Title: Surface Texturing for Friction Reduction Via 3D Printing

Author names: Raissa Araujo Borges, Min Zou

Department and Institution: Mechanical Engineering Department, University of Arkansas

Author Contact Information (Tel/email): (864) 603-4568 / raraujob@uark.edu

Poster abstract:

The introduction of surface-texturing is one of the most effective ways to enhance the tribological performance of interfaces because it reduces the real contact area and consequently, the friction forces between the surfaces. Current manufacturing methods, such as laser surface-texturing and photolithography, allow the fabrication of regularly shaped protrusions and holes, inducing precise functionalities to the surface. Although powerful, those techniques have limited design flexibility. Furthermore, pricey and laborious pre- and post-processing steps are required. Additive manufacturing is an alternative to create surface textures with more design flexibility through simpler processing. Herein we demonstrate the applicability of a 3D printer in the fabrication of surface textures for investigation of their effects on the friction forces and wear resistance.

A fused deposition modeling 3D printer was used to make polylactic acid samples from Solidworks models. Surface texturing was introduced by designing cylindrical cavities or hollow cylinders on sample surfaces, which were arranged in different densities with uniform or random-height. Graphite was sprayed on a group of samples to investigate chemistry modification of textured surfaces. Linear reciprocating friction test was performed to evaluate the different types of surfaces. Results show that the addition of graphite significantly reduced the coefficient of friction (COF) by 50%. The lowest COF results were from the uniform height textures, which may be explained by a better load distribution among the cylinders during friction test. Furthermore, the graphite on the uniform height textures was worn off more evenly than that on the textures with random height.
Title: The Effects of Polydopamine Coated Cu Nanoparticles on the Tribological Properties of Polydopamine/PTFE Coatings

Author names: Samuel Beckford and Min Zou

Department and Institution: University of Arkansas, Mechanical Engineering

Author Contact Information (Tel/email): 479-263-6922 sbeckfor@uark.edu

Poster abstract:

This investigation examines the effects of using polydopamine (PDA) coated Cu nanoparticles (PDA-Cu) as a filler in the polytetrafluoroethylene (PTFE) topcoat of a PDA/PTFE dual-layer coating in which PDA is used as an adhesive basecoat. Tribological tests show that the addition of PDA-Cu in PTFE increases the wear life of PDA/PTFE by a factor of two, a durability approximately three orders of magnitude greater than pure PTFE without a PDA basecoat. This increase in wear life is achieved without compromising the low coefficient of friction characteristic of pure PTFE. Scratch tests show that the PDA-Cu filler improves adhesion between the PTFE and the PDA, preventing large scale delamination and also increases the toughness of the coating, preventing ruptures at lower loads.
Title: Photochromic Thermochromic Nanocomposite

Author names: Syed Mohammed Mustafa Akailvi

Department and Institution: University of Arkansas Little Rock

Author Contact Information (Tel/email): smakailvi@ualr.edu

Poster abstract:

We have proposed a new nanocomposite consisting of F-127 polymer, AuNR and thermochromic dyes (TCD) which change color when they are heated above a tunable transition temperature. This nanocomposite has been demonstrated to show rapid, reversible and easily detectable color change at the timescales of ~60ms without degradation of any of its constituents which makes it a good candidate for in-vitro and in-vivo studies of thermal ablation treatment for cancer. This nanocomposite makes it possible to overcome one of the major shortcomings of photothermal therapy (PTT) and plasmonic photothermal therapy (PPTT) by allowing the detection of heating occurring during PPTT to reduce the risk of unintentional thermal damage to healthy tissues alongside cancer cells. In addition to applications in cancer therapy, this material also has potential industrial applications as a component of a remote switching system, laser & radiation safety equipment and low power, ambient light based display systems.
Title: Removal of Nitrophenols and Chloramphenicol from Water Using Cellulose-based N-doped and Metal Oxide Containing Doped Carbonaceous Materials.

Author names: Ambar Bahadur Rangu Magar¹, Hunter Wayland¹, Charlette M. Parnell², Yahya Albkuri¹, Susan Boury¹, Ganesh Kannarpady², Alexandru S. Biris², Anindya Ghosh¹*

Department and Institution:

¹Department of Chemistry, University of Arkansas at Little Rock, 2801 South University Avenue, Little Rock, AR 72204, USA

²Center for Integrative Nanotechnology Sciences, University of Arkansas at Little Rock, 2801 South University Avenue, Little Rock, AR 72204, USA

*Corresponding author

Author Contact Information (Tel/email): +15016135025 abrangumaga@ualr.edu and axghosh@ualr.edu

Poster abstract:

Nitrophenols and their derivatives are highly toxic. They are mutagenic and bio-refractory pollutants commonly present in many natural water resources and industrial waste water. Chloramphenicol is a broad-spectrum antibiotic that is considered a contaminant of emerging concern due to its persistence and toxicity. In order to remove nitrophenols and chloramphenicol from water, N-doped carbonaceous materials were prepared simply by heating a mixture of cellulose and nitrogen containing benign material such as dopamine or urea. We also synthesized a few other doped nanocomposite materials using metal oxides (e.g. TiO₂). The materials were characterized by scanning electron microscopy and x-ray photoelectron spectroscopy. Experiments were carried out in the absence and presence of visible light irradiation. The control reaction was done in the absence of TiO₂ and both dopamine and TiO₂. Removal of nitrophenol was further studied under several parameters such as solution pH and its initial concentration, different ratios of cellulose and nitrogen containing material in the absorbent and the doses of absorbent used. The absorbent material showed the most efficient result when absorbent dose was high in acidic solution with low initial concentration of nitrophenol. Moreover, when absorbent was doped with large amount of dopamine, nitrophenol removal increased significantly. Cellulose doped with urea, mixed with TiO₂, and pyrolyzed was found to be effective in degradation of chloramphenicol in aqueous solution at pH 7 under visible light conditions. The material causes degradation of the antibacterial agent under these conditions, and control trials do not appear to result in degradation of the chloramphenicol to any significant degree within the two hour studies. Thus prepared materials were found to be effective for both absorption and degradation of organic pollutants.
Title: Novel Self-Assembly of Fullerene Based Dyads

