NanoFlorida 2020

Hosted Virtually by the Dr. John T. Macdonald Biomedical Nanotechnology Institute of the University of Miami (BioNIUM)

September 25th, 2020
12:00 – 5:00 PM EDT

Poster Presentation Abstracts

UNIVERSITY OF MIAMI

Presenter Name

Brandon Applewhite

Video Title

Periadventitial Release of BAPN to Improve AVF Outcomes

Link to Unlisted YouTube Video

https://youtu.be/g_Uvl-aJr9g

Abstract

Arteriovenous fistula (AVF) stenosis has confounded surgeons for decades, exacerbating the suffering of over 400,000 End-Stage Renal Disease patients in the U.S. and contributing to ~$2 billion/year in healthcare costs. Our lab has established a link between lysyl oxidase (LOX), postoperative fibrosis, and subsequent AVF failure. Accordingly, we postulated LOX inhibition using β-aminopropionitrile (BAPN) as a novel therapy to improve AVF performance. BAPN was injected systemically or delivered locally to the AVF adventitia using nanofiber scaffolds which released BAPN over 21 days in a rat AVF model. Systemic LOX inhibition improved blood flow compared to vehicle controls (23.40 ± 10.50 vs. 10.33 ± 4.27 mL/min, P=0.047) and reduced wall fibrosis (10.42 ± 3.38 vs. 23.72 ± 11.88 %, P=0.010). BAPN delivery via nanofiber scaffolds had similar effects on fibrosis (34.79 ± 3.83 vs. 47.17 ± 8.65 %, P=0.029) and flow compared to vehicle controls (34.03 ± 17.32 vs. 24.80 ± 7.60 mL/min, P=0.28). Both strategies were effective in reducing immature collagen crosslinking in the extracellular matrix compared to control groups (Systemic- 0.42 ± 0.12 vs. 1.19 ± 0.33 μmol/mg of dry weight; Local- 0.82 ± 0.32 vs. 1.28 ± 0.29 μmol per mg of dry weight, P=0.025). Pressure myography assessment revealed improved distensibility and stiffness of the AVFs treated systemically and locally. We are now optimizing the BAPN release profile to match the expression of LOX substrates and ECM remodeling enzymes for maximum efficacy. These findings suggest that periadventitial controlled release of BAPN is a promising approach to improve AVF outcomes.

Presenter Name

Kaveena Autar

Video Title

The Application of hiPSC-Cortical Neurons to Drug Evaluation in a Body-on-a-Chip System

Link to Unlisted YouTube Video

https://youtu.be/MhTV1EGBSrc

Abstract

The application of iPSC-derived cortical neurons to an in vitro human-on-a-chip system allows for additional electrophysiological characterization of the neurons on a systemic level. As a result, populations of neurons rather than an individual neuron can be evaluated in response to various drug compounds. Neurons were characterized for electrical activity using whole-cell patch clamp, and were subsequently cultured on multi-electrode arrays (MEAs) to determine the effects of chemicals on neural circuit physiology. Spontaneous activity recordings mirrored patch clamp results, suggesting neurons are most active on day 40. Biological genuineness of the MEA signals was validated through signal enhancement following the addition of glutamate and signal abolishment by common local anesthetic and Na+ channel blocker lidocaine. Synaptic connectivity was confirmed following the addition of an AMPA receptor blocker NBQX, which caused a reduction of approximately 50% of spontaneous neuronal activity. Long-term potentiation (LTP) was induced via a high-frequency stimulation (HFS), whose induction was blocked by NBQX. Afterwards, a GABAA receptor antagonist and agonist were tested as chemical convulsants or anti-convulsants, respectively. GABAA receptor antagonist administration enhanced spontaneous activity mimicking an epileptic phenotype that was subsequently abolished after the addition of valproic acid, a common anti-epileptic therapeutic. The versatility of this model lies in its ability to be adaptive to chemical regulation and future genetic modification so as to model an array of brain diseases, which can be characterized by functional phenotypic analysis. This serum-free, hiPSC cortical neuron model establishes a platform for the evaluation of neuron activity as well as a platform for drug testing in vitro.

Presenter Name

Balaashwin Babu

Video Title

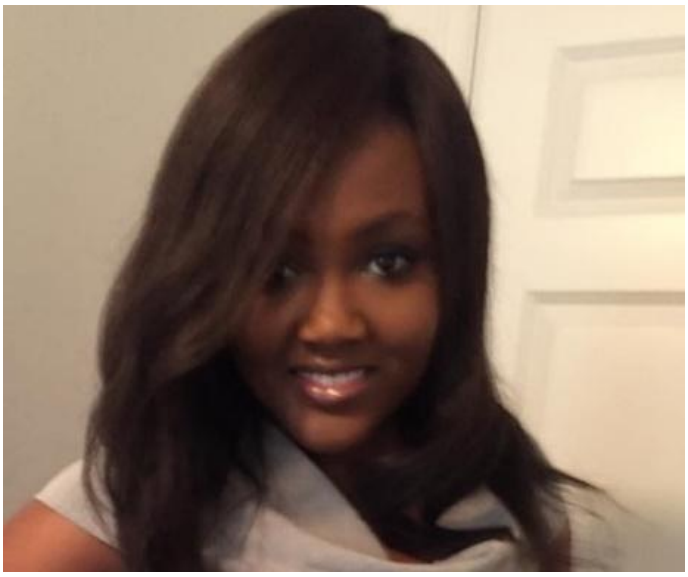
Hollow ceria nanoparticle synthesis and biomedical applications

Link to Unlisted YouTube Video

https://youtu.be/kTNU2oYE7Eg

Abstract

Ceria nanoparticles have a plethora of applications within the field of biomedical science, due to their enzyme-mimetic surface chemistry in interaction with reactive oxygen and nitrogen species. However, ceria nanoparticles are often manipulated in their structure to augment the potential of this capability while implementing additional biomedical applications. One example of such structure is the hollow ceria structure that utilizes an increased surface area and thus higher potential for its enzyme-mimetic properties. Additionally, the hollow architecture provides a structure viable for drug delivery and other molecule delivery systems. The objective of this work is to analyze and compare the products of hollow nanoceria syntheses using silica nanoparticles and carbonaceous nanoparticles (including quantum nanodots) as sacrificial template materials. Both silica and carbon templates provided the temporary internal structure that allowed ceria nanoparticles to be coated and were then etched away. The hollow ceria nanostructures were characterized using imaging (TEM and SEM) and other size and elemental composition analysis characterization (DLS and XPS). Through XPS analysis and imaging, silica templated hollow ceria expressed small signs of hollowness. TEM and DLS analysis show size issues with carbon templated hollow ceria (nearly 1-3 um) compared to the silica templated version (~100nm) while qualitative analysis (mainly from TEM imaging) shows high level of hollowness. Further research regarding these structure's enzyme-mimetic activities (e.g. catalase and superoxide dismutase) can be conducted using assay kits as well as investigations into its use as a nanocarrier for therapeutic agents (e.g. μRNA, drugs).



Presenter Name

Agnes Badu-Mensah

Video Title

Investigation of Neuromuscular Pathology in ALS by Developing Patient iPSC-derived Phenotypic Model

Link to Unlisted YouTube Video

https://youtu.be/Yc-fe6Gdu7E

Abstract

Amyotrophic Lateral Sclerosis (ALS) is an aggressive adult-onset disease characterized by progressive motoneuron degeneration as well as muscle weakness and wasting. There is currently no cure for ALS and it typically leads to death within 1-3 years of diagnosis. While there have been advances in ALS research in the past decade, the cause of disease onset remains elusive. Neuromuscular junction (NMJ) dysfunction is established as an early event in ALS pathology. However, its cause is not understood. To begin elucidating factors that induce NMJ disruption, in vitro microphysiological NMJ models were developed from ALS patient-derived induced pluripotent stem cells (ALS-iPSCs). These ALS NMJ models that had either diseased skeletal muscle or motoneurons, were characterized for functional NMJ integrity in comparison with healthy (WT) NMJs. Functional assessment revealed significantly reduced number of NMJ formed in the diseased NMJ cultures compared to WT. However, co-cultures with diseased hSKM paired WT hMNs had the least number of NMJs. Additionally, the diseased NMJs had markedly reduced stability, coupled with high fatigue index. Assessment of individual contraction traces also revealed reduced contraction fidelity in diseased NMJ cultures. Collectively, these results agree with both clinical and transgenic model studies that report altered NMJ integrity in ALS. Moving forward, ALS-iPSC NMJ model will be utilized in characterizing the nature of ALS synapse, in the quest of unraveling events that may induce NMJ instability. Lastly, this model holds the promise of serving as a viable platform for drug studies, in effort of hastening the ALS drug discovery process.

Presenter Name

Priyal Bagwe

Video Title

Microneedle Delivery of Microencapsulated Gonorrhea Vaccine Induced Strong Immunity-Priyal-Mercer U

Link to Unlisted YouTube Video

https://youtu.be/OcotTRyBL60

Microneedle Delivery of Microencapsulated Gonorrhea Vaccine Induced Strong Immunity

Priyal Bagwe[1], Lotika Bajaj[1], Rikhav Gala[1], Susu Zughaier[2], Martin D'Souza[1]

1. Mercer University, Center for Drug Delivery, College of Pharmacy, Atlanta, GA 30341
2. Qatar University, College of Medicine, Doha, Qatar

PURPOSE: *Neisseria gonorrhoeae* is the bacteria causing gonorrhea infection and has gradually developed antimicrobial resistance. This study aims to investigate the immunogenicity of novel whole-cell inactivated gonococcal microparticulate vaccine formulation loaded in dissolving microneedles for skin delivery.

METHODS: *N. gonorrhoeae* was grown on GC agar and pileated colonies were used for bulk production in GC broth. The culture was formalin-fixed, gonococcal pellets were harvested, washed and saved as dense suspension at -80°C. The matrix for vaccine particles contained pre-crosslinked bovine serum albumin and microparticles were prepared using Buchi Mini Spray Dryer B-290. Similarly, adjuvants (Alum, MF59®) particles were prepared. The dry microparticles with 20% antigen-loading were mixed with Hyaluronic acid and Trehalose to form an aqueous solution. This solution was then loaded into the microneedle molds. PVA backing layer was later added to the partially dried microneedles in the molds. Scanning Electron Microscopy (SEM) was carried out to observe surface morphology and formation of microparticles and microneedles. The efficacy of vaccine formulation was assessed in vivo using female mice. The mice were immunized with a prime dose at week 0 followed by two boosters at weeks 2 and 4. Enzyme linked immunosorbent assay (ELISA) was used to measure immunoglobulin levels in collected mice sera.

RESULTS: Formalin-fixed gonococci were intact (native form) as observed by SEM. The average size of the particles ranged from 3.5 ± 1.2 µm. ELISA demonstrated significantly higher serum immunoglobulin levels in groups receiving adjuvanted gonorrhea particulate vaccine (Vaccine + Adjuvants) when compared to untreated group ($p<0.001$).

Presenter Name

Alexandria Brady-Mine

Video Title

Incorporation of Lysine into PNIPAAm to Enhance Protein Adsorption

Link to Unlisted YouTube Video

https://youtu.be/HWEZWYySIVE

Abstract

Improving cell adhesion to poly(N-isopropylacrylamide) (PNIPAAm) polymer is essential to the development of new stimuli-responsive tissue engineering technologies based on PNIPAAm. Cell adhesion to PNIPAAm gels is poor due to minimal protein adsorption. Based on our observation that coating the surface with polylysine enhanced cell adhesion on PNIPAAm gels, we tested the hypothesis that incorporation of lysine-like monomers into the NIPAAM network would enhance protein adsorption. A series of cross-linkable NIPAAm polymers incorporating 0-5% lysine was synthesized. Fibronectin was coupled onto 10 μm carboxylated polystyrene microparticles. The beads were then absorbed on circular glass coverslips coated with the crosslinked PNIPAAm polymer films. The adhesion strength of protein-coated microparticles was quantified using a spinning disk which exposed each disk to a range of hydrodynamic shear stresses. The adhesion experiments were conducted with PNIPAAm polymers in both the solvated and collapsed states.

Presenter Name

Keegan Braz Gomes

Video Title

Flu Fighters: A transdermal subunit vaccine to protect against influenza... - Braz Gomes K- MercerU

Link to Unlisted YouTube Video

https://youtu.be/nXdxRTcO8H4

Abstract

Title
Flu Fighters: A transdermal subunit vaccine to protect against the influenza virus

Background: Based on the varying performance of recent marketed flu vaccines, there is a need for a universal influenza vaccine. The aim of our research was to investigate the efficacy and protectivity of a cross-protective matrix-2 protein virus-like particle (M2e VLP) transdermal vaccine administered in a pre-clinical mouse model for influenza using microneedles.

Methods: The antigen was encapsulated into a polymer matrix along with adjuvants, Alhydrogel® and MPL-A® and spray dried into microparticles (MPs). For in vivo testing, C57BL/6 mice were immunized with three doses of the vaccine intramuscularly (IM) or transdermally (TD), after which the mice were challenged with live influenza. Blood samples were collected to assess antibody titers and T cell phenotypes were examined in the primary and secondary lymphoid organs. Whole lung tissue was collected following challenge for determination of viral load.

Results: The mice vaccinated with M2e VLP, M2e VLP MP, and M2e VLP MP + MPL-A® + Alhydrogel® produced elevated levels of IgG, and IgG1. Mice immunized with the M2e VLP MP and M2e VLP MP + MPL-A® + Alhydrogel® demonstrated high expression of CD4+ and CD8+ T cells. The lung viral titers were 10-fold lower in the M2e VLP MP + MPL-A® + Alhydrogel® vaccinated mice compared to M2e VLP and M2e VLP MP.

Conclusion: Since the current licensed vaccines against influenza are facing numerous challenges associated with production time, antigenic changes and route of administration, we developed a flu vaccine with the M2e VLP that was easy to formulate, stable, immunogenic, safe, and protective.

Presenter Name

Nermina Brljak

Video Title

Effect of Peptide Sequence to Affinity for h Boron Nitride & Graphene - Nermina Brljak- U. of Miami

Link to Unlisted YouTube Video

https://youtu.be/2UYz29AV5Yc

Abstract

Hexagonal boron nitride (*h*-BN) is a 2D nanomaterial which consists of single atomic layers of sp^2 hybridized boron and nitrogen atoms in a hexagonal arrangement. Since typical methods of exfoliating bulk *h*-BN into individual nanosheets employ toxic surfactants, it is ideal to explore biocompatible alternative methods such as through the incorporation of peptides. The binding affinity of three peptides, BP1 (LLADTTHHRPWT), BP7 (VDAQSKSYTLHD), and P1 (HSSYWYAFNNKT) onto two surfaces (*h*-BN and graphene) were analyzed in order to determine selectivity of the biomolecules. It was found that all peptides preferred binding to graphene over *h*-BN where P1 had a stronger binding affinity for both surfaces compared to BP1 and BP7. Additionally, BP1 and BP7 had similar binding affinities to both *h*-BN and graphene. To further explore which amino acid residues within the sequence contributes to the binding affinity of BP7 to *h*-BN, various mutations were studied by replacing native residues with alanine. The mutations show that tyrosine is critical for binding, valine slightly contributes, and aspartic acid made little to no effect. Furthermore, another modification was analyzed by integrating a 10-carbon fatty acid chain into the BP7 structure, mimicking lipidation processes used *in vivo*. This modification demonstrated affinity for the *h*-BN surface, but generated a highly viscoelastic interface. By understanding the binding affinity of peptides to the h-BN surface, such biomolecules could be adapted for sustainable nanosheet exfoliation.

Presenter Name

Maria Campos

Video Title

Nano-zinc coated urea: an innovative approach to systemic delivery of Zn-micronutrient

Link to Unlisted YouTube Video

https://youtu.be/N23dAquTceU

Abstract

Zinc (Zn) is an essential micronutrient for plants and animals. Its deficiency in plants causes stunted growth, leaf size reduction and yield loss in crops. In animals, zinc plays an important role in enzyme systems and is involved in protein synthesis, carbohydrate metabolism, and many other biochemical reactions. For crop production, zinc is usually mixed with urea and applied to the soil, as almost half of the arable soil in the world is zinc deficient. However, the effectiveness of zinc uptake by is limited by water-solubility and bioavailability of zinc products. In order to facilitate uptake by the plants and improve the efficiency of zinc application in the soil, Zn nanoparticles were obtained by a water-based sol-gel process at room temperature. Three capping agents (sodium salicylate - SAL, urea- UREA and n-acetylcysteine – NAC) combined two by two (NAC-SAL, NAC-Urea and Urea-SAL) were used to produce ultra-small particles. X-ray Diffractometry (XRD) and High resolution transmission microscopy (HR-TEM) Fast Fourier Transform (FFT) techniques were used for Zn nanoparticles' characterization. Urea-SAL capped Zn nanoparticles showed more defined and intense XRD peaks compared to NAC-SAL and NAC-Urea samples. Nanoparticles' diameters were found to be around 5nm by HR-TEM. According to the crystal lattices distances (d-spacing) obtained by HR-TEM FFT, the crystalline structure of the three samples matched with Wulfingite zinc hydroxide. The ultimate goal is to coat urea granules using these Zn suspensions in a fluidized bed, and test the effects of the combined product (Zn + urea) on sorghum in a greenhouse study.

