show that the αA(66-80) plasmid enters cultured human LECs, with the aid of delivery agent Turbofectin, then is translated, resulting in the peptide binding to α A-crystallin and forming aggregates, which result in the generation of reactive oxygen species. This data provides evidence for the role of αA(66-80) peptide in causing human nuclear cataracts.

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Title: Copine A is involved in lysosome maturation and adhesion in *Dictyostelium discoideum*

Student Presentation, Poster Session

Abstract:

Copines are calcium-dependent phospholipid-binding proteins found in many eukaryotic organisms and are thought to be involved in the regulation of membrane trafficking and signaling pathways. We are using Dictyostelium discoideum to study the role of copine A (CpnA) in endocytic pathways. Using flow cytometry, and fluorescence and confocal microscopy, we examined the endocytic and phagocytic properties of wild-type and cpnA knockout (cpnA-) cells. Wild-type cells and cpnA- cells exhibited similar rates of small fluorescent-labeled bead (0.04 μm) endocytosis. However, cpnA- cells had lower amounts of fluorescence and smaller vesicles labeled with beads at the later timepoints, suggesting that they have defects in the maturation of endosomes to lysosomes to postlysosomes. We also monitored postlysosomes and found that cpnA- cells had smaller and fewer postlysosomes. When phagocytosis was assayed, we found that cpnA- cells took up more fluorescent-labeled large beads (1 μm) and GFP-labeled bacteria than wild-type cells. To determine if this was due to increased adhesion properties of cpnA- cells, we treated cells with latrunculin A, which depolymerizes actin filaments and inhibits phagocytosis, and found that in the absence of phagocytosis, more beads were attached to cpnA- cells than wild-type. Adhesion assays showed that cpnA- cells were also more adherent to plastic dishes. Overall, our studies indicate that CpnA is not involved in the initial uptake of materials by endocytosis, but does play a role in later steps of the endocytic pathway. In addition, CpnA has a role in adhesion, which subsequently causes increased phagocytosis.