Author names: Ashley Anderson and Brian Berry

Department and Institution: Applied Science, Chemistry UALR

Author Contact Information (Tel/email): 501-773-6964 / adanderson2@ualr.edu

Poster abstract:

Porphyrrins are a critical component in natural photosynthesis due to their ability to undergo photoinduced electron transfer. This property also makes porphyrins excellent candidates for applications such as solar cells, water splitting, and sensing. Researchers have previously tethered porphyrins to fullerene (C\textsubscript{60}), an excellent electron acceptor, to mimic the reaction centers in photosynthesis. Photoinduced electron transfer in these donor-acceptor dyads has been investigated with particular focus on factors such as the donor, acceptor, and linker between the two. The goal of this project is to study nanostructured donor-acceptor dyads created using liquid-liquid interfacial precipitation (LLIP). LLIP is a self-assembly technique in which supramolecular 1, 2, and 3-D structures are fabricated. The morphology of these LLIP structures can be tuned by adjusting a variety of parameters. Specifically in this work, a porphyrin-C\textsubscript{60} dyad has been synthesized using 5-(4-NH\textsubscript{2}-phenyl)-10, 15, 20-triphenylporphyrin and [6, 6]-phenyl-C\textsubscript{61}-butyric acid (PC\textsubscript{61}BA). Preliminary characterization data of the covalently bonded porphyrin-C\textsubscript{60} dyad will be shown. Future work includes elucidating the effect of factors such as the position at which the acceptor moiety is linked to the porphyrin as well as metal cation contained in the porphyrin ring. Factors controlling the morphology via LLIP such as the solvent and ratios will also be investigated.
Title: Synthesis, Characterization and the Photocatalytic activity of Cellulose-Based Doped Nanocomposites in Degradation of Organic Dyes under Visible Light

Author names: Bijay Paudel Chhetri¹, Charlette M. Parnell², Dave Soni¹, Anil P. Thankam¹, Fumiya Watanabe², Ganesh Kannarpady², Alexandru S. Biris², Anindya Ghosh¹*

Department and Institution:

¹Department of Chemistry, University of Arkansas at Little Rock, 2801 South University Avenue, Little Rock, AR 72204, USA

²Center for Integrative Nanotechnology Sciences, University of Arkansas at Little Rock, 2801 South University Avenue, Little Rock, AR 72204, USA

*corresponding author

E-mail: axghosh@ualr.edu, Phone: 501-400-4422, Fax: 501-569-8838

Author Contact Information (Tel/email): 501-316-6004/ bpchhetri@ualr.edu

Poster abstract:

Doped cellulose nanocomposites were synthesized by using a low cost, environmentally benign resource. Cellulose, which is an abundant and renewable bio-polymer, was used as a carbon source during fabrication of the doped nanocomposite. Synthesis of this material was accomplished by simple mixing, and annealing at 900 °C in a tube furnace under nitrogen atmosphere for 2 hr. The black nanocomposite was grinded into mortar to obtain in a fine powder form. In a similar way, different nanocomposites materials were also synthesized by changing the ratio of cellulose in the material. The doped nanocomposites were characterized via various characterization techniques such as X-ray photoelectron spectroscopy and scanning electron microscopy. The photocatalytic activity of the nanocomposites was studied in the presence of several dye solutions under visible light irradiation. Control studies were performed in the absence of light with the nanocomposites and under light irradiation without the nanocomposites present. An ultraviolet-visible spectrometer was used to measure photocatalytic activities. The results showed that the doped cellulosic nanocomposites possess a higher percentage removal of dye under visible light conditions, which alluded to their photocatalytic nature. Additional studies were conducted in various pH environments and organic dyes (i.e. methyl orange, orange IV, alcian blue, etc.). Therefore, integration of cellulose via a simple synthetic process proved to be sufficient for dye removal and could be further used for the pollution mitigation from wastewater.
Title: Surface Enhanced Infrared Absorption on Optimized Copper Nanostructures

Author names: Bakarie Branch, Mary Lindsey, Morgan Sweere, William Henry, Donald Perry

Department and Institution: University of Central Arkansas, Department of Chemistry

Author Contact Information (Tel/email): Bakarie Branch: (879) 514-6052, bbranch1@cub.uca.edu; Mary Lindsey: (501) 837-3560, mlindsey2@cub.uca.edu

Poster abstract:

It has long been thought that Cu nanostructures are inferior to Ag and Au nanostructures for surface-enhanced infrared absorption (SEIRA) in terms of achievable enhancement factors in part because of the rapid oxidation of Cu versus Ag and Au. It is demonstrated here that Cu nanostructures fashioned by oblique angle deposition (OAD) of gaseous Cu atoms onto CaF$_2$ substrates have SEIRA enhancement factors obtained in open air that are close to par with Ag and Au nanostructures formed using vapor deposition at an incident angle (no substrate tilt). Cu nanostructures grown at incident show about x5 in SEIRA enhancement of a $p$-nitrobenzoic acid (PNBA) monolayer and have a broad range of over 100 nm in particle size. Conversely, Cu nanostructures deposited by OAD show SEIRA enhancement of approximately x40 and are more uniform in size with approximate circular shapes averaging 25 nm and spacing less than 10 nm.
Title: Characterizing the Interactions of Dopamine and Nature-Inspired Polydopamine

Author names: Caleb Denton, Grekeem Cartwright, Kate Myers, Brandon Wilde, Donald Perry

Department and Institution: University of Central Arkansas, Department of Chemistry

Author Contact Information (Tel/email): Caleb Denton: (501) 205-6194, cdenton2@cub.uca.edu; Grekeem Cartwright: (501) 470-6770, gcartwright1@cub.uca.edu; Kate Myers: (918) 857-1379, mmyers7@cub.uca.edu

Poster abstract:

Dopamine, a major brain chemical, undergoes oxidative polymerization to form polydopamine (PDA), a mussel-inspired polymer with versatile characteristics. PDA mimics a protein that mussels utilize to adhere to their respective substrate with exceptional binding force. PDA possesses biocompatibility and adhesive properties that allow it to attach to hydrophobic and hydrophilic surfaces. The aforementioned characteristics have allowed PDA to become a novel candidate as an intermediate for a variety of hybrid materials including multi-layers systems involving polytetrafluoroethylene (PTFE-or Teflon).