Presenter Name

Derek Chamberlin

Video Title

Nano CT reveals and Bomb ^{14}C validates Otolith-based Age Estimation in Gray Triggerfish, (*Balistes capriscus*)

Link to Unlisted YouTube Video

https://youtu.be/DR-1vro5awY

Abstract

Nano CT reveals and Bomb ^{14}C validates Otolith-based Age Estimation in Gray Triggerfish, (*Balistes capriscus*)

Derek Chamberlin[1] and William F. Patterson III[1]

[1]University of Florida, School of Forest Resources and Conservation, Fisheries and Aquatic Sciences Program, Gainesville, FL 32611

Corresponding author: derek.chamberlin@ufl.edu

Age is the fundamental parameter of population ecology and is key to stock assessment upon which science-based fisheries management is based. Gray triggerfish (*Balistes capriscus*) is a common fishery species targeted throughout the Gulf of Mexico whose stock is not recovering at projected rates. Dorsal spines have been the preferred ageing structure for gray triggerfish, but the lack of precision in age estimates derived from dorsal spines is well-documented and recent evidence exists that spines may produce biased age estimates as well. Unlike many marine fishes, gray triggerfish have not been routinely aged with otoliths due to small otolith size, thus difficult extraction and preparation. Nano CT scanning revealed distinct opaque zones in gray triggerfish otoliths, which were counted to produce preliminary age estimates. Age estimates were also produced by reading whole otoliths under a dissecting microscope with transmitted light. Age estimation based on both sets of counts was validated by analyzing radiocarbon ($\Delta^{14}C$) of eye lens cores and fitting radiocarbon signatures to the regional coral bomb radiocarbon chronometer. Results indicated age estimates produced with light microscopy were accurate, while those produced from nano CT scans were negatively biased by 1 year. However, nano CT scans were instrumental in interpreting otolith microstructure with either approach to ageing. Improved age estimates will allow for the more accurate modeling of current gray triggerfish population dynamics and better fisheries management.

Presenter Name

Mark Ciappesoni

Video Title

Multiplexed biomarker detection using plasmon field effect transistor

Link to Unlisted YouTube Video

https://youtu.be/0lwBZfjr-JQ

Abstract

Localized surface plasmon resonance (LSPR) provides unique sensing capability using various binding molecules. Combining gold nanostructures and active semiconductor devices, the LSPR can be directly converted to electric current without using additional readout optics. We have developed a miniaturized diagnostic platform, the Plasmon field effect transistor (FET), for measuring interfacial binding events of various analytes. Our device enables direct plasmon-to-electric conversion using a thin film transistor by incorporating gold nanostructures on top of the semiconducting layer. The gold nanostructures are functionalized using an antibody to detect targeted analyte. And the unique optical design and integrated device structure enable detection of targeted analytes directly from a whole blood sample. In this work, we present a more accurate sensing mechanism using an integrated reference device that can eliminate device-to-device variation. In addition, we will report multisensory integration in a microfluidic channel for multiplexed sensing that provide better sensitivity and selectivity for targeted diseases.

Presenter Name

Mark Ciappesoni

Video Title

Robust biosensing platform using a plasmon field effect transistor with a Si-based active channel

Link to Unlisted YouTube Video

https://youtu.be/kctw1RCxiO4

Abstract

Since the development of semiconductor transistors in the 1950's silicon has become the most well studied and technologically important element. Our group developed the plasmon Field effect transistor (FET), a device capable of direct transduction of plasmonic energy into electrical signals. Previous iterations used ZnO or indium gallium doped zinc oxide (IGZO) as a semiconducting thin film due to its absorption spectrum that is not overlapped with gold nanoparticle absorption spectrum. However, ZnO and IGZO suffers from poor stability. Moreover, the weak chemical resistance of these semiconducting thin film limits the use as a biomedical sensor device. To address this issue, we demonstrate a Si-based plasmon field effect transistor. Although there is an overlap of absorption between gold nanoparticle and Si thin film, we can still detect the plasmonic absorption from the functionalized gold nanoparticles. Since Si is an indirect bandgap material, a thin (50nm) Si film has poor optical absorption at visible wavelength, where the localized surface plasmon resonance spectrum of gold nanoparticles. In this presentation, we discuss details of hot electron detection based on a Si thin film field effect transistor useful for plasmonic signal detection and amplification.

Presenter Name

Andrew Ciciriello

Video Title

Synthetic Ligand-Receptor Binding for Targeted Delivery to the Spinal Cord

Link to Unlisted YouTube Video

https://youtu.be/fC4XO7pHGd4

Abstract

Targeted drug delivery strategies have advanced significantly in recent years with applications including cancer, diabetes, and cardiovascular therapeutics. These treatment strategies rely heavily on drug or drug carrier modifications to express high-specificity ligands for tissues or cells, resulting in selective binding at a designated target. These systems have been successful, but they assume the same surface molecules are presented throughout the necessary therapeutic window, which is not the case for many injuries or diseases. Spinal cord injury (SCI) has a dynamic cellular response that complicates the use of a single targeting ligand as the injury is continually remodeling and different cell populations infiltrate over time. To address these design challenges, we developed a synthetic ligand-receptor targeting system that amplifies therapeutic-loaded nanoparticle (NP) binding without the need to specifically target one cell population increasing delivery specificity and adaptability. Our system uses a functionalized biomaterial that is implanted into an SCI and expresses receptor moieties to serve as a beacon for the intravenous delivery of targeting ligand functionalized NPs (L-NPs). To test the system, Balb/c mice received a thoracic hemisection with immediate implantation of receptor biomaterial followed by injection of a therapeutic dose of L-NPs 3 days post-implantation. L-NPs were fabricated to have a diameter of approximately 150 ± 4 nm and were conjugated with fluorescent tag for post-delivery detection. Selective binding of the L-NPs was observed at the functionalized implanted biomaterial compared to the implant alone and sham conditions, demonstrating the feasibility of direct delivery to SCI.

Presenter Name

Chiara Deriu, MS

Video Title

Optimization of the surface environment of SERS-active colloidal nanomaterials

Link to Unlisted YouTube Video

https://youtu.be/Fsq69z5WyXA

Abstract

Surface-enhanced Raman spectroscopy (SERS) is a powerful tool for analytical scientists: it enables single molecule detection via adsorption on nanostructured surfaces. Homeland security, medical diagnostics, and environmental science are just a few of the fields currently benefiting from SERS. However, these applications are relegated to occasional cutting-edge experimentation, while routine analyses by SERS are undeservingly scarce. Why? The SERS community is increasingly attributing this setback to a poor understanding of nanoscale surfaces and their chemical environment. Since molecular adsorption at the nanostructured surface enables SERS detection, uncertainty about what happens at the surface makes SERS experiments convoluted and often inaccessible. Therefore, there is a pressing need to further nanoscale surface chemistry studies: they are the key to effect the transition of SERS from academic sensation to benchmark technique for routine diagnostics.

The present research takes this call by developing a library of SERS-active nanostructures, and utilizing them to systematically assess the impact of the surface chemical environment on the performance of SERS measurements. Emphasis is given to experimental and computational studies of the energies directing the interaction of molecules with the developed nanoscale surfaces. This multi-analytical, theory-assisted approach to colloid development allowed for the fabrication of a set of well characterized SERS-active nanostructured surfaces, capable of providing unprecedented surface control. This ultimately allows for straightforward protocol development, setting foundations for the establishment of SERS as the next golden standard analytical technique. Proof of this capability is demonstrated by applications of public health interest, such as the detection of opioids.

Presenter Name

Emily Eachus

Video Title

Peptide-Functionalized Dendrimer Nanocarriers for Delivery of Microdystrophin

Link to Unlisted YouTube Video

https://youtu.be/TDctLeJJ7RQ

Abstract

Gene therapies have gained popularity in recent years and can be used for both the prevention and treatment of diseases. Duchenne Muscular Dystrophy (DMD) is a disease characterized by bodily weakness and the progressive degeneration of muscles. This disease is caused by a mutation in the dystrophin gene. Clinical trials have shown improved muscle functions in animals who received gene therapy with the microdystrophin gene (a shorter, functional version of the dystrophin gene). There are currently no procedures which allow cell-specific targeting and transport of the microdystrophin gene to the nucleus, which prevents its use in humans. Other barriers to efficient transfection are intracellular trafficking and transport through the nuclear membrane. Nanocarriers have been shown to be efficient in the delivery of desired cargo but they have not been approached from the angel of site-specific delivery of gene in DMD. We have developed a nanocarrier consisting of a G5 polyamidoamine (G5 PAMAM) dendrimer that allows cell-specific targeting to skeletal muscular cells and will transport the DNA through the nuclear membrane. This dendrimer was chosen because of its efficient DNA packing, and ability to transfer genetic material into a cell. The G5 PAMAM was modified with a skeletal muscle targeting peptide (SMTP) to be able to target skeletal muscle cells. Then the dendrimer was polyplexed with plasmid DNA containing the microdystrophin gene. Lastly, a fusion peptide containing a DLC8-binding peptide (DBP) and a nuclear localization signaling (NLS) peptide was polyplexed to the dendrimer for cytoplasmic transport and localization into the nucleus. Testing with Zetasizer characterization showed that this dendrimer peptide-DNA complex is stable and the ideal size for use in human gene therapy. Cytotoxicity assays also confirmed that the nanocarrier has low toxicity and maintains a high cell viability. Initial transfection studies have demonstrated the efficacy of the nanocarrier, but further optimization is needed to enhance the transfection efficiency. Future work is to optimize the transfection efficiency in vitro in skeletal muscle cells and test the nanocarriers in vivo using mouse models. In conclusion, this complex will allow targeted delivery of the microdystrophin gene to skeletal muscle cells and will result in improved muscle function in human patients.

Presenter Name

Chaker Fares

Video Title

Temperature-Dependent Electrical Characteristics of β-Ga_2O_3 Diodes with W Schottky Contacts Up to 500°C

Link to Unlisted YouTube Video

https://www.youtube.com/watch?v=_qKSebA-QmA

Abstract

There is a rapidly growing need for high performance power switching semiconductors in applications such as renewable energy systems, smart grids, transportation electrification, electric and hybrid electric vehicles, industrial machinery control, electricity production, and military systems. Switches fabricated from wide bandgap semiconductors such as Ga_2O_3 have a higher power density, better efficiency, and thermal tolerance compared to Si, which can reduce the need for expensive bulky cooling systems. Thermally stable Schottky contacts for these rectifiers are also needed to ensure stability in power conversion systems.

In this study, we have measured the electrical characteristics of sputter-deposited W Schottky contacts with Au overlayers for reducing sheet resistance on n-type Ga_2O_3 before and after device operation up to 500°C. Assuming thermionic emission is dominant, the extracted barrier height decreases with measurement temperature from 0.97 eV (25°C) to 0.39 eV (500°C) while showing little change from its initial value of 0.97 eV after cooling down from each respective operation temperature. The room temperature value is comparable to that obtained by determining the energy difference between binding energy of the Ga 3d core level and the valence band of the Ga_2O_3 when W is present, 0.80 ± 0.2 eV in this case. The Richardson constant was 54.05 $A.cm^{-2}.K^{-2}$ for W and the effective Schottky barrier height at zero bias ($e\Phi_{b0}$) was 0.92 eV from temperature-dependent current-voltage characteristics. The temperature coefficient for reverse breakdown voltage was 0.16 V/K for W/Au and 0.12 V/K for Ni/Au. The W-based contacts are more thermally stable than conventional Ni-based Schottkies on Ga_2O_3 but do have more reverse leakage current at higher operating temperatures.

Presenter Name

Chaker Fares

Video Title

Demonstration of a SiC Protective Coating for Titanium Implants

Link to Unlisted YouTube Video

https://www.youtube.com/watch?v=Zo7MaTySZH8

Abstract

To mitigate the corrosion of titanium implants and improve implant longevity, we investigated the capability to coat titanium implants with SiC and determined if the coating could remain intact after simulated implant placement. Titanium disks and titanium implants were coated with SiC using plasma-enhanced chemical vapor deposition (PECVD) and were examined for interface quality, chemical composition, and coating robustness. SiC-coated titanium implants were torqued into a Poly(methyl methacrylate) (PMMA) block to simulate clinical implant placement followed by energy dispersive spectroscopy to determine if the coating remained intact. After torquing, the atomic concentration of the detectable elements (silicon, carbon, oxygen, titanium, and aluminum) remained relatively unchanged, with the variation staying within the detection limits of the Energy Dispersive Spectroscopy (EDS) tool. In conclusion, plasma-enhanced chemical vapor deposited SiC was shown to conformably coat titanium implant surfaces and remain intact after torquing the coated implants into a material with a similar hardness to human bone mass.

Presenter Name

Hamidreza Farzaneh

Video Title

Development of Rivastigmine-loaded magneto-electric nanoparticles for Alzheimer's disease

Link to Unlisted YouTube Video

https://youtu.be/mgx67UrC8TY

Abstract

Alzheimer's disease (AD) is the most prevalent neurodegenerative disorder in the world, as approximately 44 million people are affected by this disease or related dementia.

The level of acetylcholine (ACh) is low in patients with AD, thus enhancing ACh levels will help to moderate the severity of it. Rivastigmine is used to treat moderate AD. It is a reversible, non-competitive and carbamate-type dual Cholinesterase inhibitor of the brain. Since the blood-brain barrier (BBB) impedes this drug from reaching the brain, magnetoelectric-nanoparticles (MEN) were chosen as Nano-vehicles to ensure targeted delivery and on-demand release of the drug. This was conjugated by applying a magnetic field. MENs were prepared by a hydro-thermal method and suspended in an aqueous medium using probe sonication, which helped in generating MENs at a lower nanoscale, which produced better results than the bath sonication.

The zeta potential reported that the prepared MENs suspensions were highly stable in an aqueous medium. The technique used for non-covalently binding PEG to MENs was highly promising; zeta potential values of MENs drastically changed after incubating PEG with MENs. Also, the nanoparticles size increased after PEGylation as an indication that the nanoparticle pegylated successfully.

The future study will focus on modifying PEGylated MEN with ApoE and loading it with Rivastigmine. A successful development of this nanocarrier will increase the carrier half-life in the blood circulation system, cross the blood– brain barrier (BBB) and allow for externally controlled release to the target via applications of a DC field. This will eventually lead to the biodistribution of this drug in the brain and minimize the side effect of its administration orally or by patch.

Presenter Name

Yifei Fu

Video Title

Study of MicroRNA(miRNA) Loading on Antioxidant Cerium Oxide Nanoparticles for Clinical Application

Link to Unlisted YouTube Video

https://youtu.be/a4XiiXpBbuI

Abstract

Yifei Fu[1], Elayaraja Kolanthai[1], Udit Kumar[1], Tamil Selvan Sakthivel[1], Kenneth Lichty[2], Sudipta Seal[1]*

[1]Advanced Materials Processing and Analysis Center, Dept. of Materials Science and Engineering, Nanoscience Technology Center, College of Medicine, University of Central Florida, Orlando, FL

[2]Laboratory for Fetal and Regenerative Biology, Department of Surgery, University of Colorado Denver School of Medicine and Children's Hospital Colorado, Aurora, CO, 80045

*Corresponding author: Sudipta.Seal@ucf.edu

MicroRNAs (miRNAs) are non-coding endogenous RNAs composed of 20-24 nucleotides. It extends the development of miRNA research in clinical applications of cancer and wound healing treatment due to its excellent regulation in gene expression for various processes, such as proliferation, differentiation, metabolism, and apoptosis. Despite the therapeutic value of this compound, use in pharmaceutical applications is limited due to poor stability/bio-availability. To overcome this challenge, various technique have been used to improve the stability of miRNAs, such as applying chemical modifications, integrating locked nucleic acids, encapsulation in polymers and conjugation with nanoparticles. Nanoparticle conjugation exists as a particularly useful approach: affording the ability to add new biomedically useful functionalities/modalities (e.g. imaging agents, targeting agents). In this study, miRNAs were conjugated to cerium dioxide nanoparticles (CNPs), previously demonstrated to possess high free radical scavenging activity (through reaction with surface oxygen vacancies and Ce^{3+}/Ce^{4+} redox cycling), by a wet chemical method using 1,1'-carbonyldiimidazole (CDI) as a linker. Upon conjugation, the average particle hydrodynamic diameter increased according to dynamic light scattering measurements and the polarity of the particle zeta potential reversed, confirming the conjugation. Further, the miRNA loading on CNPs increased with increase in initial concentration of miRNA, confirmed using a commercial miRNA quantification kit. There was no significant change in SOD activity between naked and miRNA conjugated CNPs, which is due to the relatively low number of miRNA molecules loaded onto the nanoparticles' surface. Currently, the miRNA loading efficiency on various shape of CNPs is being investigated along with the efficacy of miRNA-modified particles in wound healing applications.