PDA’s adhesive properties allow it to attach to both organic and inorganic substrates. This characteristic has attracted considerable interest for PDA in multiple disciplines that involve surface chemistry and nanotechnology. However, PDA’s structure and adhesion mechanism remain elusive. The goal of this research is to characterize the interactions of dopamine and PDA with its respective binding components by utilizing various experimental and theoretical approaches.

Surface-enhanced infrared absorption (SEIRA), surface-enhanced Raman spectroscopy (SERS), temperature-programmed desorption (TPD), and density functional theory are being employed to investigate the adsorption of dopamine on Ag, Au, and Cu nanostructures. DFT is also being used to determine the binding energies and corresponding intermolecular attractions between various PDA/PTFE complexes.
Title: Nano-Scratch Study of PTFE with and without Silicon Embedded Nanoparticles

Author names: Matthew Brownell and Arun. K. Nair

Department and Institution:

1Department of Mechanical Engineering, University of Arkansas, 863 W. Dickson St, Fayetteville, AR, 72701, USA.

2Institute for Nanoscience and Engineering, 731 W. Dickson Street, University of Arkansas, Fayetteville AR-72701.

Author Contact Information (Tel/email):

*Corresponding author: nair@uark.edu, Ph: 479-575-2573, fax: 479-575-6982

Poster abstract:

Polytetrafluoroethylene (PTFE) is low friction materials desirable for many applications, however it has poor wear resistance making its uses limited. It has been established that by introducing Silicon Dioxide nanoparticle fillers in PTFE, it can reduce the wear rate of PTFE while maintaining a low coefficient of friction. However the nanoscale mechanisms associated with this process needs further investigation. We study the interaction of PTFE with Silicon nanoparticles to better understand how wear resistance in PTFE is affected at the nanoscale. We use molecular dynamics simulations to conduct indentation and scratch tests on PTFE chains and silicon nanoparticles imbedded within PTFE layers. We use ReaxFF force field to model the interactions between silicon and PTFE. Scratch tests are conducted at 0, 45, and 90 degrees normal to the PTFE chain orientation on both samples. Preliminary results show that scratch tests parallel to chain orientation show increase in resistance to the indenter and a low resistance to the indenter is predicted in the direction perpendicular to the chain orientation.
Title: Multi-asperities and its Effect on Frictional Properties on Aluminum Surface

Author names: S. Raghuram Reddy¹ and Arun. K. Nair ¹,²,*

Department and Institution:
¹Department of Mechanical Engineering, University of Arkansas, 863 W. Dickson St, Fayetteville, AR, 72701, USA.

²Institute for Nanoscience and Engineering, 731 W. Dickson Street, University of Arkansas, Fayetteville AR-72701.

Author Contact Information (Tel/email):
*Corresponding author: nair@uark.edu, Ph: 479-575-2573, fax: 479-575-6982

Poster abstract:

Asperities are considered as unevenness of surfaces, in other terms it is also called as surface roughness. The surfaces that are finely polished are still considered having unevenness at the atomic scale. This unevenness of the surface reduces the actual contact area when two surfaces come into contact. Therefore, understanding the asperities is very important because the friction and wear properties depend on nano scale contact between surfaces. Many experimental studies concluded that some surface texture could help in improving the contact characteristics and reduce the frictional forces. In order to study atomic scale characteristics, we use molecular dynamics (MD) simulations to study the frictional and mechanical responses of an aluminum surface with single and multiple asperities. The atomic mechanisms representing specific defect structure are compared to the observed frictional and mechanical response of the material. We have developed multi-asperity model, which resembles the true surfaces. Spherical and cylindrical asperities are studied individually and compared. The results obtained from these studies are expected to guide the experimental group to design multi-asperity surfaces.
Title: Mechanical Properties of Graphene and Carbyne as Laminates in Nickel Matrix

Author names: Scott Muller¹, Tim Schlenger¹ and Arun. K. Nair ¹,²,*

Department and Institution:
¹Department of Mechanical Engineering, University of Arkansas, 863 W. Dickson St, Fayetteville, AR, 72701, USA.

²Institute for Nanoscience and Engineering, 731 W. Dickson Street, University of Arkansas, Fayetteville AR-72701.

Author Contact Information (Tel/email):
*Corresponding author: nair@uark.edu, Ph: 479-575-2573, fax: 479-575-6982

Poster abstract:
Graphene is a two-dimensional material with superior mechanical properties, and much research has been done to explore its potential use in future applications. Previous experimental work has observed that graphene is able to prevent dislocation propagation between different regions in a metal matrix. And under some circumstances graphene has also exhibited ultralow friction characteristics, or superlubricity. Our research separately explores both of these two key mechanical behaviors. First, using molecular dynamics, we test the effect graphene has on dislocations generated by a crack tip within a Ni-graphene nanocomposite under mode I loading normal to the graphene sheet. It is found that dislocations generated from a crack tip within the Ni matrix are unable to propagate through the graphene sheet, preventing plastic deformation caused by the crack. Second, we use steered molecular dynamics to study the tribological behavior of graphene sheets of varying width placed atop Ni (111) surface. The interface properties of graphene sheet and Ni (111) surface are studied by conducting shear and peeling tests. Carbyne, a one-dimensional carbon allotrope, is also tested in this study and its tribological properties on the Ni (111) surface are compared to those of graphene.
Title: Detection of Nanoparticle- and Drug-induced Apoptosis in Circulating Cells

Author names: Jacqueline Nolan, Chenzhoung Cai, Kai A. Carey, Dmitry A. Nedosekin, and Vladimir P. Zharov

Department and Institution: Arkansas Nanomedicine Center, University of Arkansas for Medical Sciences, Little Rock, AR

Author Contact Information (Tel/email): janolan@uams.edu / 501-912-1225

Poster abstract:

The detection and enumeration of apoptotic and necrotic cells in response to nanoparticles (NPs) is important to control nanoparticle toxicity and efficiency of anti-tumor therapy. Previous studies recorded in vitro are not able to be effectively translated into in vivo conditions, as invasive extraction of cells from a living system may alter cell properties (e.g., morphology or marker expression), induce artifacts, or prevent the long-term study of cell-NP and cell–drug interactions in their biological environment. Another limitation is the low sensitivity in detecting rare circulating apoptotic tumor cells (CTCs) that are indicators of metastatic progression. Here we show that these limitations can be overcome by the use of in vivo flow cytometry (FC), which allows real-time monitoring of circulating normal blood cells and CTCs in response to NPs and anti-tumor drugs. We introduce high speed, multicolor in vivo FC that integrates photoacoustic (PA) fluorescence FC (PAFFC) to demonstrate a promising preliminary application of this unique technique for detection of rare circulating apoptotic cells in a mouse model. The verification of this approach was performed initially in vitro by the induction of apoptosis in cancer cells using a chemical apoptotic inductor (H₂O₂) and compared with apoptosis induced by graphene NPs. followed by the injection of these cells in the circulatory system of a mouse. PA and fluorescence channels were used to detect cells with graphene and apoptotic cells in microvessels of the mouse’s ear. The coincidence of PA and fluorescence signals indicated cells with graphene–induced apoptosis.
Title: Inertial Force-Driven Synthesis of Gold Nanosphere Composites with Tunable Near-Infrared Plasmon

Author names: Joseph Batta-Mpouma\textsuperscript{1, 2, 3}, George Sakhel\textsuperscript{1, 2}, Arvind Sinha\textsuperscript{1, 2}, Vladimir P. Zharov\textsuperscript{4}, and Jin-Woo Kim\textsuperscript{1, 2, 3}

Department and Institution: \textsuperscript{1}Bio/Nano Technology Laboratory, Institute for Nanoscience & Engineering; \textsuperscript{2}Department of Biological & Agricultural Engineering; \textsuperscript{3}Microelectronics & Photonics Graduate Program, University of Arkansas, Fayetteville, AR 72701; and \textsuperscript{4}Arkansas Nanomedicine Center, University of Arkansas for Medical Sciences, Little Rock, AR 72205

Author Contact Information (Tel/email): (479)-200-0570 / jnbattam@uark.edu

Poster Abstract:

Nanoparticles (NPs) with plasmonic response in the near-infrared (NIR) region like gold (Au) nanorods (GNRs) are important in biomedical fields because of their transparency for biological tissues. Although GNRs are sought after as contrast agents for theranostics in cancer studies, capping ligands like cetyl trimethyl ammonium bromide (CTAB) used for the GNR synthesis are toxic for biological tissues. This work presents a physicochemical method to synthesize an alternative to toxic GNRs. Our synthesis process, using citrate-capped colloidal Au NPs, was simple, cost-effective, and did not require a toxic chemical like CTAB. The inertial (gravitational \([g]\)) force-driven formation of nanosphere composites (NSCs) resulted in two NPs combined together with little or no gaps between them. NSCs showed rod-like characteristics, which are typified by the evolution of absorption spectra from the transverse to longitudinal mode, similar to GNRs. When three combinations of Au NPs with different diameter sizes were used, heterodimers were formed and their plasmonic wavelength values shifted further to the right compared to those of homodimers, demonstrating high promise of NSCs plasmonic tunability towards NIR. The new nanomaterials by the g-force-driven technique showed high potential to be an effective alternative to GNRs.
Title: Bioinspired Hemozoin Nanocrystals as High Contrast Photothermal and Photoacoustic Agents.

Author names: Kai A. Carey, Yulian A. Menyaev, Chengzhong Cai, Dmitry A. Nedosekin, Mustafa Sarimollaoglu, Ekaterina I. Galanzha, Jason S. Stumhofer, Vladimir P. Zharov

Department and Institution: Arkansas Nanomedicine Center, University of Arkansas for Medical Sciences

Author Contact Information (Tel/email): 501.838.6900 / kcarey@uams.edu

Poster abstract:

Unprecedented nanotechnological advances promise to revolutionize deadly disease diagnosis and therapy by enhancing imaging contrast and improving drug/vaccine delivery. Nevertheless, challenges still remain in treating malaria which kills over half a million people every year. Early disease diagnosis and accurate staging are crucial for good treatment outcomes. We show here that early noninvasive (needleless) label-free diagnosis and, hence well-timed treatment of malaria are feasible by the use of hemozoin (Hz) nanocrystals as intrinsic high contrast photoacoustic (PA) agents in combination with in vivo PA flow cytometry (PAFC). Hemozoin, with the average size of 50-400 nm are created in infected red blood cells (RBCs) as a result of detoxification of the byproducts from hematophagous parasites, in particular, P. yoelii. We discuss the properties of these not yet well characterized nanoparticles (NPs) and demonstrate that they can provide very high levels of PA contrast in infected RBCs above hemoglobin background comparable to that of engineered artificial metal NPs used for targeting circulating tumor cells and bacteria. Moreover, laser-induced vapor nanobubbles around overheated hemozoin nanocrystals as a PA signal amplifier makes it possible to detect rare infected RBCs even in deep vessels that improve diagnostic speed and sensitivity. PA detection of hemozoin in combination with fluorescent detection of GFP-expressing parasites provide a detailed real-time picture of infection dynamics. Laser disruption of hemozoin containing RBCs may be used for destruction of infected cells. We are confident that natural hemozoin nanoparticles may find multiple applications in health care similar to those of metal engineered nanomaterials.
Title: Synthesis and Characterization of Polydopamine Coated Nanostructures

Author names: Leanne E. Mathurin, Emily K. Miller, Savannah Ullrich, Jingyi Chen

Department and Institution: Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville, AR

Author Contact Information (Tel/email):
- Chen - 479-575-6203, chenj@uark.edu
- Leanne Mathurin – (479)575-3883, lmathuri@uark.edu

Poster abstract:

Polydopamine is a bioinspired polymer that mimics the adhesive function of proteins secreted from mussels. Polydopamine can be deposited on the surface of nanoparticles forming a coating layer that enables their use in various applications including energy storage, pollution reduction, and nanomedicine. In this work, we develop a polydopamine coating process for oil-based copper nanostructures with various morphologies, which can be utilized as fillers in tribology applications to engineer a durable, low friction surface. Since the polymerization of dopamine generally occurs in an alkaline, aqueous solution, several surface modification strategies for phase-transferring nanomaterials from oil phase to aqueous phase were developed. This research compares the different phase transfer and coating methods’ influence on nanomaterial morphology and the polydopamine layer. This research also optimizes the polydopamine coating process on aqueous phase nanostructures. We have developed an in situ method for tuning the structure and thickness of polydopamine layer as well as monitoring the coating process on aqueous based nanostructures. This method is based on the change of localized surface plasmon resonance of metal nanoparticles. The advantage and limitation of this method will be discussed.
Title: Mie's Scattering Theory for the Analysis of the Plasmonic Resonance of Metal Nanospheres and Core-shell Nanoparticles.