Presenter Name

Zhenyu Fu

Video Title

Microstructure and chemical states of fission products in irradiated UCO fuel

Link to Unlisted YouTube Video

https://youtu.be/EagVyEnmKOM

Abstract

To support the development, licensing, and operation of high temperature gas cooled reactors (HTGRs), a fundamental understanding of the fuel kernel response to different burn-up levels, fuel fabrication processes, U-235 enrichments, kernel size, and fuel stoichiometry has been pursued as one of the advanced gas reactors (AGR) post irradiation examination (PIE) objectives. Over the past three years, extensive microstructural characterizations were conducted on irradiated AGR-1 and AGR-2 TIRSO fuel kernels using scanning transmission electron microscope (STEM) and other technologies. It was found that the irradiated fuel kernel mainly consists of UO2 and UC, while the UO2 is the dominating fuel phase. Results from Energy-dispersive X-ray spectroscopy (EDS) analysis and limited atom probe tomography (APT) study show that the lanthanides, e.g., Nd, are more likely to enrich within the UO2 phase. The carbide forms rare earth elements (RECx) play an important role in reducing oxygen potential from. UC phase contains a significant amount of fission products including Zr, Nb, Mo, Ru, Tc, Rh and Xe due to the UC phase has higher fission rate than the UO phase. However, UC phase was found devoid of fission product Pd and rare earth elements due to the thermal effect. The post irradiation safety testing significantly promotes the precipitations of U2Ru(Rh)C2 and UMo(Tc)C2 phases.

Presenter Name

Mounisha Ganesan

Video Title

Development of CNT based transparent heaters for deicing application

Link to Unlisted YouTube Video

https://youtu.be/6AGlpFZ7IBI

Abstract

Carbon nanomaterials such as Carbon nanotubes (CNTs), graphene, or carbon nanofibers generally have high thermal and electrical conductivity and can offer a great advantage by converting the applied electrical energy into instant heat with minimum energy loss. CNTs have been used previously as heaters in laboratory experiments. However, these may not scale well to large surface areas, need to be combined with other materials, or may not be suitable to apply in the field as a retrofit solution.

In this research, we explore a method that uses carbon nanomaterials that can be spin coated to produce a transparent heater. The materials were chemically treated with strong acids and neutralized at room temperature. The tested solution was centrifuged at 5000 rpm to remove large particles and to concentrate the solution. The electrical connection was constructed by application of the silver paint after multiple layers of the solution were applied. Several materials and performance characteristics of the coated glass slides were investigated, including resistance, Raman spectroscopy, optical transmittance, and thermal imaging. The samples demonstrated a resistance of 15-30 Kilo Ohms, and a 2 to 3ºC rise in temperature in less than 200 seconds. The cooling effects are under study, Applications of this study include de-icing of car or aircraft windows, rotor blades, turbine blades or aircraft leading edges.

Presenter Name

Andrew Garcia

Video Title

Monte Carlo Simulations of MOF Crystal Growth - Andrew Garcia - University of Florida

Link to Unlisted YouTube Video

https://youtu.be/pL-yQIX8tMk

Abstract

Metal organic frameworks (MOFs) are crystalline materials with high surface areas and tunable pore geometries. Among their wide range of applications in adsorption and separations technology, there is a subset of MOFs with a "rod-packing" or 1-D channel motif ("rod-MOFs") which have promising nanostructural features which would have novel applications in size-selective, passive chemical separation processes. To make these applications possible, it is necessary to make these rod-MOFs larger than the conventional micron scales currently published. It is also helpful to make these crystals with the least amount of intergrowths as well to enable chemicals to flow freely through the 1-D channels without physical interruptions.

Though the processes to make MOFs are ubiquitous, the optimization and understanding of their crystallization phenomena remains a challenge. Likewise, as these MOFs are typically synthesized in a closed system, empirical, real-time kinetic control is also a complex task. Being able to estimate the crystallization kinetics of MOFs with high-accuracy and in real time can thus be quite useful in the design of crystallization protocols for MOFs.

Through an understanding of the physics of crystallization, statistics, Monte Carlo methods, and established kinetic Monte Carlo algorithms (kMC) based on crystallization processes, we have adapted a kMC model for MOF crystal growth which can be used as a medium to provide a deeper insight on MOF crystallization phenomena, as well as predict the kinetics thereof in real time.

Presenter Name

Subham Guin

Video Title

Metabolic Modulation of the Tumor Microenvironment Leads to Multiple Checkpoint Inhibition and Immune Cell Infiltration

Link to Unlisted YouTube Video

https://youtu.be/zO8eAziWYv4

Abstract

The most important aspect of tumor proliferation is the nature of the tumor microenvironment (TME), which experiences certain modifications and as a whole support the growth of the tumor. Suppressing glycolysis of the glycolytic cells present in the tumor microenvironment can be a way to bring back the potency of the Tumor infiltrating lymphocytes (TILs) as well as downregulating the immune checkpoint proteins. The mitochondrial metabolic enzyme, pyruvate dehydrogenase kinase-1 (PDK-1) which is required for activating pyruvate dehydrogenase complex is overexpressed in most glycolytic tumors. Dichloroacetate (DCA), the orphan drug has the capability to amend tumor metabolism and inhibit PDK-1. High doses DCA doses are needed to suppress the growth of tumor and it is mainly due to lack of effective cellular uptake and its localization inside the target organelle, the mitochondria of tumor cells. Here in this work, we report MitoDCA, a mitochondrial specific DCA formulation and its nanoparticle (NP) formation which regulates the tumor microenvironment and suppresses tumor cells by immune activation of CD8+ and CD4+ cells. To deliver Mito-DCA with highest efficiency inside mitochondria of cancer cells, we constructed a biodegradable nanoparticle (NP) from poly (lactic-co-glycolic acid) (PLGA)-block (b)-polyethyleneglycol (PEG) functionalized with a terminal triphenylphosphonium (TPP) cation. Here, we report the discovery that targeted inhibition of glycolysis only in cancer cells (sparing the immune cells) by Mito-DCA and its NP formulation, using multiple syngeneic tumor models, activates pathways to initiate inhibitory effects on multiple immune checkpoint proteins such as programmed cell death protein 1 (PD-1) and cytotoxic T-lymphocyte-associated antigen-4 (CTLA-4), while enhancing the infiltration of cytotoxic T cells.

Presenter Name

Daiki Hara

Video Title

Quantification of PSMA-Targeted Gold Nanoparticles through X-ray Fluorescence Computed Tomography

Link to Unlisted YouTube Video

https://youtu.be/WpXX3Cj5SM8

Abstract

Daiki Hara, Wendi Ma, Junwei Shi, Wensi Tao, Ali Pourmand, Totiger Tulasigeri, Brian Marples, Nesrin Dogan, John Chetley Ford, Alan Pollack

Purpose/Objectives: Gold nanoparticles (GNPs) are attractive theranostic agents for tumor therapy and molecular imaging. In this study, we developed an x-ray fluorescence computed tomography (XFCT) system onboard a murine stereotactic radiotherapy system to noninvasively monitor the biodistribution of GNPs. We also designed PSMA-targeted GNPs to improve GNP accumulation and retention time in prostate tumors.

Materials/Methods: 15-nm GNPs were functionalized with polyethylene glycol (PEG) to keep GNPs from aggregating and to avoid uptake by the reticular endothelial system. PEGylated GNPs were conjugated to anti-PSMA antibodies using 1-Ethyl-3-(3-dimethylaminopropyl) carbodiimide and N-hydroxy sulfosuccinimide. GNP quantification imaging was accomplished on an in-house-developed dual-modality XFCT/transmission CT imaging and radiotherapy system which is composed of: a benchtop x-ray tube, a translation/rotation stage, a flat panel detector for transmission projection detection, a 3D printed source collimator, and a silicon drift detector to collect L-shell x-ray fluorescence. Mice (n=6) bearing LNCaP xenografts were injected with GNP intravenously to evaluate active targeting efficiency. In vivo GNP pharmacokinetic analysis was completed using x-ray fluorescence signals, and 3D tumor XFCT was conducted 24hrs post GNP injection. The tumor was dissected post-imaging for inductively coupled plasma mass spectrometry (ICP-MS).

Results: In vivo GNP x-ray fluorescence signals demonstrated the higher accumulation and longer retention of PSMA-targeted GNPs compared to non-targeted GNPs. Active-targeting GNPs reached their peak accumulation in tumor at ~24 hr after intravenous injection. XFCT simultaneously identified GNP spatial distribution and quantified GNP concentration. Both tumor in vivo and ex vivo XFCT shows ~4 times higher accumulation of PSMA-targeted GNPs. Moreover, ICP-MS results validated the accuracy of XFCT imaging in GNP quantification.

Conclusion: PSMA-targeted GNPs increase XFCT tumor detection sensitivity, which is especially beneficial to visualize heterogeneous distribution of GNPs in prostate tumors. XFCT onboard the murine stereotactic radiotherapy system will be a helpful tool to further investigate the GNP-aided radiotherapy.

Presenter Name

Ryan Heetai

Video Title

Formulated Antimicrobial ZnO: Mode of Action Study Against Pathogenic Plant Bacteria

Link to Unlisted YouTube Video

https://youtu.be/w17Q30abZto

Abstract

In agriculture, biotic and abiotic stresses contribute to crop loss. Biotic stress due to bacterial and fungal disease pressure is significant in Florida due to favorable climate conditions. Copper (Cu) based bactericide/fungicide are commonly used as broad-spectrum tool to combat against disease pressure. Tomato and citrus growers have been aggressively using Cu products for many years. Such practices have detrimental effect on the environment due to Cu build up in soil that increases the risk of ecotoxicity. Cu accumulation in soil slows down Zn uptake by the root system that also detrimental to plant health due to Zn deficiency. Development of Cu tolerance is a pressing issue. For example, bacterial spot of tomato caused by Xanthomonas perforans cannot be effectively managed in FL due to development of Cu tolerance. Therefore, an alternative to Cu is desperately needed for sustainable crop protection. Cu is known to rupture the cell membrane on contact (aka contact killing) with plant pathogens. In this work, we have proposed a Zn based alternative that appears to possess some similar mode of action (MOA) as found in Cu products. To understand MOA, we have done a comparative study of several Zn based materials, (i) N-Acetyl Cysteine (NAC) coated ZnS, (ii) NAC coated ZnO, (iii) Agri-grade ZnO (CR-41) and Zn Nitrate Hexahydrate. ZnS was doped with 2 mol% Mn so that they can be traced under fluorescence microscope. NAC was used as control. We evaluated the minimum inhibitory concentration (MIC) by using a standard broth dilution method. To measure the minimum bactericidal concentration (MBC), we performed CFU plating and a cytotoxicity assay using a resazurin assay on 2 pathogenic strains of bacteria: X. alfalfae and C. michiganensis. We have developed a membrane leakage assay to check for cell membrane ruptures. Ion release studies were also done to determine zinc release from the material. We will share some preliminary MOA data that suggest that Zn MOA against X. alfalfae and C. michiganensis is related to cell membrane integrity loss due to ROS (Reactive Oxygen Species) and possible uptake of Zn treatments (ionic and/or particulate) to the intra-cellular environment that may have contributed to additional cytotoxic effect.

Presenter Name

Michael Hnatiuk

Video Title

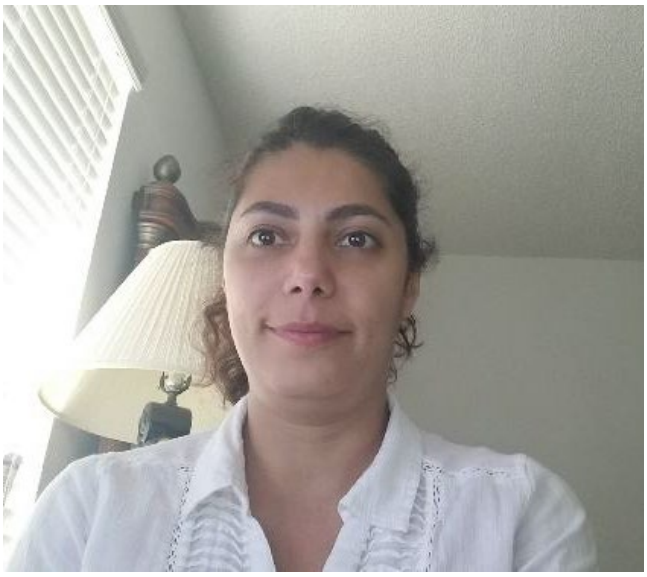
Enhancing Nano Research with Arduino Controlled Devices

Link to Unlisted YouTube Video

https://youtu.be/Cz8kxAnUOM8

Abstract

Laboratory/experimental scale processes are limited by human error (poor control over motion, personal subjectivity); especially under fatiguing conditions involving precise, repetitive operations, incurring compounding error. At the industrial manufacturing scale, human error has been largely removed through process-wide automation. Nanoscience and technology research is resource-intensive and particularly sensitive to error/variation: suggesting high value in including such methods. However, the automation equipment on the market is cost prohibitive for many laboratory research budgets. Here, it will be shown how precise and reliable laboratory equipment can be produced from low-cost commercial, 3D printed, and universal part components while allowing automated processing with high levels of size and task customization. In particular, a novel automated multi-beaker dip coater was made to accelerate covid-19 related research by freeing up hours of time compared to manual dip coating while providing improved precision at ±0.1mm. The equipment consisted of two motorized linear actuators mediating bi-axial sample positioning, 3D-printed sample holders allowing simultaneous multiple substrate coating, and was programmed for unique experiments using a commercial Arduino micro-controller unit. The possibilities for automation beyond the mentioned device are detailed including software interfaces, physical control methods, and sensors for data collection/analysis or for triggers of automated tasks. The financial accessibility of lab automation has the potential to be greatly increased through the use of Arduino programming/compatible devices and innovative 3D printing.



Presenter Name

Hana Nazari Hrim

Video Title

Nano--optical imaging of graphene oxide

Link to Unlisted YouTube Video

https://youtu.be/dfEBb6-ijuo

Abstract

Graphene oxide (GO) has been a promising nanomaterial for biomedical applications and biosensing. However, nano-optical characterization of this materials has been challenging due to weak optical signals at the nanoscale. We used tip-enhanced photoluminescence (TEPL) to enhance the photoluminescence (PL) signals due to the interaction with the plasmonic Au-coated Ag tip and investigated the limits of signal enhancement by varying the tip-sample distance (TSD) down to the picometer scale. We observed the dependence of different plasmonic hybrid modes on TSD. We attributed the dramatic decrease of the PL intensity with the decreasing TSD to the quantum plasmonic tunneling effects. In addition, we investigated the spectral shift of the PL which correspond to the quantum plasmonic regime. The spectral control of the plasmon resonances of the hybrid tip-sample coupled modes may provide an improved tunability which could be used for nanoimaging and sensing applications. Using GO as a spacer in the plasmonic gap picocavity, we show an extended range of the quantum plasmonic effects.

Presenter Name

Meysoun Jabrane

Video Title

Adsorption of Iron-Phthalocyanine (FePc) on transition metal surfaces: a DFT+vdWs study

Link to Unlisted YouTube Video

https://youtu.be/9gqmGhaBor8

Abstract

We investigate the adsorption of Iron-phthalocyanine (FePc) on Cu(111), Ag(111) and Pt(111) using density of functional theory calculations and taking into consideration the self-consistent inclusion of van der Waals interaction. We report a detailed study of the adsorption properties of FePc/substrate interfaces, geometric structure, adsorption heights, adsorption heights. The calculations were performed for several adsorption configurations. In addition, the electronic properties were carried out for the energetically preferable configurations including charge transfer at the interface. We observed through the analysis of adsorption properties that the interaction of FePc molecule with Pt(111) surface is much stronger than that of silver and copper (111) surfaces, with a charge transfer that occurred from the molecule to Pt surface. The adsorption also led to the loss of the total magnetization of the molecule in all surfaces.

Presenter Name

Aadithya Jeyaranjan

Video Title

Ceria/ carbon composite aerogels – A promising electrode material for high-performance supercapacitors

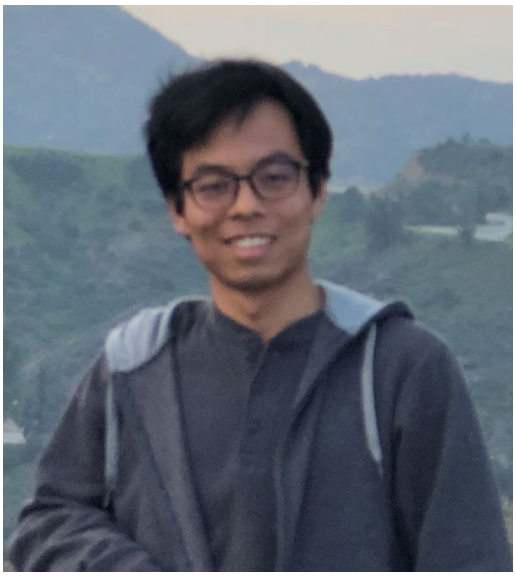
Link to Unlisted YouTube Video

https://youtu.be/lbI5eE3dXz0

Abstract

There is a dire need to develop new materials for Electrochemical Energy storage Devices (EEDs) which can cater better to the rapid advancements in energy harvesting/ conversion and flexible electronics. Moreover, currently used EED materials such as cobalt-based oxides, have major shortcomings such as toxicity, high cost, low suitability, and dubious ethical origins. In this regard, we have developed a low cost, non-toxic, high performance supercapacitor electrode material composed of nano Cerium Oxide (CeO_2) decorated over reduced Graphene Oxide (rGO) aerogels. The design philosophy is that the symbiotic relationship between the components can effectively suppress the drawbacks of the individual components and could also lead to a synergic effect which can significantly improve the overall electrochemical performance of the composite electrode.