Author names: Mohammad Habibur Rahaman and Brandon A. Kemp

Department and Institution: College of Engineering, Arkansas State University

Author Contact Information (Tel/email): mohammad.rahaman@smail.astate.edu

Poster abstract:

An alternate correction of Mie scattering theory for the analysis of plasmonics resonance of metal nanosphere is proposed. The analysis is based on the correction of Mie scattering theory originally developed for negative index media, which employs a solution using the Ricatti-Bessel functions in the calculation of Mie coefficients. Therefore, the viewpoint of a time-reversal problem for the scattered fields is not a necessary, fundamental correction to the Mie scattering theory for spherical metal particles. We have also presented a study of the Lorentz force on a metallic Mie particle using the bound and free current and charges, which are actually modelled for complex permittivity and permeability. The Lorentz force on silver and gold Nano-particle are calculated where the particles are illuminated by TE polarized plain wave. We are also working on an analytical solution of Mie scattering theory which was developed for negative index media for the case of core shell particle. Mie scattering theory of homogeneous isotropic sphere will be further expanded for the core shell homogeneous particle. We have validated our analytical simulation results with finite element results in COMSOL Multiphysics. We are working toward simplifying the solution to a closed form approximation for modeling the interactions of multiple, core-shell nanoparticles, which is useful for experimental researchers designing tunable surfaces.
Title: Piezo Response Coefficient of Barium Titanate

Author names: T. Al. Morgan, M. Zamani-Alavijeh, G. Story, A. Schroeder, A. V. Kuchuk, M. Benamara, G. J. Salamo

Department and Institution:
Institute for Nanotechnology and Engineering, University of Arkansas

Author Contact Information (Tel/email): 479-203-8270  mzamania@uark.edu

Poster abstract:

Ferroelectric materials have intrinsic polarization, piezoelectric properties, high tunable dielectric constant, and surface charges. They have applications in non-volatile memories, solar, and actuators. All these properties are tunable with electric field. We have investigated ferroelectric properties of off-stoichiometric grown 40 nm thin films barium titanate using PFM. We quantitatively compared the piezoelectric coefficient (d33) for a broad range of material properties (stoichiometry, lattice parameter). We found d33~4pm/v for most of them with which other reported values of piezo response for BTO measured by PFM agrees. This indicates that BTO persists to have ferroelectric properties in a variety of off-stoichiometry and lattice parameters.
Title: Development of an Image Analysis Toolbox for ECM Fiber Structure Analysis

Author names: Samia Sanjari, Dr. Brandon Kemp
Department and Institution: Department of Engineering, Arkansas State University
Author Contact Information (Tel/email): samia.sanjari@smail.astate.edu, bkemp@astate.edu

Poster abstract:

Researchers are using artificial extracellular matrix (aECM) to generate new tissues from cells, to control the cell behaviors, and to replace the damaged tissues. Recent studies show that biological function of extracellular matrix are highly correlated to its structure and by varying the structural property of ECM it is possible to control the cell behavior. In order to develop the next generation aECMs it is very important to understand the aECM fiber structure and to analyze how cells are interacting with it and remodel it. Automatic cell image analysis plays a vital role to achieve this aim. In this study we have developed a toolbox by using the Matlab software to measure the mean pore size, length and diameter of ECM fiber structure from the microscope images. The pore size of the extracellular matrix is an important parameter that governs its mechanical properties and influences the ability of cells to colonize and migrate through the ECM. A simple circle fitting technique is used to calculate the average pore diameter of fibrous structure. Euclidean distance mapping (EDM) technique is applied to find the distance between the nearest fiber structures and local regional maxima of the EDM is computed to locate the center points of largest circles that fit into the pores. To measure the Fiber length and diameter curve fitting technique have been applied. Also several image preprocessing techniques have applied to remove noise and extract accurate information from the microscope images.
Title: Growth of Different Structural Phases of Barium Titanate

Author names: T. Al. Morgan, M. Zamani-Alavijeh, G. Story, A. Schroeder, A. V. Kuchuk, M. Benamara, G. J. Salamo

Department and Institution: Institute for Nanotechnology and Engineering, University of Arkansas

Author Contact Information (Tel/email): 501.222.7340, tamorga@uark.edu

Poster abstract:

Barium titanate (BTO) is a ferroelectric material. It has a giant polarization, dielectric constant, and surface charge which are all tunable with applied electric field, strain, light, or composition. Molecular Beam Epitaxy (MBE) was used to grow 40nm BTO thin films on STO:Nb (0.5%) substrates. We adjusted the titanium and barium deposition times using Reflection High Energy Electron Diffraction (RHEED) oscillations as a guide to change the titanium-barium ratio to be off stoichiometric. The titanium-barium ratio varied from 0.67 – 1.23 as measured by X-ray Photoelectron Spectroscopy (XPS). The lattice parameter for the whole film was determined using X-ray Diffraction (XRD) and the surface morphology was determined using Atomic Force Microscopy (AFM). For a wide variety of RHEED oscillation patterns, a majority of the films had a lattice parameter close to bulk BTO. The surface chemistry and morphology varied significantly between the films with similar lattice parameter, suggesting nature prefers to form BTO over defects or other material phases. This is the first step in a new and exciting opportunity to explore the potential of designing a material “made of nanoscale interfaces” which dominates the material response to an outside stimulus and stimulates discovery of novel phenomena and enhanced tunable properties.
Title: “Regulation of Endoplasmic Reticulum Stress Mediated Apoptosis by Inositol Polyphosphate Metabolizing Enzyme, Minpp1”

Author names: Pooja Singh*, Mohd Zubair*, Surya Kilaparty and Nawab Ali

Department and Institution:
Department of Biology, College of Arts, Letters and Sciences, University of Arkansas at Little Rock.