The CeO_2/rGO aerogels were synthesized by a simple hydrothermal – freeze drying technique. The composite aerogels were physiochemically characterized using XRD, FTIR, SEM, XPS, and gas adsorption surface analysis techniques. Nao CeO_2 was homogenously distributed and robustly anchored over the rGO aerogels. Electrochemical analysis reveal that the optimized composite has high specific capacity (~ 500 F/g), good rate performance and excellent cycle life (93% capacitance retention after 10,000 cycles). Kinetic analysis shows that composite electrodes also exhibit improved charge storage at the bulk of the electrode, which leads to higher energy density. Thus, we demonstrate a simple yet effective strategy to produce CeO2/rGO aerogels for high-performance supercapacitor applications.



Presenter Name

Peng Jiang

Video Title

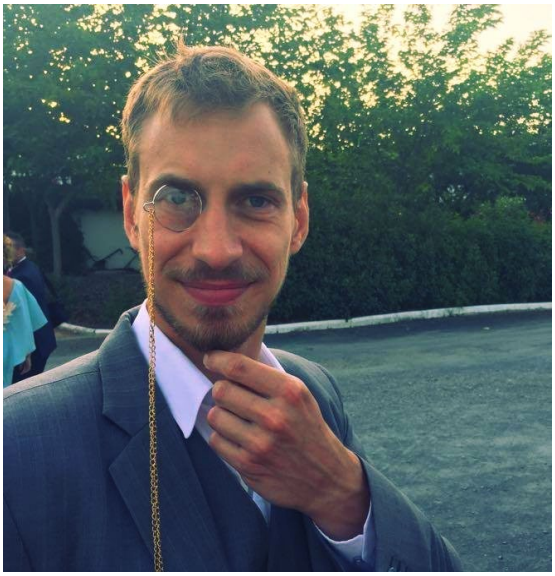
Pushing the boundaries for electron microprobe: sub-micron scale high-precision and high-accuracy minor and trace element analyses

Link to Unlisted YouTube Video

https://youtu.be/8DwN18xYtuQ

Abstract

The electron microprobe (EMP) is a significant tool for research in material science, engineering, and Earth and planetary sciences. In the geosciences field, such a tool can determine chemical compositions of minerals at a sub-micron scale, making it possible to decipher complex igneous, metamorphic, and hydrothermal processes that shape the Earth. Traditionally, EMP was mainly used for the analysis of major and minor elements (>0.1 wt.%). However, with the advancement of hardware, software, and more sophisticated analytical protocols, trace elements (<0.1 wt.%, i.e., <1000ppm) can now be analyzed. We applied the Cameca SXFive field emission EMP at the University of Florida to push the boundaries for the technique. High beam current (up to 600nA), high voltage (up to 25kV), long counting time (up to 480s on peak), and multiple spectrometers' simultaneous counting have been applied to maximize data precision. U-Th-Pb in monazite, Ti in zircon/quartz, and Ca-Al-Ti-Ni-Co-Na-P in olivine were analyzed. We obtained a detection limit of 6 ppm for Ti, significantly lower than 100s of ppm obtained by traditional protocols. The data accuracy is confirmed by "measuring zero", and by testing elements with matrix-matched standards. We obtained 2±5 ppm Ti for Ti-free synthetic zircons and obtained consistent minor and trace elements in olivine, monazite, and zircon. Using a focused beam, we can extract 0.8-1μm volume information under 10kV, and 1-1.5μm under 15kV, ensuring the high spatial resolution of the technique. As extreme beam conditions are applied, Aluminum and Carbon coatings are recommended to minimize the beam damage on samples



Presenter Name

Ladan Jiracek

Video Title

Assessing the Electrical Isolation Performance of Microgaskets for Miniature High-Channel-Density Neural-Implant Connectors

Video Link

https://youtu.be/_dHoenyZdQo

Abstract

Implantable neural-interface systems have been used successfully for decades to treat conditions ranging from the debilitating symptoms of neurodegenerative movement disorders disease to restoring lost sensory functions in prosthetics. Implanted electrode arrays are connected to hermitically sealed electronic circuits used to sense or stimulate bioelectronic information. To enable changes to the implanted electronics (e.g., battery changes, circuit upgrades) without the damage to delicate neural tissue associated with requiring the electrode arrays to be explanted and re-implanted, reliable re-usable implantable connectors are needed. Implant connectors have been used successful for many years in commercial low-channel-count neural interfaces, such as deep-brain stimulators (DBS) and spinal cord stimulators. However, as the field of implantable neurotechnology is driven towards higher-channel-counts system, existing implant connectors cannot scale up to meet demand (i.e., they are too bulky and expensive). Our work has involved microfabricating and testing devices designed to assess the performance of a key component of high-channel-density implant connectors: channel-isolating microgaskets. The electrical isolation of implant-connector channels has been tested in heated saline to quantify dielectric performance as a function of gasket clamping pressures, temperatures, and gasket compositions in an accelerated fashion. In this on-going project, the microgaskets assessed have proven to be very highly effective (10 Mohm at 1 kHz) and resistant to failure over time. We are working towards testing higher-density connectors in harsher conditions to accelerate failure and the understanding need to mitigate these failure modes in a chronically implanted device.

Presenter Name
Jeny Jose

Video Title

Fabrication and characterization of Cissus Quadrangularis (CQ) doped Hydroxyapatite

Link to Unlisted YouTube Video

https://youtu.be/zsLrXy4IULw

Abstract

Bio-Nanomaterial preparation is one important domain of Nanotechnology. I have carried out my Master's dissertation in this field with special emphasis on Tissue Engineering. The material I prepared is 'Cissus Quadrangularis' (CQ) doped Hydroxyapatite. CQ is a medicinal plant used for bone regeneration in Indian Ayurvedic medicines traditionally. Both external and oral intake of stems of this plant reduces the time for normal bone regeneration up to 60%. Hydroxyapatite is a calcium phosphate compound already used in modern allopathic medicines for bone and teeth. It is a mineral used for filling holes in decayed teeth. But it lacks mechanical strength. Zirconium has high mechanical properties with biological inertness. It was doped with hydroxyapatite which resulted in a biologically active and effective combination. The motivation of our research was to dope materials together to get the best composition which has improved Osteo-conductive property. Only 0.6% of CQ was considered as reinforcement to the novel composition. The material was characterized for XRD, SEM, FTIR, UV-Spectroscopy, and Vickers hardness test. Even with a minimum doping, this novel composition showcased a drastic change in the mechanical properties of Hydroxyapatite. The aforesaid patented combination is not yet reported elsewhere.

Presenter Name

Nedgine Joseph

Video Title

Destabilizing Nanosized Biochar- Nedgine Joseph- University of Florida

Link to Unlisted YouTube Video

https://youtu.be/ojNZS7pRqSM

Abstract

Biochar has been widely developed as a low-cost and environmental-friendly carbon material for its application in energy, environment, and agriculture. Its applications are largely due to its physicochemical characteristics such as its outstanding porous structure, large surface area, and abundant functional groups which all contribute to its adsorption abilities of contaminants. Recently, a novel method, ball milling has been investigated to enhance the adsorption abilities of biochar in removing organic and inorganic pollutants from contaminated sources. As a new type of engineered biochar, ball-milled biochar (BMB) presents outstanding porous structure, larger surface area, and more abundant functional groups than pristine biochar. Due to its nanosized structure, however, BMB also displays increasing stability and suspension in aqueous environments, which hinders its separation regarding regeneration and waste disposal.

The goal of this research is to investigate to what extent conventional coagulation and flocculation methods could effectively destabilize BMB from aqueous solutions. Three types of ball-milled biochar will be tested for this experiment: Bamboo and Bagasse biochar all made at 450C. This is to investigate the effect of the different sources of biochar on coagulation. Different pH conditions will also be tested to examine their effect on coagulation. Biochar's destabilization is imperative as it will enhance its compatibility to the current water treatment and separation processes and will provide the wastewater treatment industry a practical way of using an inexpensive, environmentally friendly, and sustainable carbon material to improve wastewater effluents released into the environment.

Presenter Name

Devyani Joshi

Video Title

Measles vaccination via 3D printed Oral Dissolving Films (ODFs)

Link to Unlisted YouTube Video

https://youtu.be/9DVCuM6PzdI

Abstract

Measles, a highly contagious infection was responsible for high worldwide morbidity before introduction of vaccine. Since, tremendous progress is achieved in reducing the number of deaths. Since children are primary recipients, we aimed at delivering the vaccine via needle-free oral dissolving films (ODFs). The oral cavity is rich in dendritic cells and high density of T lymphocytes and mucosal associated lymphoid tissue. The antigen will be recognized by immune cells in the oral cavity and processed to produce protective antibodies. Goal of this study is to formulate the ODFs via fully automated 3D printing technology and to evaluate the potential of ODFs to deliver the microparticulate measles vaccine. The crosslinked BSA microparticles encapsulating measles antigen are formulated using Buchi spray dryer B-290. ODFs will be formulated using completely automated 3D printing technique, utilizing the INKREDIBLE plus CELLINK 3D bioprinter. UV curing of polymers will allow formation of the films in few seconds as compared to several hours in the traditional technique. The films will be formulated in the 3 different layers such that the middle layer having the microparticles will be protected by the top and bottom layers of the film which will aid in the muco-adhesion. The film so formed will be evaluated for thickness, Tensile strength, Young's modulus, Percent elongation and dissolution. The ODFs loaded with the measles vaccine will be further tested in a pre-clinical mouse model for induction of the immune response.

Presenter Name

Devyani Joshi

Video Title

Regenerative-medicine based Cell-therapy for Treatment of Parkinson's Disease

Link to Unlisted YouTube Video

https://youtu.be/jrz__K0OUyI

Abstract

Parkinson's Disease, the second most prevalent neurological disorder, is a result of decreased dopamine release. Goal of our study is to use regenerative medicine-based cell therapy to increase dopamine level in brain. PC12 cells produce, store and secrete dopamine. Microencapsulation of the PC12 cells in alginate-chitosan polymeric membrane can be used to immune-isolate these cells. The neuron differentiated stem cells can be later substituted for PC12 cells.

For fabrication of microcapsules, cells were suspended in the trehalose-alginate solution and sprayed through 1.40mm Buchi spray dryer nozzle into calcium chloride solution. The microcapsules were reacted with chitosan glutamate and stored in media. FTIR spectroscopy was performed to confirm crosslinking to form calcium alginate in microcapsule membrane. Short- and long-term stability study was performed to evaluate the strength of the microcapsule membrane and mechanical stability. The viability of cells inside microcapsules was determined. Griess's nitrite assay was performed to confirm non-immunogenicity of microcapsules.

The microcapsules with average diameter of 52µm were formulated using air flow rate of 350L/Hr and pump speed of 9RPM. FTIR spectra confirmed formation calcium alginate in the microcapsule membrane. The cells were viable for a period of 30 days. More than 85% of the microcapsules were intact in short- and long-term stability studies. Griess's assay showed that microcapsules encapsulating PC12 cells were non-immunogenic. The microencapsulated PC12 cells were found to release dopamine over a period of 30 days. The successful formulation of microcapsules encapsulating viable PC12 cells demonstrate the potential of using cells-based therapy.

Presenter Name

Alexia Lydia Kafkoutsou

Video Title

NanoVanilloid Formulations for the Induction of Targeted Therapeutic Hypothermia

Link to Unlisted YouTube Video

https://youtu.be/pfdOU_VNNbk

Abstract

Herein we developed carrier-free, non-toxic, drug-based nanomaterials (nanodrugs) for application in therapeutic hypothermia (TH). Aim of TH is to prevent a surge in neuronal cell death by intentionally decreasing the core body temperature, and can be applied in cases of brain trauma, cardiac arrest, spinal cord injury, stroke, and other acute conditions. Currently, application of TH as a neuroprotective treatment is limited by the lack of efficacy to rapidly achieve the target temperature in a controlled manner. Therefore, we synthesized nanodrugs with enhanced absorption properties that lead to the onset of hypothermia in a faster and accurate manner. These nanodrugs are solely composed of vanilloids and can efficiently deliver multiple therapeutic agents per nanoparticle to the brain, by successfully crossing the blood-brain barrier (BBB) without causing side effects. Nano-vanilloids can be integrated into aerosol formulations for intranasal delivery and rapid induction of hypothermia. Size-control of the nanodrugs was investigated for a better and efficient performance as hypothermia-inducing agents. The syntheses were performed using bottom-up approaches based on ultrasonic cavitation in the presence or absence of soft templates. Transmission electron microscopy and dynamic light scattering showed the formation of various structures at nanoscale range. Zeta potential measurements indicated high stability of the nanosuspensions, obtained upon optimization of the synthetic procedure. In vitro studies, including cytotoxicity and calcium influx assays, were conducted to confirm the safety of the engineered nanodrugs and efficacy compared to their bulk counterparts. Our preliminary data show the nanodrugs' efficacy in activating the thermoregulatory brain receptor: transient receptor potential cation channel TRPV1, thus, presenting intrinsic "cooling" properties.

Presenter Name

Akil A. Kalathil

Video Title

Therapeutic Nanoparticles for Treatment of Atherosclerosis

Link to Unlisted YouTube Video

https://youtu.be/MIWXudl81oU

Abstract

Therapeutic nanoparticles for treatment of atherosclerosis

Akil A. Kalathil, Bapurao Surnar, and Shanta Dhar*

NanoTherapeutics Research Laboratory

Department of Biochemistry and Molecular Biology

Sylvester Comprehensive Cancer Center

University of Miami, Miami, Florida, USA

Treatment of atherosclerosis is a complex arena. Currently, various forms statins are used to treat atherosclerosis. While effective, statins do not treat the totality of the disease and the mechanism of action results in less available biological antioxidants. In the current work, we describe a nanoparticle (NP) formulation which has the capability to selectively target areas of high plaque formation, and prevent reduce the plaques, while at the same time reducing the disease induced reactive oxygen species (ROS). ROS are known to play a major role in cardiovascular disease, as oxidative stress is the cause of oxidized low density lipoproteins (oxLDL), which forms the majority of the atherosclerotic plaque. The plaques are made up of macrophages and foam cells which take up the oxLDL and stores them, forming the thrombus which restricts blood flow. These macrophages cause the release of several cytokines and chemokines which result in the generation of ROS. In *in vitro* studies on macrophages, we have observed the NP's ability to reduce ROS, as well as their ability to target macrophages. In an $ApoE^{-/-}$ high fat diet mouse model, the therapeutic NP has shown the ability to reduce triglycerides, total cholesterol, and LDL, while increasing high density lipoproteins (HDL), or good cholesterol. Remarkably, the NPs are capable of reducing atherosclerotic lesion formation in the aortic arch of the mice compared to PBS and to statin treatment. This therapeutic NP can provide a much-needed treatment for atherosclerosis while improving the overall lipid profile of the patient.

This work was supported by the Sylvester Comprehensive Cancer Center, American Heart Association, NHLBI, and Barth Syndrome Foundation.

Presenter Name

Akanksha Kale

Video Title

Surface Functionalized Nanoparticles of Oxytocin to cross the Blood-Brain Barrier

Link to Unlisted YouTube Video

https://youtu.be/9t7Sciu4vd4

Abstract

Introduction:

BBB is a major impedence in drug delivery to the brain. Conjugation of nanoparticles with brain targeting ligands - Transferrin (Tf) or Rabies Virus Glycoprotein (RVG) enhances the delivery. We developed Tf/RVG conjugated oxytocin (OT) loaded polylactide-co-glycolic acid (PLGA) nanoparticles and bovine serum albumin (BSA) nanoparticles to cross BBB.

Methods:

Nanoparticles were formulated by multiple emulsion solvent evaporation and nanoprecipitation methods followed by lyophilization and conjugation with ligands. Particles were characterized for size, zeta potential, encapsulation efficiency and release profile. Total amount of OT released was detected by ELISA. Immunogenecity and cytotoxicity were assessed by nitric oxide and MTT assay respectively. Brain penetrance was determined after intraperitoneal administration of indocyanin loaded nanoparticles to mice.

Results:

Size and zeta potential of PLGA and BSA nanoparticles ranged between 197.7-278.3 nm and 100.1-197 nm and -11.9 to -19.6 mV and -15.4 to -22.8 mV respectively. No particles were immunogenic or cytotoxic. The encapsulation efficiency was ≥75% for both. As per release studies BSA particles exhibited a faster initial burst release and sustained release than PLGA particles. Bio-imaging data revealed that particles crossed BBB within 30 minutes of administration.

Conclusion:

OT loaded Tf or RVG conjugated PLGA and BSA nanoparticles were non-immunogenic, non-cytotoxic and showed sustained release of oxytocin.

Presenter Name

Dawin Khiev

Video Title

Niosomes as an essential nanocarrier for ophthalmic drug delivery system

Link to Unlisted YouTube Video

https://youtu.be/0ZZ-kIHNsas

Abstract

Age-related macular degeneration (AMD) is one of the irreversible blinding diseases in the elderly due to the loss of light-sensitive retinal photoreceptor cells and underlying retinal pigment epithelial (RPE) cells in the eye. Current therapies are limited to treat this disease due to drug delivery challenges across the retinal blood barrier. Numerous effective methods using biodegradable nanoparticles are developed to overcome the difficulties of ineffective drug delivery. In this scenario, a spherical nonionic surfactant niosomes have gained considerable attention amongst pharmaceutical researchers. It can entrap both lipophilic and hydrophilic drugs with high permeation of medications on the ocular surface. Several scientific research pieces have reported the successful use of niosomes as a potential vehicle in ocular drug and gene delivery systems. In this study, we aim to develop niosomes using ultrasonication methods to encapsulate drugs that could be characterized and tested for ophthalmic drug delivery.

Presenter Name

Chitvan Killawala

Video Title

Portable Solid-State Sensor System for Firefighter Exposure to PAH

Link to Unlisted YouTube Video

https://youtu.be/wJ_0Af84-UU

Abstract

Studies conducted on firefighters indicate high rates of cancer compared to general populace. Previous studies using passive sampling techniques during work shift suggest increased exposure to toxic compounds including poly aromatic hydrocarbons (PAHs) known for their carcinogenicity. No readily available methods exist for determining the presence of these high-risk compounds in field, real-time. It is thereby necessary to reduce firefighter's exposure to carcinogens by constant monitoring. We designed a solid state sensor array based detection system using commercial sensors. Laboratory validation of performance was performed using spiked air sampling in airtight environment. The system was subsequently made portable and deployed in controlled live fire situations to evaluate their effectiveness in detecting carcinogenic PAHs in an active fire situation. Sensor responses were measured at varying distances from outside the hot zone of a live firefighter training drill in order to simulate firefighter exposure. Results suggest significant differences in sensor activity consistent with expected PAH intensity in the area. To further improve performance modifications in hardware are investigated. To improve the detector, we propose a graphene based nanosensor capable of outperforming commercial sensors in stability and selectivity. Current Sensor performance justifies the system as a viable proof of concept as real time deployable PAH sensors. A fully realized PAH detection sensor array will help inform policy and regulations to advance firefighter safety in the field.

Presenter Name

Elayaraja Kolanthai

Video Title

Self-luminescent RGO/Sr- incorporated hydroxyapatite for bioimaging application

Link to Unlisted YouTube Video

https://youtu.be/oL22AFk68_o

Abstract

Self-luminescent reduced graphene oxide/strontium-incorporated hydroxyapatite for bio-imaging application

Elayaraja Kolanthai[1], Udit Kumar[1], Yifei Fu[1], Craig J Neal, Balaashwin Babu[1], Tamil Selvan Sakthivel[1], and Sudipta Seal[1,2]*

[1]Advanced Materials Processing and Analysis Center, Dept. of Materials Science and Engineering, University of Central Florida, Orlando, FL.

[2]College of Medicine, University of Central Florida, FL.

*Corresponding author: Sudipta.Seal@ucf.edu

Bioimaging is an expedient technique in the field of medicine, enormously aiding in disease diagnosis, in situ monitoring of unique cell populations, and delivery system tracking. Currently, inorganic nanoparticles (NP) represent a substantial fraction of published novel probes used in bioimaging. The use of non-toxic fluorescent nanoparticles hold several advantages, such as high sensitivity, amenability to surface functionalization for cell/tissue targeting (selective imaging, delivery/release of biomolecules or drugs), or improved bio-compatibility (engineered circulation time), and long-term photo-stability for repeated imaging. Most NP probes do not possess auto-luminescence properties while others are luminescent with poor photostability and demonstrate cytotoxicity. To overcome these issues, a biocompatible, self-luminescent reduced graphene oxide/strontium-incorporated hydroxyapatite (RGO/Sr-HAp) was successfully synthesized by a rapid microwave irradiation technique. The synthesized NP showed rod and sphere shapes confirmed by TEM. The obtained particles showed an intense bright blue emission, which might arise from Sr or carbonate ion incorporation in the HAp structure confirmed by the PL study. The crystal structure and incorporation of RGO, Sr, and carbonate group into Hap were confirmed by XRD and XPS analysis. Further, this nanoparticle showed no toxicity on a normal-type cell line. This nanoparticle can be used to deliver the biomolecules or drugs at the targeted site.

Presenter Name

Udit Kumar

Video Title

Viral inactivation using localized UV emission and application in self-cleaning PPE

Link to Unlisted YouTube Video

https://youtu.be/3SCdXUxxfYI

Abstract

As COVID-19 pandemic rising on everyone is looking for an effective way to kill viruses, we present here a novel method to catch and kill viruses on PPE (personal protective equipment) surfaces to minimize the spread. Using a UV radiation to sanitize laboratory fume hood and working table etc. has been a standard operating procedure in microbial research. The idea here is to expose viruses with a UV radiation (within the mutagenic range) to kill or deactivate them. Transcending this idea to come up with a product which can produce UV radiation locally and regeneratively, inspired us to look for a material which can upconvert visible light (White light which is most abundantly available) to UV radiation. Here we present Yttrium Orthosilicate based up-conversion (visible to UV) nano materials. Yttrium Orthosilicate has been used as a host lattice, Praseodymium (Pr), Gadolinium (Gd) and lithium (Li) as dopants. These nanoparticles were coated on PPE surfaces along with cationic and anionic using layer by layer (LBL) coating method. An oligosaccharide species, chosen to possess strong bond affinity/complementarity to novel coronavirus S glycoprotein, was grafted to the polymer using functional groups/sites via click chemistry to add one more mechanism of virus inactivation. Overall efficacy of material as an antiviral material is under study and we have observed virus inactivation with our material in comparison to the contol. Our material will lead to self-cleaning PPEs development.

Presenter Name

Calen Leverant

Video Title

Patterning Shape Memory Polymer Nanostructures

Link to Unlisted YouTube Video

https://youtu.be/Dtdl1Rt4QtM

Abstract

Shape memory polymers (SMPs) can transition between a temporary and permanent shape in response to external stimuli. Typically, SMPs are utilized for a transition in macroscale shape after exposure to high temperatures. Here, we show the less common ability of SMPs to perform shape changes on the nanoscale and without the use of high temperatures. A post curing exposure to ultraviolet light can be used to deactivate the stimuli responsive ability of the SMPs. As a result, we show that a photolithography-like exposure of UV light through a photomask can be used to selectively pattern nanostructures. We fabricated proof of concept photonic crystal SMPs with switchable structural color that have the ability conceal or reveal hidden patterns, words, and symbols. This process can be used as a low-cost alternative to pattern various functional nanostructures controlling disparate properties.

Presenter Name

Julian Long

Video Title

Sub-Nanometer Scale Surface Finishing of Fused Silica Laser Optics

Link to Unlisted YouTube Video

https://youtu.be/IHVD9A5sJEY

Abstract

Polished fused silica often has subsurface damage and a layer of contamination. The damage and contamination can be present at depths of up to 100 µm and 100 nm, respectively, and have proven challenging to remove. The presence of contamination on the surface of polished fused silica also contributes to a significant reduction in the laser-induced-damage threshold (LIDT). Magnetic field-assisted finishing (MAF) using a synthetic polishing cloth has been applied to remove the subsurface damage and the contamination layer from fused silica while maintaining sub-nanometer surface roughness. The process was shown to improve surface LIDT and no abrasive residue was detected by secondary ion mass spectrometry. However, the polishing characteristics are strongly dependent on the polishing pad conditions.

This presentation proposes the removal of the fused silica contamination layer using MAF with an iron-particle brush as a polishing tool, which, unlike the synthetic polishing cloth used previously, does not degrade during polishing and is reusable. This will help maintain consistent material removal regardless of polishing time. Polishing experiments using MAF with an iron-particle brush will demonstrate the polishing characteristics on the surface of fused silica.

Presenter Name

Ipshita Menon

Video Title

Needle-Free Transdermal delivery of a Microparticulate VLP Vaccine

Link to Unlisted YouTube Video

https://youtu.be/O1zIY5OTepk

Abstract

Introduction:

Vaccine-enhanced respiratory disease has thwarted attempts to develop a vaccine for Respiratory Syncytial Virus (RSV) using the inactivated form of the virus. The objective of this study was to evaluate the immunogenicity of encapsulated fusion protein virus like particle (F-VLP) vaccine. Furthermore, this study aims to use Precise Laser Epidermal System (P.L.E.A.S.E) laser to administer the vaccine via the transdermal route of administration.

Methods:

Vaccine-adjuvant combination was administered to Swiss Webster mice via the transdermal route using P.L.E.A.S.E laser. The mice sera were analyzed by enzyme-linked immunosorbent assay (ELISA) to determine immunoglobulin G (IgG) and the subtypes. The mice were then challenged with RSV A2 virus at week 13. Post challenge, the immune-organs and lungs was assessed for the expression of T and B cell subtypes by flowcytometry. In addition, the lung homogenates were analyzed for levels of IgG and subtypes as well as IgA by ELISA. Furthermore, the viral load in the lungs was analyzed using an immune plaque assay

Results:

The immune sera as well as lung homogenates of mice immunized with F-VLP MP + Adj MP had significantly high levels of IgG and IgG2a. The induced immune response seemed to be skewed towards the (Th)1 arm which is essential in fighting an infectious disease. The mice immunized with F-VLP MP + Adj MP elicited a higher CD8+ and CD4+cell count in lymph node and spleen cell populations when compared with the mice immunized with FI RSV as well as naïve mice. They also had significantly higher expression of IFN-γ in the spleen cells. The ELISA analysis of the lung homogenates results revealed significantly higher levels IgA in the mice immunized with F-VLP MP + Adj MP. IgA is a marker of mucosal immunity and confers protection against RSV. The immune plaque assay proved that the mice immunized with F-VLP MP+ Adj had negligible viral plaques as compared to mice immunized with FI RSV.

Presenter Name

Ipshita Menon

Video Title

Quick Dissolving Microneedle based Nanoparticulate vaccine for RSV: Formulation

Link to Unlisted YouTube Video

https://youtu.be/tSyibPTYMAE

Abstract

Introduction:

Previous attempts to develop a vaccine using a formalin inactivated Respiratory Syncytial Virus (RSV) ended in a tragic failure as a result there is no vaccine for RSV. Polymeric dissolving microneedles is one of the most sought-after method of transdermal vaccination due to their non-invasive nature and ease of application. The objective of this study is to formulate and optimize quick dissolving polymeric microneedles as well as polymeric nanoparticle encapsulating F-VLP.

Methods:

Hyaluronic acid at various concentration was used to prepare the microneedles. A backing of either hyaluronic acid or polyvinyl alcohol was added, and the molds were kept to airdry in a desiccator. The microneedles were characterized using Scanning electron microscopy (SEM). Pore formation was studied using 1% crystal violet solution and hematoxylin and eosin (H&E) staining of transverse section of skin. The formulation development of microparticles involved the formulation of a stable w/o/w emulsion of polymers (Poly(lactic-co-glycolic acid) (PLGA), using a model antigen. The nanoparticles were characterized for size using differential light scattering and SEM. The antigen integrity was tested using sodium dodecyl sulfate and polyacrylamide gel electrophoresis.

The final optimized batch of PLGA microparticels loaded hyaluronic acid + trehalose microneedles will be used to carry out the immunization study. The mice will be bled at regular intervals to analyze immunoglobulin (Ig) IgG and subtypes using enzyme linked immunosorbent assay. The immunized mice will be challenged with live RSV A2 virus (1x10^6 PFU) and the post challenge the immune organs and lungs would be T and B cell subsets.

Results:

The dissolving microneedles made with hyaluronic acid and trehalose was selected as the optimized formulation and dissolve within 10 minutes. The microneedles approximately 400µm in length which will be very suitable for further immunization studies involving mice. The nanoparticles were in the size range of 700-800nm ± 50nm with an entrapment efficiency of approximately 70% ± 10% and a final yield of 90%±10%.

Presenter Name

Stephen Michel

Video Title

Co-Surfactant Mediated Functionalization of SWCNTs for Biomedical Applications

Link to Unlisted YouTube Video

https://youtu.be/7cJyEaYAxnc

Abstract

Single walled carbon nanotubes (SWCNTs) display potential for applications as biomedical sensors and electronics due to their unique optical and chemical properties. Given their ideal NIR-Fluorescence range for in vivo sensing and resistance to photobleaching, SWCNTs are ideal candidates for implantable biosensors. SWCNTs can be functionalized to provide quantitative measurements of minute analyte concentrations and can be further embedded in electronic substrates to produce unique physical and electrical properties. However, the ability to functionalize the specific (n,m) chiralities in a general solution of SWCNTs, and therefore diversify the utility of SWCNT solutions, is limited. Central to this functionalization is control over the local structure surrounding the SWCNTs. Our group has previously shown that the use of specific ratios of co-surfactants enables the selective coating of (n,m) species. By altering the concentration of co-surfactants in solution, SWCNT solutions containing multiple (n,m) types were functionalized such that each (n,m) type exhibited unique sensing behavior. These findings provide a promising pathway for functionalizing SWCNTs that can be utilized for the creation of multi-responsive sensors or SWCNT-polymer composites.

Presenter Name

Keenan J. Mintz

Video Title

A deep investigation into the structure of carbon dots

Link to Unlisted YouTube Video

https://youtu.be/SCFJAujf79w

Abstract

Since their discovery, carbon dots (CDs) have been a promising nanomaterial in many fields including nanomedicine. Despite their promise in this area, there are many barriers to overcome for CDs to be approved for use in humans. One major obstacle to CDs' approval is related to their poorly defined structure. A structural study of CDs will be presented in order to rectify this shortcoming. The properties of three different CDs prepared in our lab which have significant promise in terms of biomedical applications, black CDs (B-CDs), carbon nitride dots (CNDs), and yellow CDs (Y-CDs), will be compared in order to develop a coherent structural model for each nanosystem. The absorption coefficients at a range of wavelengths was measured for each system and information from this data was extracted to show the level of disorder in each system with Y-CDs being the most ordered and B-CDs the least. Furthermore, extensive structural characterization was performed in order to derive structural information for each system. From these we found that B-CDs and CNDs are functionalized to a greater degree and are also more disordered and amorphous than Y-CDs. This wide array of techniques was used to develop a structural model consistent with our data and what is known for carbonic nanostructures. These models can be used in future work to analyze CDs' emission properties and to better understand the structure-property relationship in CDs.

Presenter Name

Ahmed Moawad

Video Title

ACOF-1@BiOBr core–shell spheres as an efficient photocatalyst for dyes degradation

Link to Unlisted YouTube Video

https://youtu.be/QZeDk0qccRA

Abstract

We demonstrate the delicate design and construction of hierarchical ACOF-1@BiOBr core–shell spheres for the photocatalytic degradation of dyes. This smart design rationally combines the structural and functional advantages of catalytically active covalent organic framework (ACOF-1) and BiOBr as an *p*-type semiconductor into a three-dimensional core-shell architecture, which can remarkably facilitate the migration and separation of photogenerated charge carriers, enhance the adsorption dyes molecules, and provide more active sites for photocatalytic reactions. Benefitting from these unique structural and compositional features, the hierarchical ACOF-1@BiOBr core–shell spheres manifest considerable performance for dye degradation.

Presenter Name

Mohammad Mofidfar

Video Title

Pharmaceutical jewelry: Earring patch for transdermal delivery of contraceptive hormone

Link to Unlisted YouTube Video

https://youtu.be/N1b6Qjgy1nw

Abstract

Lack of medication adherence is a significant cause of morbidity and mortality with large associated financial costs. This is especially true for contraceptive hormones, which provide almost perfect prevention of pregnancy when used correctly, but have significant failure rates in typical use due largely to poor adherence. To increase medication acceptability and adherence, we introduce pharmaceutical jewelry, in which a transdermal patch is incorporated into jewelry worn on skin. To demonstrate the approach, we incorporated transdermal patches containing contraceptive hormone levonorgestrel (LNG) into an earring, ring, necklace and wrist watch. Transdermal delivery of LNG from earring patches across pig skin ex vivo achieved a steady state flux of 1.7 $\mu g/cm^2$.h. Pharmacokinetic analysis in hairless rats yielded LNG delivery rates that maintained serum LNG levels near 1500 pg/ml throughout the one-week patch application period, which is well above the human contraceptive threshold concentration of 200 pg/ml. When patches were applied cyclically for 16 h on and 8 h off to simulate earring removal at night, serum LNG concentration dipped during off periods, but remained well above the human contraceptive threshold. Earring patches were well tolerated by the rats. We conclude that pharmaceutical jewelry can provide a novel method of drug delivery, especially for contraceptive hormones, that has the potential to improve acceptability and increase medication adherence.