Author Contact Information (Tel/email):
Pooja Singh: 1-405 334 3672; pxsingh1@ualr.edu
Mohd Zubair: 1-501 502 5621; mxzubair@ualr.edu
Surya Kilaparty: 1-501 442 0770; kskilaparty@ualr.edu
Nawab Ali; 1-501 247 3248; nali@ualr.edu

*presenting student authors

Poster abstract:

The endoplasmic reticulum (ER) is responsible for various cell functions including protein synthesis, folding, transport, and calcium homeostasis. These processes are essential for normal cell function. Environmental stressors including those induced by nanomaterial exposure are likely to affect ER function. Mitochondria plays key signaling roles in programmed cell death called apoptosis. Recent investigations have proposed a signaling relationship between mitochondria and ER. ER membrane structure is also affected by apoptotic signals. Multiple Inositol Polyphosphate Phosphatase1 (Minpp1), a luminal soluble protein which resides in ER, is known to metabolize inositol polyphosphates (InsPs). These InsPs play a key signaling role in various cellular processes including apoptosis. The role of Minpp1 in apoptosis is not known. In this study, changes in Minpp1 expression were investigated under various cellular stress conditions including apoptotic, osmotic, oxidative, and heat shock stress. The expression of Minpp1 was correlated with apoptotic and ER stress markers. Knocked down of the Minpp1 expression by Minpp1 specific Si-RNA suppressed the expression of Minpp1 and attenuated apoptosis. These results suggest that the ER proteins are involved in apoptosis and cell stress.
Title: Multifunctional Engineered Surfaces Using Deformation-resistant Core-shell Nanostructures

Author names: Drew Fleming and Min Zou

Department and Institution: Department of Mechanical Engineering, University of Arkansas

Author Contact Information (Tel/email): dxf04@uark.edu / (870) 307-3644

Poster abstract:

Engineered surfaces with high durability and low friction have been developed using patterned arrays of novel Al/a-Si core-shell nanostructures (CSNs). To fabricate these surfaces, Al nanodots with diameters of 100-300 nm were produced with electron beam lithography and metal lift-off, and then coated with a conformal shell of PECVD a-Si to create well-ordered arrays of CSNs. Significantly lower friction (COF = ~0.016) and minimal detectable nanostructure deformation are observed after nanoscratch testing on the CSNs, in contrast to surfaces patterned with bare Al nanodots, which show both higher friction (COF = ~0.05) and heavy deformation of the Al nanostructures. This deformation-resistant behavior is hypothesized to be enabled by dislocation activities within the confined Al core of the CSNs, with supporting molecular dynamics simulations showing that dislocations nucleated in the cores of the CSNs during loading are annihilated after removal of the applied load, leading to recovery of plastic deformation. The results of this study provide an avenue for fabricating nanostructure-textured surfaces with both low friction and deformation resistance and can potentially serve as a foundation for fabricating surfaces with additional novel functionalities.
Title: Novel Surface Modifications of Cellulose Polymer – Click Chemistry on TEMPO Cellulose Surfaces

Author names: Punnamchandar Ramidi, Narsimha Reddy Penthala, Shobanbabu Bommagani and Peter A. Crooks*

Department and Institution: Department of Pharmaceutical Sciences, College of Pharmacy, University of Arkansas for Medical Sciences, Little Rock, AR-72205

Author Contact Information (Tel/email): PRamidi@uams.edu, PACrooks@uams.edu

Poster abstract:

Cellulose is the most abundant naturally available polymer and consists of repeating anhydroglucose unit (AGU) with equatorial 1 to 4 linkages, and it has many beneficial properties such as, hydrophilicity, biocompatibility, biodegradability, stereoregularity, multichirality, reactive hydroxyl groups and the ability to form superstructure, all of which make this polymer very promising for various industrial and biological applications. Although cellulose has many useful applications, it possesses poor processability and solubility, which is likely due to the possibility for inter-molecular and intra-molecular hydrogen bonding. In order to utilize cellulose more effectively, the primary hydroxyl groups need to be chemically modified by regioselective chemical modification. The goal of this project is to develop novel scalable, hierarchical cellulose self-assembly processes for manufacturing more complex, controlled, and sustainable cellulose-based regulated multifunctional surfaces. This will be achieved by structural modification of cellulose by investigating covalent and ionic attachment of chemical moieties onto carboxylated and sulfated cellulose surfaces. We have successfully synthesized carboxylated cellulose polymers by employing 2,2,6,6-tetramethyl-1-piperidinyloxy (TEMPO) in the presence of a primary oxidizing agent such as sodium hypochlorite (NaOCl). TEMPO catalyzes the conversion of carbohydrate primary alcohols to carboxylate (COO−) functionalities. TEMPO oxidized cellulose represent a unique platform for carrying out a plethora of surface modifications and for generating a myriad of functional moieties via covalent grafting techniques. We have performed novel surface click chemistry reactions on TEMPO cellulose surfaces in order to generate novel cellulose surface architectures.
Title: Digitization and Direct Laser Writing of Natural Surfaces

Author names: Mahyar Afshar Mohajer, Min Zou

Department and Institution:
Department of Mechanical Engineering, University of Arkansas

Author Contact Information (Tel/email): 470-881-0892 / mafsharm@email.uark.edu

Poster abstract:

Natural surfaces have been a great source of inspiration for producing surfaces with a wide variety of functionalities and applications. Different techniques have been utilized for producing bioinspired surfaces such as soft lithography [1], ion beam roughening [2], and nanocasting [3]. With the advent of CAD/CAM systems, digital models combined with 3D printing techniques have shown to be very promising routes for surface fabrication. Using high resolution 3D laser scanning microscopy, it is possible to digitize the surfaces of interest such as surfaces found in nature with less than 200 nm resolution. Using advanced 3D printing techniques, such as direct laser writing, the digitized surfaces with micro and nanoscale features can then be fabricated. Here we show the proof of concept of scanning a surface found in nature using a 3D laser scanning microscope, obtaining the CAD model of the surface and printing it using a 3D laser lithography system. This concept will be integrated with other fabrication processes to create bioinspired multifunctional surfaces.