Presenter Name

Mirra Mogensen

Video Title

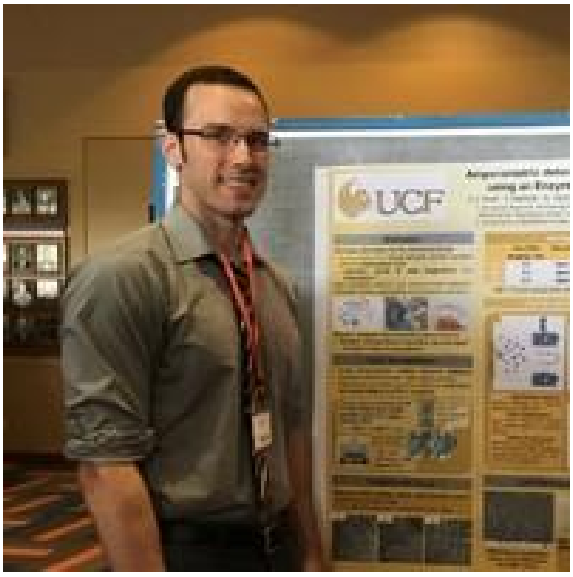
Photophysical characteristics of nanocrystalline lead halide perovskites encapsulated in PET

Link to Unlisted YouTube Video

https://youtu.be/YQwAaKJrOqs

Abstract

The room temperature photophysical characteristics of nanocrystalline inorganic- and organic lead halide perovskite (LHP) films encased in polyethylene terephthalate (PET) will be introduced by way of combined photoluminescence (PL) spectra, PL lifetime and Raman spectra acquired over multiple areas of the films using a lab-built confocal microscope. The ability to simultaneously correlate structure from acquired spectra with the time evolved PL emission represented by lifetime decay serves a dynamic purpose to unfolding the structure-function relationship of this class of material. Although microcrystalline and nanocrystalline lead halide perovskite films have proved to hold many desirable traits for the semiconductor industry, the core mechanism behind their light emission and flow of charge has yet to be fully understood. Beyond the chemical nature of the nanocrystalline perovskite, the inherent unit cell for which the perovskite adopts plays a major role in light-matter interactions. The goal of this study is to offer further clarification on the material characteristics of nanocrystalline LHPs which, relevant to room temperature uses, may serve as an inexpensive and color pure alternative to some of the leading contenders in the display industry. The colloidal NC LHPs are stabilized in situ of PET polymer films, appeasing the inherent vulnerability of perovskites to moisture, temperature changes and light. The superior stability and photophysical characteristics of this material are thus presented to the extent that the films have been aged in the ambient.



Presenter Name

Craig Neal

Video Title

Nanoengineering Methods for low Solid Solubility Compositions: optimized Silver modified Nanoceria for Biomedical Applications

Link to Unlisted YouTube Video

https://youtu.be/vERkWM5c-Lw

Abstract

The utility of noble metal species in catalysis has been further broadened by investigations into their complex substrate interactions (catalyst-substrate/support effects). Such studies highlight the impact of chemical environment on material character as emergent phenomena (e.g. varied plasmon character, unique reaction selectivity (reactivity)). In the presented study, noble metal silver's limited solubility in and surface-phase formation on redox-active cerium oxide nanoparticles is overcome by manipulating the unique chemistry of ionic silver in aqueous solution. In particular, the oxidation of silver and, thereby, the final nanomaterial synthesis products, are *nanoengineered* by top-down chemical etching process to remove contaminant silver (oxide) phases post-synthesis (utilizing Tollen's reagent, $[Ag(NH_3)_2]^+$, formation from silver (oxide)) or selective-oxidation of Ce^{3+} over silver by hydrogen peroxide (H_2O_2+Ag^0,Ag_2O □ Ag^++H_2O+(radical oxygen species)), bottom-up process, to preclude silver (oxide) particle phase formation. Three synthesis methods, leading to near-monodisperse suspensions, are undertaken (AgCNP1, AgCNP2, AgCNP3) using a NaOH-mediated forced-hydrolysis; hydrogen peroxide and NH_4OH mixed hydrolysis; and hydrogen peroxide oxidation reaction, respectively. Each synthesis produces surface/near-surface silver-phases of varied oxidation states (evidenced by x-ray photoelectron spectroscopy) due to the unique crystal environments evolved by each synthetic route (evidenced by transmission electron microscopy, Raman spectroscopy, x-ray diffraction, electroanalysis). Biomedically-relevant enzyme-mimetic catalysis assays (peroxide-degrading: catalase, superoxide radical scavenging: superoxide dismutase) were performed for each formulation, demonstrating high specific activity of the AgCNP composition. The influence of crystal chemical environment on surface silver activity will be further probed via electrochemical analysis (Tafel analysis, potentiodynamic polarization, Mott-Schottky analysis, impedance spectroscopy) in biological buffers.

Presenter Name

Mary Olagunju

Video Title

Remotely Responsive Nanoparticle Catalysts

Link to Unlisted YouTube Video

https://youtu.be/MjXbFXwd3po

Abstract

Nanoparticles have been of great interest due to their surface to volume ratio which leads to an increase in the number of catalytic active sites.1 While many conventional ligands are used to stabilize the materials in solution, peptides offer unique capabilities, including the ability to change the overlayer conformation via external stimuli. For this, azobenzene photoswitches can be incorporated into the peptides adsorbed at the particle surface that can reversibly reconfigure the biomolecule conformation between two different conformation (e.g., cis and trans). We have probed this configuration change using atomically resolved spectroscopic methods, which support alterations in the peptide overlayer structure. These significant changes are shown to have profound effects on the nanoparticle catalytic activity, potentially leading towards the ability to remotely actuate nanoparticle function via external stimulus.

Presenter Name

Juanpablo Olguin

Video Title

Polymer hydrogels with tunable carbohydrate content to probe extracellular matrix-lectin interactions

Link to Unlisted YouTube Video

https://youtu.be/SVU7ZJjWj9U

Abstract

Protein-carbohydrate interactions are attractive drug targets due to their involvement in various pathological processes such as infections, cancer, inflammation, and autoimmunity. Lectins are carbohydrate binding proteins that can act as signaling molecules to modulate various aspects of cell phenotype and function, including adhesion, migration, differentiation, apoptosis, and proliferation. Within tissues, lectins can bind to glycans on both the extracellular matrix (ECM) and the cell surface. However, little is presently known about the role of lectin-ECM interactions in the context of cell signaling because existing tools to probe them depend on naturally-derived reagents, such as Matrigel or extracted mammalian glycoproteins, which have ill-defined carbohydrate content. Here we will present a synthetic ECM with highly reproducible and user-defined glycan content that can be used to study lectin-ECM interactions. Specifically, we created two-component hydrogels by mixing poly(ethylene glycol) diacrylate and carbohydrate-modified peptide nanofibers. Peptide nanofibers modified with N-acetylglucosamine (GlcNAc) provide hydrogels that selectively capture the GlcNAc-binding lectin, wheat germ agglutinin (WGA). Tuning GlcNAc content dictates the extent of WGA binding and the duration of its retention within the hydrogel. Carbohydrate content can be precisely varied by changing either the total concentration of nanofibers or the ratio of glycosylated to non-glycosylated peptides that are co-assembled into nanofibers. WGA absorption can also be controlled by changing PEG molecular weight, with increasing polymer chain length leading to higher WGA binding likely due to increases in hydrogel pore size. Collectively, these data demonstrate that glycosylated peptide nanofibers embedded within PEG hydrogels endow specific lectin binding properties.

Presenter Name

Popular Pandey

Video Title

Dynamic Surface Charge Discrimination of Single Protein Molecules in Solution by Potentiometric Nanoimpact Method

Link to Unlisted YouTube Video

https://youtu.be/1oJ4dSc53UY

Abstract

Nanoscale electrochemical methods based on nanopores and nanoelectrodes have gained remarkable popularity for single-entity detection and analysis. This work integrates two aforementioned methods in one nanopipette apex to simultaneously monitor the ionic current and surface potential changes at the nanopore and the nanoelectrode when a protein translocates through the nanopore or collides with the nanoelectrode. In this presentation, I will demonstrate a facile potentiometric method for probing dynamic surface charge variation of proteins at the single-molecule level in solution based on the nanoimpact events at the nanoelectrode. The experimental results are further supported by molecular dynamics and numerical simulations. Proteins, such as ferritin, hemoglobin, and cytochrome-c are tested to validate the method. When a protein molecule arrives at the vicinity of the electrically floating nanoelectrode, open-circuit potential (OCP) changes are detected at the nanoelectrode. Compared with the ionic current change, the OCP changes can be detected with better signal-to-noise ratio and higher time resolution. The nanopipette based novel potentiometric detection method provides new opportunities to study various biological entities at a single-entity level with close to physiological conditions.

Presenter Name

Atul Parab

Video Title

Peptides-Induced Generation of 2-D Nanomaterials In Aqueous Media

Link to Unlisted YouTube Video

https://youtu.be/7p64_ERWioY

Abstract

Material recognition properties of the peptides can be exploited and modulated to access unique two-dimensional nanomaterials such as graphene and hexagonal boron nitride (*h*-BN). Interestingly, while many graphene-binding peptides are available, modification of these sequences using non-natural elements remains underexplored, but could be used to enhance the resultant properties of the final materials. Here we discuss recent studies in the use of the graphene binding P1 peptide for the aqueous exfoliation of graphene from graphite using bath sonication. To modulate the exfoliation and binding process, the P1 was modified with fatty acid chains at both the N- and C-termini, potentially enhancing the affinity for the hydrophobic surface. Remarkably, all of the sequences were able to exfoliate graphene; however, the fatty acid modified substrate generated nanosheet materials with fewer defects. Computational modeling confirmed the role of the fatty acid, suggesting that it edge wrapped the graphene sheets, potentially providing a steric defense of this region to prevent defect formation.

Presenter Name

Smital Rajan Patil

Video Title

Addressing the SARS pandemic: A novel vaccine for COVID-19

Link to Unlisted YouTube Video

https://youtu.be/N1YQAEyORRQ

Abstract

Addressing the SARS pandemic: A novel microparticulate microneedle vaccine for COVID-19 using the SARS Spike S-1 protein antigen

Purpose: The rampancy of COVID-19 has affected around 21.7 million people and caused more than 776,000 deaths globally. Considering the highly contagious nature of the virus, the need for a safe and efficacious vaccine for COVID-19 is highly critical.

Introduction: The spike protein is a viral epitope that is capable of inducing an immune response in the body and thus a suitable antigen for formulating a coronavirus vaccine. Microparticles (MPs) are suitable delivery vehicles for vaccines as they are better up taken by antigen-presenting cells inducing a more robust immune response to the antigen. The spike protein PLGA MPs were loaded into dissolving microneedles, a promising delivery system for large molecules such as proteins.

Method: Spike-protein loaded MPs (SPMPs) were formulated via a soluble emulsion method. The microparticles were subsequently lyophilized and assessed for innate and adaptive immune response in vitro. Vaccine microparticles were loaded into a hyaluronic acid gel and centrifuged to procure the vaccine-loaded fast-dissolving microneedles arrays and assessed in vivo for induction of humoral response.

Results: The SPMPs were successfully formulated and induced a significantly higher ($p<0.05$) innate immune response and significantly higher ($p<0.05$) expression of antigen presenting molecules MHC I, CD80, MHC II, and CD40 on the surface of dendritic cells.

Conclusion: This formulation thus shows a promise in inducing both, humoral as well as cellular immune response and offer longer lasting protection against coronavirus. This has a potential to be promising vaccine in the ongoing pandemic the world is facing currently.

Presenter Name

Devon Pawley

Video Title

In Vivo Assessment of Dexamethasone (DXM) Infused and Coated Poly(lactic-co-glycolic acid) (PLGA) Microneedles as an Improved Drug Delivery System for Intracochlear Biodegradable Devices

Link to YouTube Video

https://youtu.be/EtZ_EjVq0c0

Abstract

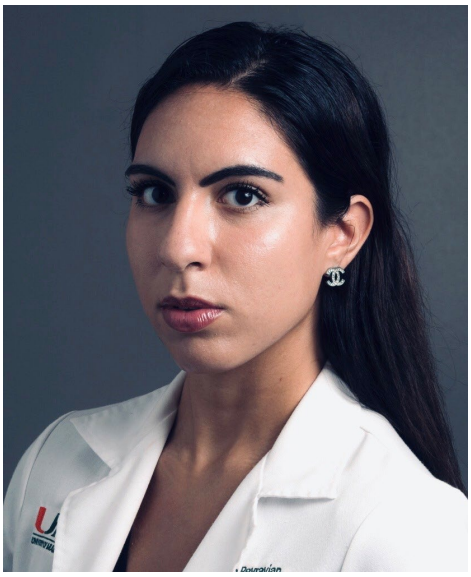
Inner ear drug delivery techniques are challenging to develop due to the inherent complexity of the cochlear anatomy, which limits molecular transportation. A promising solution is the use of biodegradable polymers because the continuous release of bioactive molecules without introducing foreign compounds is highly desirable. Using a microneedle approach lends the drug infused polymeric microneedle the capability to pierce the tissue and be placed inside of the cochlea, allowing the appropriate amount of drug to be released overtime to the desired area.

Biopolymer microneedles were prepared by mixing PLGA copolymer and DXM in an appropriate solvent. The solution was cast into a custom made mold engineered via photolithography and shaped as the desired microneedles. The needles were allowed to dry, removed from the mold, and coated with DXM. A fluorescent compound, Rhodamine B, was used instead of DXM to study the drug release profile. High performance liquid chromatography was also performed.

Ototoxicity assessment was performed using whole organ of Corti (OC) explants dissected from 3-day-old rat cochleae, and the OC explants were exposed to the dexamethasone microneedles in culture. Fluorescent microscopy for viable hair cell (HC) counts (FITC-phalloidin) was also performed. ANOVA and Bonferroni post hoc testing were used for statistical analysis.

Additionally, the biopolymer microneedles were blended with FM1-43, a dye that behaves as a permanent blocker of the mechanotransducer channel. The needles were introduced in the scala tympani in adult mice for in vivo assessment of the intracochlear drug release. Subsequently, animals were euthanized, cochlea were harvested and analyzed under confocal microscopy to assess the distance travelled in the cochlea.

Drug infused polymeric microneedles provide a novel method to deliver dexamethasone to the inner ear over a controlled period of time without introducing foreign agents to the cochlea, and thus protect the hair cells from ototoxicity.



Presenter Name

Nadia Peyravian

Video Title

Formulation and novel repurposing of Naloxone and Naltrexone nanoparticles to attenuate opioid-induced tight junction disruption

Link to Unlisted YouTube Video

https://youtu.be/Cernke6K5C4

Abstract

Chronic prescription opioid use exacerbates risk and severity of ischemic stroke. There is a need for novel drugs to promote stroke recovery as there are no approved neuroprotective or neurorestorative for the pathological damage to the blood brain barrier (BBB) that arises from opioid induced ischemic stroke. Prescription opioids such as morphine have been shown to alter tight junction (TJ) protein expression, resulting in the disruption of the BBB, leading to stroke pathogenesis. As BBB disruption is a pathological hallmark in ischemic stroke, protection of the BBB as a therapeutic strategy for promoting stroke recovery is suggested. To addresses the deficiency in stroke pharmacological options, we propose a novel application and repurposing of FDA-approved opioid antagonists, naloxone and naltrexone, as a prospective neuroprotective therapeutic strategy to minimize BBB damage, reduce stroke severity, and promote recovery. In order to overcome the bioavailability and drug delivery challenges associated with current formulations of naloxone and naltrexone and to maximize naloxone and naltrexone as therapeutic agents for stroke recovery, a novel synthesis of "nanodrugs" based on carrier-free nanoparticles derived from pure naloxone and naltrexone drugs is proposed. Nanoparticles offer longer bioavailability compared to traditional forms of drug delivery thus decreasing dosage and frequency of dosage. Simultaneously, nanoparticles increase absorption, rate of absorption, and enhance adhesiveness to the cell surface due to particle diminution. These nanodrug formulations are envisioned to (1) enhance the therapeutic efficacy of naloxone and naltrexone in relation to current drug formulations, and, thus, (2) as a result, promote stroke recovery.

Presenter Name

Mackenson Polche

Video Title

Analysis of thermoelectric nanoantennas for solar energy harvesting.

Link to Unlisted YouTube Video

https://youtu.be/FPpumWWZhAc

Abstract

In this work, we present the numerical simulations of different sizes and structures of thermoelectric nanoantennas that are able to capture different types of electromagnetic wavelengths and convert them into electricity and thus increase the efficiency of solar cells.