Title: Quantitative Microinjection for Studying Directed Neural-Stem Cell Differentiation

Author names: Christopher L. Moore, Erin M. Taylor, Kelly K. Ball, Laura J. Bernock and Michael J. Borrelli

Department and Institution: Department of Radiology
University of Arkansas for Medical Sciences

Author Contact Information (Tel/email): 501-526-6147 / cmoore3@uams.edu

Poster abstract:

The goal of the Artificial Extracellular Matrix (aECM) Thrust is to produce and develop aECMs that outperform natural ECMs in promoting neural-stem cell (NCS) differentiation into specific neuron types. Microinjection of compounds into NSCs grown on aECMs will be necessary to elucidate cell signaling pathways responsible for aECM directed differentiation. A problem with microinjection is determining the exact amount of compound injected into each cell. We developed a method for quantifying the microinjected volume using fluorescent dextran as a co-injected tracer molecule of known concentration to produce a fluorescence vs. volume calibration curve. Aqueous dextran solution was microinjected onto a superhydrophobic surface-coated dish containing si550 silicone and light mineral oil. This produced various sized, spherical droplets whose diameter and fluorescence intensity were measured with a fluorescence microscope. The formation of spheres on the hydrophobic surface allowed droplet volumes to be easily calculated from diameter measurements. A calibration regression line was generated by plotting droplet fluorescence vs. droplet volume. Prostate Dut-145 cells were microinjected with fluorescent dextran and cell fluorescence was captured under identical conditions as the droplets. The droplet regression line was used to determine the injected volume based on cell fluorescence. Advantages of this method include rapid quantitative analysis of injection volumes and no need to calibrate each microinjection pipet for injection length and pressure values. Quantitative microinjection provides a tool for understanding the process of natural and aECM directed cellular differentiation which has many potential scientific and medical applications such as NSC implantation therapy for brain trauma.
Title: Tuning Optoelectronic Properties of Single-Walled Carbon Nanotubes by Selective Adsorption of Sodium Dodecyl Sulfate (SDS)

Author names: Jakob Hockman, Arvind Sinha and Jin-Woo Kim

Department and Institution: Bio/Nano Technology Laboratory, Institute for Nanoscience & Engineering and Department of Biological & Agricultural Engineering, University of Arkansas, Fayetteville, AR 72701

Author Contact Information (Tel/email): 417-438-6512; jthockma@uark.edu

Poster abstract:

Gel filtration with sodium dodecyl sulfate (SDS) dispersed single-walled carbon nanotubes (SWNTs) was used to separate SWNTs based on electronic and optical subtypes. Samples enriched in either metallic or semiconducting SWNTs (m- and s-SWNTs, respectively) were isolated and characterized using absorbance spectroscopy using a method optimized for biological applications. At least three unique peaks in the near-infrared region were detected from separated samples in semiconducting SWNTs. The optical response of individual nanotube samples was shown to be dependent on the length of sonication used to disperse the SWNTs. We successfully demonstrated the use of this method to tune the optical and electronic properties of SWNT-based materials for biological applications.
Title: Inflammatory Factors in Extracellular Matrix Modulate the Repertoire of Proteins Secreted by Astrocytes via Exosomes

Author names: Rajshekhar A. Kore\textsuperscript{1}, Edathara C. Abraham\textsuperscript{2}, Robert J. Griffin\textsuperscript{1}

Department and Institution:
\textsuperscript{1}Department of Radiation Oncology, University of Arkansas for Medical Sciences, Little Rock, Arkansas 72205;
\textsuperscript{2}Department of Biochemistry & Molecular Biology, University of Arkansas for Medical Sciences, Little Rock, Arkansas 72205

Author Contact Information (Tel/email): rakore@uams.edu ; RJGriffin@uams.edu

Poster abstract:

Astrocytes constitutively secrete exosomes, a set of distinct nanovesicles (30-100 nm) of endosomal origin. In the human brain, exosomes are involved in mediating intercellular communication by their ability to deliver protein and genetic cargo leading to modulation of tissue microenvironment and cellular fate. During various pathological conditions, proinflammatory cytokines like interleukin-1 beta (IL-1\textbeta) and tumor necrosis factor-alpha (TNF-\textalpha) are elevated in the brain extracellular matrix and in serum. Among others, these cytokines play an important role in progression of neuroinflammation. We have recently studied these processes in glioma cell lines.

Exosomes (~70-80nm in size) secreted by cytokine-stimulated astrocytes rescue both glial and neuronal cells from oxidative stress induced cell death. MS analysis demonstrates profound changes in exosomal proteome following IL-1\textbeta and TNF-\textalpha stimulation of astrocytes. Many of the proteins identified are involved in pathways promoting remodeling of extracellular matrix (ECM), biological adhesion, developmental processes and progression of inflammation. Our study demonstrates the role of the tissue microenvironment in dictating exosomal content secreted by astrocytes in the brain, and their ability to determine the fate of target or recipient cells.
Title: Extracellular matrix and oligodendrocyte differentiation of neural progenitor cell

Author names: 1Krishna Deo Sharma, 2Malathi Srivatsan

Department and Institution: 1, 2 Department of Biological Science, 2Arkansas Bioscience Institute, Arkansas State University

Author Contact Information (Tel/email): 8702106649/krishna.sharma@smail.astate.edu

8708976526/msrivatsan@astate.edu

Poster abstract:

Oligodendrocytes (ODCs) are glial cells that form myelin sheath around axons in the central nervous system. The sheath facilitates conduction of electrical impulses and serves as a protective layer of axons. Damage to the myelin sheath, due to the degeneration of ODCs, leads to diseases, such as multiple sclerosis which is not curable till date. In recent times, stem cell therapy has given a hope to serve as a potential cure for the disorder. Although, differentiating stem cells into ODCs for cell transplantation appear promising, generating a large number of functional ODCs for transplantation has been a challenge. Extracellular matrix (ECM), a network of macromolecules that surround the cells in an organ, is believed to play a fundamental role in the process of cellular differentiation through interactions between ECM components with each other and with their specific receptors on the cell surface. Researchers have begun to use either natural ECM such as matrigel or ECM components, such as collagens, elastin, fibronectin, vitronectin, laminin, and tenascin, for differentiating neural stem cells (NSCs) in vitro. Other researchers have synthesized nano materials to use as a matrix to promote differentiation. Since (1) ECM and differentiating cells interact and influence each other during normal development, and (2) we can functionalize/fabricate man-made matrices in many different ways, we decided as our long term goal to use synthesized matrix and determine if they can increase the rate of differentiation of ODCs and/or they influence the ability of ODC to myelinate axons. To establish base line control condition, NSCs are maintained on matrigel for different periods and immunocytochemistry, fluorescence imaging techniques are employed to determine the rate of differentiation. Co-culture of neurons and the newly differentiated ODCs is planned for the future to test if the newly differentiated ODCs could form myelin sheath. Our preliminary results of stem cell culture and differentiation will be presented.
Title: Enhancement of Neuronal Differentiation Through Use of Extracellular Matrices

Author names: ¹Marley Hanna, ¹,²Malathi Srivatsan

Department and Institution: ¹Molecular Biosciences Graduate Program at Arkansas State University, ²Department of Biological Sciences and Arkansas Biosciences Institute at Arkansas State University

Author Contact Information (Tel/email): (870) 972-3167 msrivatsan@astate.edu

Poster abstract:

Neurons initiate and regulate functions of organisms through communication networks. Unlike other cells, mammalian neurons are mostly unable to self-renew once they are damaged/dead. This leads to permanent functional loss through neurodegenerative disorders, and from Traumatic Brain Injury (TBI) creating a costly burden on society, demanding the need for an effective treatment. Functional loss could be halted or even reversed if we could replace a large number of damaged/lost neurons. Stem cells maintain the ability to differentiate into countless cell types such as neurons, providing a valuable resource for new neurons. For neurons to survive and differentiate, a specific microenvironment, similar to the one found within the body such as Extracellular Matrix (ECM) can help. Recent studies suggest that through the use of specific matrixes, one can enhance neural differentiation. Although neuronal differentiation is promoted, resulting population of neurons are still inadequate for cellular replacement therapies. Therefore, our long-term goal is to provide an environment that promotes maximum differentiation of neurons that are healthy and functional; to achieve that we began differentiating rat fetal neural stem cells (NSC) on natural extracellular matrixes, such as matrigel, to establish a control baseline. Results from this study will serve as the foundation for comparing neurons differentiated on natural ECM, such as matrigel, to those grown on specific engineered nano material surfaces, such as carbon fibers, graphene and gold. When completed, results will allow us to make greater strides toward clinical applications using cellular replacement therapies to address the burden brought on by neurodegeneration.
Title: Fungal-Organosolv Delignification of Pinus taeda Softwood for Enhanced Enzymatic Hydrolysis and Cellulose Extraction

Author names: Gurshagan Kandhola1,2, Kalavathy Rajan1,2, Danielle J. Carrier3 and Jin-Woo Kim1,2

Department and Institution: 1Bio/Nano Technology Laboratory, Institute for Nanoscience & Engineering, and 2Department of Biological & Agricultural Engineering, University of Arkansas, Fayetteville, AR 72701; and 3Department of Biosystems Engineering & Soil Science, University of Tennessee, Knoxville, TN 37996

Author Contact Information (Tel/email): (479) 575-2542 / gkandhol@email.uark.edu

Poster abstract:

Softwoods, a major source of renewable lignocellulosic feedstock, have potential for conversion into carbohydrates and fuels. However, the recalcitrant nature of lignocellulosic biomass necessitates additional pretreatment steps in order to enhance the enzymatic hydrolysis and the corresponding cellulose yields. Recent studies have shown that biological pretreatment of wood chips with lignin-degrading white rot fungi, Trametes versicolor, is an environmental friendly process to manufacture cellulose. In this study, the effect of fungal and organosolv pretreatments on the susceptibility of pine wood chips to enzymatic hydrolysis was evaluated. Samples of wood chips (8 x 2.5 x 1 mm) from Pinus taeda were subjected to solid substrate fermentation in the presence of Trametes versicolor for 15, 30 and 45 days. The fungal pretreated material was washed with alkali in order to dissolve the lignin and then hydrolyzed using a cellulolytic enzyme cocktail for cellulose extraction. The biological pretreatment was also coupled with organosolv pretreatment, where 65% ethanol and 1.1% sulfuric acid were used at 170°C for 60 min. Results indicated that fungal pretreatment enriched the cellulose content of pine chips by approximately 11% after 45 days and that the subsequent organosolv pretreatment dissolved up to 85-95% of the available cellulose, which was removed in the liquid fraction. The fungal-organosolv pretreated material also showed enhanced amenability to enzymatic hydrolysis, where the digestibility increased 9 folds compared to the fungal only pretreated material. Thus, combining fungal and organosolv pretreatments would be a valuable add-on step to conventional organosolv processes for processing of softwoods into biofuels and value-added chemicals.
Title: Synthesis of Cellulose Nanoparticles from Lignocellulosic Feedstock: A Roadmap

Author names: Kalavathy Rajan, Angele Djioleu, Elizabeth Martin and Jin-Woo Kim

Department and Institution: Bio/Nano Technology Laboratory, Institute for Nanoscience & Engineering and Department of Biological & Agricultural Engineering, University of Arkansas, Fayetteville, AR 72701

Author Contact Information (Tel/email): (479) 575-2542, kxr016@uark.edu

Poster abstract:

Cellulose is one of the most abundant polymers found in nature. When deconstructed to nanocrystalline particles, it finds a variety of applications from drug delivery to material engineering owing to its unique physicochemical properties. Cellulose can be extracted from lignocellulosic biomass, an inexpensive and renewable feedstock, which contains cellulose in the ranges of 35 to 50%. There are different methods available for the production of cellulose nanoparticles from lignocellulosic biomass such as biological and chemical delignification, chemical and mechanical diminution, dissolution and integrated chemical synthesis, etc. These methods are used to fractionate the lignocellulosic biomass and extract the cellulose fibers, which are then processed further to produce cellulose nano fibrils or cellulose nanocrystals. Each method has its own advantages and disadvantages and can be customized to fit the end user requirements. Lignocellulose is a complex polymer and it often necessitates combining two or more of the fractionation techniques in order to improve the yield of cellulose nanoparticles. This presentation provides a road map for the deconstruction of lignocellulosic biomass to cellulose nanoparticles and a comparison of the feasibility and suitability of each of the production processes.