Presenter Name

Sherwin Reyes

Video Title

An Intact Cell Bioluminescence-Based Assay for the Simple and Rapid Diagnosis of Urinary Tract Infection

Link to Unlisted YouTube Video

https://youtu.be/tp9XS2ZJjmU

Abstract

Urinary tract infection (UTI) is one of the most common infections, accounting for a substantial portion of outpatient hospital and clinic visits. Standard diagnosis of UTI by culture and sensitivity can take at least 48 hours, and improper diagnosis can lead to an increase in antibiotic resistance following therapy. To address these shortcomings, rapid bioluminescence assays were developed and evaluated for the detection of UTI using intact, viable cells of Photobacterium mandapamensis USTCMS 1132 or previously lyophilized cells of Photobacterium leiognathi ATCC 33981™. Two platform technologies, Tube Bioluminescence Extinction Technology Urine (TuBETUr) and Cellphone-based UTI Bioluminescence Extinction Technology (CUBET), were developed and standardized using artificial urine to detect four commonly isolated UTI pathogens – namely Escherichia coli, Proteus mirabilis, Staphylococcus aureus, and Candida albicans. Besides detection, these assays can also provide information regarding pathogen concentration/level, which helps guide treatment decisions. These technologies were able to detect microbes associated with UTI at less than 105 cfu/mL which is usually the lower cut-off limit for a positive UTI diagnosis. Among the 30 positive UTI samples yielding 105-106 cfu/mL pathogen concentrations, a total of 29 urine specimens were correctly detected by TuBETUr as UTI-positive based on a 15-minute detection window. Similarly, the rapid CUBET method was able to discriminate UTIs from normal samples with high confidence ($p = <0.0001$) using single-pot conditions and cell phone-based monitoring. These technologies could potentially address the need for point-of-care UTI detection while reducing the possibility of antibiotic resistance associated with misdiagnosed cases of urinary tract infections, especially in low-resource environments.

Presenter Name
Gabrielle Roberts

Video Title

Study of Small Bimetallic Clusters using DFT - Gabrielle Roberts- University of Central Florida

Link to Unlisted YouTube Video

https://youtu.be/1XP0e1LtKYQ

Abstract

To investigate the effect of size-dependent and composition-dependent properties, the geometric structures, stabilities, and electronic properties of size-selected Ag_(n-1)M (M = Au, Co, Cu, Mn, Ni, Pd, Pt, Ru; n = 3, 9, 15) bimetallic clusters are systematically analyzed using spin-polarized density functional theory (DFT) within the generalized gradient approximation (GGA). The results show that doping with an M atom, referred to as a "guest atom", increases the stability of the bimetallic cluster compared to the pristine Ag_n (n = 3, 9, 15) cluster. The result for various properties including formation energy per atom, HOMO-LUMO gap, and magnetic moments, are evaluated as a function of size and composition of the system. These preliminary results will open the door for more systematic studies of alloy clusters of different size and stoichiometry.

Presenter Name

Harun Roshid

Video Title

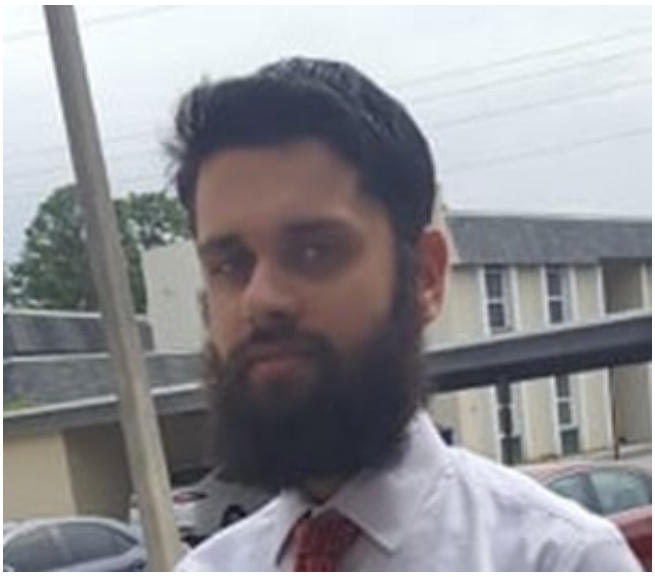
Spore-Based Biosensors for Monitoring the Chemical & Microbial Characteristics of Soil

Link to Unlisted YouTube Video

https://youtu.be/w__2F9bKzas

Abstract

Efficient agriculture and crop production are highly dependent on proper water irrigation and healthy soil, which is characterized by presence of nutrients, metals, and beneficial microorganisms. For optimal plant growth certain ions, such as zinc, copper, phosphate and sulfate should be present in soil at certain concentrations. The two most widely used analytical techniques for the detection of heavy metals are atomic absorption spectrometry (AAS) and inductive coupled plasma mass spectrometry (ICP-MS). Due to its sensitivity and selectivity, ICP-MS is considered as the "gold standard" for heavy metal analysis. However, both techniques suffer from the same disadvantages, which are the expense of the instrument, requirement of highly trained personnel, and complication of in-field deployment. Bacterial whole cell biosensors (WCBs) and, in particular, bacterial spore biosensors, have emerged as excellent tools because they can be prepared in a very reproducible manner, are cost-effective, can survive extreme conditions, and can be regenerated if/when they fail. We have constructed such biosensors using green fluorescence protein to monitor copper and zinc, by inserting an Amino Terminal Copper and Nickel Binding Motif (ATCUN) into a circularly permutated green fluorescent protein, a quencher-based biosensor has been developed for copper. For the monitoring and establishing of microbial fingerprints in the soil, we propose to prepare spore sensors that allow rapid in situ detection of quorum sensing molecules (QSMs) in soil in order to evaluate the effect of environmental changes on microbial communities. Quorum sensing molecule, a critical signalling molecule that controls the cell-to-cell communication, expression of virulence gene, biofilm formations, is an important analyte to assess and establish microbial fingerprints in the soil. Acyl homoserine lactone (AHLs), autoinducer-2 (AI-2), autoinducing peptides (AIPs) are some of the class of QSMs. Previously a long (pSB1075) and short (pSB406) chain acyl homoserine lactones (AHLs) biosensor and autoinducer-2 (AI-2) whole cell biosensor (WCB) has been developed for gram negative bacteria. These sensing systems allowed for $1x10^{-9}$ M detection of QSMs with a dynamic range of $1x10^{-9}$-$1x10^{-6}$ M. These WCBs will be further developed in a spore form and evaluated for the detection of QSMs in common agriculture soil such as sand, loam, and clay.



Presenter Name

Muhammad Sajid

Video Title

Adsorption of small organic molecules on silica/Ru(0001)

Link to Unlisted YouTube Video

https://youtu.be/DgHsgDelC0o

Abstract

Organic electronic devices have the potential to replace conventional silicon devices due to being light weight, cheap and malleable. The performance of these devices depends strongly on the atomic and electronic characteristics at their interface with the host metal substrate. In order to understand the interaction between organic molecules and metal, we are studying adsorption of simple aromatic molecules, benzene and pyridine on Ru(0001), both with and without ultra-thin relatively inert silica sheets inserted between the two using Density Functional Theory (DFT) calculations. These molecules serve as basic building blocks for the larger and more complex organic device materials.

Silica sheets can be grown and modeled as either chemisorbed monolayers or physiosorbed bilayers and have been chosen to provide an experimentally accomplishable means of varying the degree of separation between the targeted adsorbate molecules and the conductive support. Our simple model systems will help to understand the basics of organic metal interface in the actual device.
Our study revealed that strong chemisorption of organic molecules on Ru(0001) surface can be tuned to physisorption by insertion of monolayer or bilayer silica layers. Silica layers still provides adsorption due to weak van der Waals interactions instead of strong covalent bonding. Charge transfer between the metal and organic molecules can be minimized and electronic characteristics of free molecules can be restored.

Presenter Name

Laboni Santra

Video Title

A Flexible DLP 3D-printed Coated Microneedle Patch for the Delivery of New Therapeutics to Citrus Stem Tissue

Link to Unlisted YouTube Video

https://youtu.be/372Cm97A5LM

Abstract

This work reports the design, fabrication, and testing of a flexible digital light processing (DLP) 3D-printed coated microneedle patch, which is designed for transporting copper-based therapeutics to the stem tissue of Huanglongbing (HLB)-affected trees. HLB has decimated the previously $9 billion citrus industry in Florida, reducing turnover to a mere $3.28 billion as of 2018. HLB is caused by a phloem-limited bacterium "Candidatus Liberibacter asiaticus" (Clas), so any treatment must be delivered to phloem tissue to be effective, demanding the need for an innovative delivery mechanism that is user friendly and can bridge the gap of testing between the lab and the grove. It is hypothesized that a coated microneedle patch will efficiently create penetrations into the stem by which treatments can reach the thin stem phloem. The therapeutic selection criteria were based on 1) the potency, 2) phytotoxicity, 3) the familiarity with the industry, 4) the relative number of regulatory hurdles for EPA registration. Based on the above, metallic copper was selected and used for this study. Copper is formulated in a way that follows sustained release kinetics and can travel through the plant vascular system without causing phytotoxicity. The microneedles were designed to have an optimized surface area for maximizing the formulated copper coating. These needles were subsequently demonstrated in a series of water studies that showed the sustained release of copper over time. Work in progress includes the testing of the device prototype in vitro in lab conditions to optimize parameters required for field environments.

Presenter Name

Shrita Sarkar

Video Title

Patient Derived Glioma Stem Cell Modulation For Improved Therapeutic Outcome

Link to Unlisted YouTube Video

https://youtu.be/b46Y9wYDiOE

Abstract

Glioblastoma Multiforme (GBM) is one of the most lethal malignant primary brain tumors owing to their heterogeneity and self-renewal capacity. Specific targeting of glioma stem cells (GSCs) with chemotherapeutics and modulation of GSCs in a way which will result in complete elimination of the GSSc remain as a major challenge in the different categories of brain tumors. The GSC population is resistant to all the available conventional therapies making GBM recurrent and extremely aggressive in nature. This demands an urgent need to develop therapeutic strategies against the highly resistant GSCs. The patient derived glioma stem cells isolated from surgically resected tumor tissues were grown in culture for determining the characteristic features responsible for increased stemness characteristics in this cell population. Our results documented that the patient derived GSCs of varied backgrounds utilize pathways for their growth and survival which might be different from the bulk tumor. Preliminary studies show that inhibition of such pathways in GSCs can lead to the change in their characteristic features. Thus, we embark on a journey to find a way which can make the GSCs vulnerable. In this presentation, we will present the primary findings using the various formulations that can show metabolic inhibiton to set a stage for understanding and analyzing how attacking GSCs can affect the GBM tumor progression.

This work was supported by the Sylvester Comprehensive Cancer Center and Bankhead-Coley Cancer Research Program Grant from Florida Department of Health (GR010561).

Presenter Name

Gibson Scisco

Video Title

Resistivity of Mesopore Confined Solvent Free Ionic Liquids from EIS

Link to Unlisted YouTube Video

https://youtu.be/yX6k_neW_84

Abstract

Supercapacitors offer higher power delivery and near infinite cycle stability compared to Li-ion batteries, but they lag behind in terms of energy density. Research into improving the energy density of supercapacitors has recently been focused on the rational design of nanopore structure to balance highly energy dense micropores (<2 nm) with higher conductivity mesopores (2 – 50 nm). Replacing aqueous electrolytes with organic electrolytes such as ionic liquids (ILs) can also dramatically increase energy density by enabling voltages higher than 1.23 V. ILs can have electrochemical stability windows as high as 3 – 6 V. Experiments with single conical nanopores have shown drastic increases in resistivity for imidazolium based ILs in very small pores, but a return to bulk resistivity for pores above 20 nm in diameter. Here, we report a 5-fold increase in resistivity of 1-ethyl,3-methylimidazolium tetrafluoroborate (EMIM-BF4) IL confined in carbon nanopores of diameter 24.4 ± 4.6 nm, well into the mesopore regime. Resistivity was determined through the use of detailed analysis of electrochemical impedance spectroscopy measurements of working supercapacitors of varying pore length. By utilizing highly ordered carbon electrodes based on the anodized aluminum oxide template growth method, this analysis offers insight into the effects of mesopore confinement on ionic liquid resistivity. These results will allow for improved rational design of supercapacitors to account for the effect of pore diameter on electrolyte resistivity and overall device performance. DISTRIBUTION STATEMENT A. Approved for public release; Distribution is unlimited 412TW-PA-20358

Presenter Name

Muhammad Waqas Shabbir

Video Title

Plasmonically enhanced mid-IR light source based on patterned graphene

Link to Unlisted YouTube Video

https://www.youtube.com/watch?v=LfrQdc5AHds&feature=youtu.be&ab_channel=WaqasShabbir

Abstract

We present a proof of concept for a spectrally selective thermal mid-IR source based on nanopatterned graphene (NPG) with a typical mobility of CVD-grown graphene (up to 3000 cm^{2}V^{-1}s^{-1}), ensuring scalability to large areas. For that, we solve the electrostatic problem of a conducting hyperboloid with an elliptical wormhole in the presence of an *in-plane* electric field. The localized surface plasmons (LSPs) on the NPG sheet allow for the control and tuning of the thermal emission spectrum in the wavelength regime from $\lambda = 3\ \mu$m to 12 μm by adjusting the size of and distance between the circular holes in a hexagonal or square lattice structure. Most importantly, the LSPs along with an optical cavity increase the emittance of graphene from about 2.3% for pristine graphene to 80% for NPG, thereby outperforming state-of-the-art pristine graphene light sources operating in the near-infrared (NIR) by at least a factor of 100. According to our COMSOL calculations, a maximum emission power per area of 11×10^3 W/m^2 at $T = 2000$ K for a bias voltage of $V = 23$ V is achieved by controlling the temperature of the hot electrons through the Joule heating. By generalizing Planck's theory to any grey body and deriving the completely general nonlocal fluctuation-dissipation theorem with nonlocal response of surface plasmons in the random phase approximation (RPA), we show that the coherence length of the graphene plasmons and the thermally emitted photons can be as large as 13 μm and 150 μm, respectively, providing the opportunity to create phased arrays made of nanoantennas represented by the holes in NPG. The spatial phase variation of the coherence allows for beamsteering of the thermal emission in the range between 12° and 80° by tuning the Fermi energy between $E_F = 1.0$ eV and $E_F = 0.25$ eV through the gate voltage. Our analysis of the nonlocal hydrodynamic response leads to the conjecture that the diffusion length and viscosity in graphene are frequency-dependent. Using finite-difference time domain (FDTD) calculations, coupled mode theory, and RPA, we develop the model of a mid-IR light source based on NPG, which will pave the way to graphene-based optical mid-IR communication, mid-IR color displays, mid-IR spectroscopy, and virus detection.

Presenter Name

Anuj Shah

Video Title

Phospholipid-enhancing Targeted Nanoparticle for Treatment of Barth Syndrome

Link to Unlisted YouTube Video

https://youtu.be/vaLX9Q5KBCg

Abstract

Barth syndrome (BTHS) is a rare genetic condition related to mitochondrial dysfunction and characterized by a group of symptoms including dilated cardiomyopathy, skeletal myopathy, neutropenia, and short stature. BTHS, an X-linked genetic condition, causes mitochondria to be unable to synthesize adequate amounts of mature cardiolipin, a lipid required for normal mitochondrial structure and energy production. This study aims to synthesize a targeted biodegradable cardiolipin-containing nanoparticle with low toxicity.

The nanoformulation will consist of a mitochondria-targeted nanoparticle (NP) with the ability to fuse with the mitochondrial membrane and enhance membrane lipid content in heart and liver cells. In addition, because patients with BTHS show inflammatory signals and enhanced levels of reactive oxygen species (ROS) which further worsen the symptoms by oxidizing the lipids, an antioxidant can be incorporated into the NPs to further improve its therapeutic abilities and help manage symptoms associated with BTHS while preventing mitochondrial toxicity, the release of cytochrome c, and subsequent apoptosis. The mitochondria-targeted nanoparticle shows gradual release of the encapsulated antioxidant drug over an extended period of time, which helps to prevent further lipid oxidation and reduce existing ROS.

The primary mutation in BTHS is in the Tafazzin (TAZ) gene, whose protein product allows the maturation of cardiolipin into the form that is present in the mitochondrial membrane. To observe the effects of cardiolipin-containing nanoparticles on cells lacking TAZ, induced pluripotent stem cells, both with TAZ and with a TAZ knockout, will be grown and tested to observe mitochondrial uptake of the targeted cardiolipin nanoparticles.

Presenter Name

Jarriaun Streets

Video Title

Sunitinib-Loaded MPEG-PCL Micelles for the Treatment of Age-Related Macular Degeneration

Link to Unlisted YouTube Video

https://youtu.be/vSxjh5RXZ7E

Abstract

Age-related macular degeneration (AMD) will be responsible for the vision impairment of more than five million late-aged adults in the next 30 years. Current treatment includes frequent intravitreal injections of anti-vascular endothelial growth factor (VEGF) agents. However, there are methods of drug delivery that can decrease the frequency of intravitreal injections by sustaining drug release. MPEG-PCL ((methoxypoly(ethylene glycol) poly(caprolactone)) has been reported as biocompatible and biodegradable. Polymeric micelles of MPEG-PCL can be useful in efficiently delivering anti-VEGF drugs such as sunitinib to the posterior segment of the eye. In this study, the novel micellar formulation exhibited an average dynamic light scattering (DLS) particle size of 134.2 ± 2.3 nm with a zeta potential of −0.159 ± 0.07 mV. TEM imaging further confirmed the nanoscopic size of the micelles. A sunitinib malate (SM)-MPEG-PCL formulation exhibited a sustained release profile for up to seven days with an overall release percentage of 95.56 ± 2.7%. In addition to their miniscule size, the SM-MPEG-PCL formulation showed minimal cytotoxicity onto the ARPE-19 human retinal pigment epithelial cell line, reporting a percent viability of more than 88% for all concentrations tested at time intervals of 24 h. The SM-MPEG-PCL micelles also exhibited exceptional performance during an anti-VEGF ELISA that decreased the overall VEGF protein expression in the cells across a 24–72 h period. Furthermore, it can be concluded that this type of polymeric vehicle is a promising solution to symptoms caused by AMD and improving the management of those suffering from AMD.

Presenter Name

Bapurao Surnar

Video Title

Dual-Targeted Synthetic Nanoparticles for Cardiovascular Diseases

Link to Unlisted YouTube Video

https://youtu.be/Ek7KUd06MKI

Abstract

Atherosclerosis is a very aggressive disease taking over 17.5 million lives per year. This disease is mainly caused by the plaque formation in the bloodstream occurred due to high amounts of lipoproteins. Eventually, these plaques undergo thrombosis and lead to a major heart damage. Most of the times these susceptible plaques are produced due to macrophage apoptosis. It is an urgent need to develop a nanomedicine that can carry both contrast and therapeutic agents to the mitochondria of these macrophages to treat and diagnose the disease. In this study, we have introduced a dual-targeted synthetic nanoparticle system that has both diagnostic and therapeutic properties. A library of dual-targeted NPs with an encapsulated iron oxide-NP, mito-magneto (MM), with a magnetic resonance imaging (MRI) contrast enhancement capability was elucidated. By *in vivo* imaging, we demonstrated the distribution of MM-encapsulated dual-targeted NPs in the heart and aorta of mice ensuring its diagnostic potential. The presence of mannose receptor targeting ligands and the optimization of the nano-formulation facilitated its ability to perform the therapeutic duty by targeting the macrophages at the plaque. This nano-platform can be used for theranostic applications against atherosclerosis.

Presenter Name

Jonathan Tabares

Video Title

Multifunctional SICM of iPSC Derived Cardiomyocytes

Link to Unlisted YouTube Video

https://youtu.be/Ajti9uIh11A

Abstract

Differentiation of cardiomyocytes from stem cells is a subject of interest for studying fundamental biological processes of maturation, drug screening, and as a future method for heart repair. Despite considerable progress in the generation of stem cell-derived cardiomyocytes, adult-like cardiac tissue is still far away. More research will advance maturity and improve our understanding of how cardiomyocytes develop in vitro. The purpose of this study is to observe how the electrical properties of cardiomyocyte plasma membranes change as they mature. We are using a multifunctional SICM method for both topographic and extracellular surface potential imaging. Our group has previously demonstrated that simultaneously monitoring the topography and extracellular surface potential change is useful for studying cell membranes. So far, we have confirmed that the SICM-based potential imaging method works both on cell surfaces and on soft, complex hydrogel surfaces. We want to reveal the distribution of T-tubules, which is dynamic and changes with cell maturity. Collecting more data will help us to understand the dynamics of cell surface assembly and changes in plasma membrane electrical properties associated with cell function and dysfunction.

Presenter Name

Ruwen Tan

Video Title

Tuning Nanostructure on Polymer Thin Film Surfaces for Dual Functionalities

Link to Unlisted YouTube Video

https://youtu.be/sz5s26dsSRU

Abstract

Bacterial adhesion, leading to surface contamination or host infections, is a growing global problem that demands the development of next-generation antibacterial materials. Recently, bactericidal nanostructures were found on cicada wings, which mechanically induce the rupture of adhered bacterial membranes by surface structure without the aid of antibiotics or chemicals. Herein, we developed a series of protrusive nanopillars on hard silicon (Si) substrates and soft poly(ethylene glycol) diacrylate (PEGDA) thin films using colloidal lithography and soft pattern transferring, respectively. We first made Si surfaces have protrusive nanopillars with different densities to study the relationship between interpillar distance and bactericidal efficacy against a model Gram-negative bacteria Escherichia coli. We found that the bactericidal efficacy increases as the density of nanopillar decreases, limited when the average interpillar distance is smaller than the cell size. We then engineered PEGDA thin films with optimized bactericidal nanopillar density to achieve both antibacterial and antireflective performance. The results showed that the surface nanostructure plays an important role in determining the antibacterial performance, regardless of the type of materials. This work would provide insights into the understanding of the physical interaction between nanostructured surfaces and bacteria and the development of practical solutions to design antibacterial polymer surfaces for medical optical lenses or screen displays.

Presenter Name

Zachary VanOrman

Video Title

Green-to-Blue Upconversion Sensitized by CdSe NPLs

Link to Unlisted YouTube Video

https://youtu.be/bZl8cloRFXU

Abstract

Green-to-blue photon upconversion bears great potential in photocatalytic applications. Current hybrid inorganic–organic upconversion schemes commonly utilize spherical CdSe nanocrystals, but size polydispersity could influence efficiencies in future solid-state applications. In this contribution, we introduce anisotropic CdSe nanoplatelets as triplet sensitizers. Here, quantum confinement occurs in only one direction, erasing effects stemming from size polydispersity. Additionally, their high quantum yields, giant oscillator strengths, and large absorption cross sections could prove useful in a triplet sensitization scheme. We investigate the triplet energy transfer process from the CdSe nanoplatelets to the surface-bound triplet acceptor 9-anthracenecarboxylic acid and the resulting upconversion in 9,10-diphenylanthracene. We further investigate the influence of nanoplatelet stacking and singlet back-transfer on the observed upconversion efficiency. We obtain an upconversion quantum yield of 5.4% at a power density of 11 W/cm2 using the annihilator 9,10-diphenylanthracene and a low efficiency threshold Ith of 237 mW/cm2.

Presenter Name

Nick Vandervoort

Video Title

Strength of amorphous and nano crystalline fine diameter fibers

Link to Unlisted YouTube Video

https://youtu.be/uufdiexsqx4

Abstract

Fine diameter ceramic fibers, produced via a melt spinning process, were evaluated with single fiber tensile tests and fiber mat compression tests in the as formed and heat-treated states. Three total chemistries were evaluated; standard RCF (56% Al_2O_3 : 44% SiO_2), high silica (70% SiO_2 : 30% Al_2O_3), and AZS (30 % Al_2O_3 : 16% ZrO_2 : 54% SiO_2). The heat treatment caused the RCF fibers to form 132 +/- 8 nm clusters of roughly 10 nm dendritic mullite crystals from their previously amorphous structure. The single filament tensile strength data was characterized using Weibull statistics. Of the as formed fibers, the RCF fiber provided the highest Weibull strength of 1272 MPa. After heat treatment, the high silica fiber was found to have both the smallest reduction in Weibull strength, 30%, and highest Weibull strength of 618 MPa. With the highest tensile strength of the heat-treated fibers, it was expected that the high silica fiber would measure the highest fiber mat compression. Surprisingly, the high silica fiber measured significantly lower compression than the RCF fiber, despite having significantly higher Weibull strength. This indicates that the nanocrystals contribute to the improved mat compression performance possibly in a toughening mechanism as the higher silica formulation s expected to retain a greater amount of amorphous structure.

Presenter Name

Riddhi Vichare

Video Title

Biodegradable Nanomedicine for effective Antioxidant Gene delivery to the eye

Link to Unlisted YouTube Video

https://youtu.be/hqhDPELrvfk

Abstract

After cataract and glaucoma, age-related macular degeneration is the third cause of blindness worldwide affecting the lives of 170 million individuals. Age-related macular degeneration (AMD) is a progressive irreversible blinding disease, generally in the older population. A major flaw associated with commercially available ophthalmic formulations is the poor retention time in the eye to target the posterior segment. The increase in oxidative stress is the hallmark of AMD. The reactive oxygen species tend to interact with the amino acids present on the peptidic backbone. Methionine and cysteine, sulfur-containing amino acids, have a higher propensity to oxidize. In the body, methionine oxidizes to sulfoxide form (MetO) creating a new asymmetric center and two diastereoisomers. The generated R-MetO and S-MetO diastereoisomers can be reduced by Methionine sulfoxide reductase (Msr). Methionine sulfoxide reductase (Msr) is a family of enzymes that are encoded by the MSRA gene. The basic function is to carry out thioredoxin- dependent enzymatic reduction of methionine sulfoxide back to methionine. Earlier data has suggested the increase in the phagocytic activity due to the overexpression of MSRA. Under the induced oxidative damage conditions, the lack of MSRA increases the cell death response. We aim to develop a chitosan-based biodegradable gene delivery system that can successfully deliver MSRA to the posterior segment of the eye. A significant number of publications have exploited the high degree of crosslinking between the cationic chitosan polymer and the plasmid backbone. We aim to circumvent the stated problem associated with current formulations and develop an effective and long-term alternative for AMD.

Presenter Name

Sharon Vijayanand

Video Title

Combating Coronavirus–Needle-free transdermal microparticulate vaccine

Link to Unlisted YouTube Video

https://youtu.be/ObM22sjl6B4

Abstract

Introduction: Coronaviruses cause mild to serious upper respiratory tract illnesses in both animals as well as humans. The novel pandemic strain, SARS CoV-2, which causes COVID-19, has become a serious global threat. This study aims to test the immunogenicity of a novel heat-inactivated coronavirus microparticulate vaccine administered via dissolving microneedles.

Method: The microparticles were formulated using a double emulsion method and lyophilization to produce antigen and adjuvant (Alum, MF59) PLGA MPs. The ability of the vaccine microparticles to elicit an in vitro innate immune response was assessed using a nitric oxide assay whereas adaptive immunity was assessed by measuring MHCI-CD80/MHCII-CD40 expression on the surface of antigen-presentation cells (APCs) using flow cytometry. Ongoing in vivo study involves immunization of mice transdermally with vaccine-loaded dissolving MN patches in three doses. Sera of mice was collected at various points to determine the antibody IgG levels following dosing.

Results: The MPs were <5 microns in size. APCs pulsed with vaccine microparticles showed a significantly higher ($p<0.05$) release of nitric oxide (NO) compared to untreated cells. Flow cytometry analysis confirmed significantly higher expression of antigen presenting molecules, MHC I and MHC II and their co-stimulatory molecules CD80 and CD40 respectively, on the surface of APCs compared to untreated APCs.

Conclusion: Therefore, the vaccine containing antigen and adjuvants produced higher levels of nitric oxide and antigen presentation molecules on APCs compared to negative controls. Further analysis of serum and T-cell phenotypes from immune organs in mice will confirm the adaptive immunity induced by the vaccine.

Presenter Name

Johnathan von der Heyde

Video Title

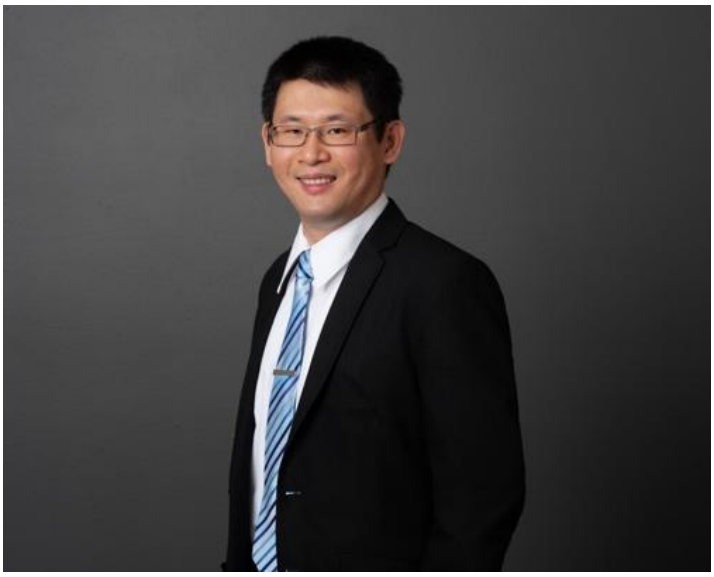
Breadth and Depth: Genetic Algorithms before DFT

Link to Unlisted YouTube Video

https://youtu.be/xIdJ7e5E7ZU

Abstract

Energetically optimized bimetallic nanoclusters of various sizes and compositions are identified with a Genetic Algorithm and re-optimized with Density Functional Theory. We analyze the energetic dependence on three principle properties for the nanoclusters: size, alloy type, and stoichiometry. Further investigations into geometric characteristics, such as coordination, chemical order, and nearest neighbor calculations reveal how these properties and characteristics interrelate. Results include the nontrivial relationship between energetic stability and geometric symmetry, as well as the core-shell segregation dependencies.



Presenter Name

Chun-Hung Wang

Video Title

Accurate Prediction of Terahertz Spectra of Molecular Crystals of Fentanyl and its Analogs

Link to Unlisted YouTube Video

https://youtu.be/mpBCvh8PGUc

Abstract

Fentanyl is a potent synthetic opioid pain reliever with a high bioavailability that can be used as prescription anesthetic. Rapid identification *via* non-contact methods of both known and emerging opioid substances in the fentanyl family help identify the substances and enable rapid medical attention. We apply PBEh-3c method to identify vibrational normal modes from 0.01 to 3 THz in solid fentanyl and its selected analogs. The molecular structure of each fentanyl analog and unique arrangement of H-bonds and dispersion interactions significantly change crystal packing and is subsequently reflected in the THz spectrum. Further, the study of THz spectra of a series of stereoisomers shows that small changes in molecular structure results in distinct crystal packing and significantly alters THz spectra as well. We discuss spectral features of synthetic opioids with higher potency than conventional fentanyl such as ohmefentanyl and sufentanil and discover the pattern of THz spectra of fentanyl analogs.

Presenter Name

Xinyi Xia

Video Title

Thiol gold Binding Study for the Biofunctionalization Process for Electronic Biosensing

Link to Unlisted YouTube Video

https://youtu.be/dK_ys-Z-TXE

Abstract

Self-assembled monolayer (SAM) with functionalized alkanethiols has been well studied and widely applied as the mediator for gold surface biofunctionalization. The SAM formation is vital for making effective biosensor for viral detections in human bodily fluids. Using surface coverage of SAM as the indicator, we quantified the effectiveness of the gold-thiol adsorption process. From literature, the thiol-gold binding step takes 6 hours to 24 hours to achieve a full coverage, and the concentrations are usually more than 6mM. In our study, we found that at 15min the thiol coverage could achieve 99% for 4mM concentration. So, the reaction time can be largely shortening at this step, which can promote the efficiency of the whole process. In order to calculate the surface coverage ratio, ethanethiol, which has a hydrophobic tail, was used to form an electron barrier by expelling water from the gold surface. As a result, the surface coverage of SAM can be determined as a function of the resistivity of the ethanethiol-treated surface. We were able to find that under the same treatment time, higher concentrations of ethanethiol achieved larger coverage areas on gold surface. In addition, sufficient treatment times to achieve full coverage for various concentrations were also determined. Finally, the relationships between the concentrations and surface coverage was established by the Langmuir extension model.

Presenter Name

Minghan Xian

Video Title

Modular Biological Sensor System for Rapid Detection of SARS-CoV-2 virus and Cardiac Troponin I

Link to Unlisted YouTube Video

https://youtu.be/rqSSavYjid0

Abstract

Biological sensor deals with measurement of various human physiological parameters, particularly biomarkers such as chemicals, enzymes and pathogens. Low cost and point-of-use sensor systems are also much needed in emergency medicine and in large-scale public health crisis. Transistor based sensor is a type of solid-state sensor utilizing semiconductor transistor to amplify biological signal and convert it into measurable electrical signal. Thus, it provides fast measurement result to assistant quick diagnosis and medical treatment. In this work, we hereby present a rapid (less than 1 second), low cost and modular biological sensor system utilizing transistor-based sensing technology. The basic principle of sensor operation will be shown, as well as demonstration of measurement result for biological targets. Since testing and diagnosis plays vital parts in treatment and prevention of heart disease and coronavirus disease 2019 (COVID-19), the pathogen for these diseased was used in order to illustrate the sensitivity and use of this system. The sensor efficacy was demonstrated by using cardiac troponin I, which is a biomarker for acute heart muscle damage down to 1 ng/mL, as well as SARS-CoV-2 virus protein (detection limit 100 fg/mL) and inactivated virus (down to $5x10^3$ PFU/mL) for COVID-19 detection.

Presenter Name

Minghan Xian

Video Title

Thermal Simulation and Forward Bias Degradation Mechanism for β-Ga2O3 Schottky Rectifiers

Link to Unlisted YouTube Video

https://youtu.be/mc2WC5hZxe4

Abstract

Power electronics are semiconductor components responsible for the conversion and control of electrical power. β-Ga2O3 is a new generation of semiconductor material with a much wider energy bandgap and critical breakdown field than Si, GaN and SiC materials, which are materials currently being used in power electronics. Such characteristics for β-Ga2O3 ¬¬had brought great promises toward its application in power devices with low conducting loss and package size, but with high switching frequency and tolerance in high operation temperature. Despite all these advantages, the thermal conductivity for β-Ga2O3¬ is roughly an order of magnitude lower than Si and other wide bandgap counterparts and had become a detrimental factor in the commercialization for this material. Schottky rectifiers is a type of semiconductor devices suitable for material physics research and with a wide variety of commercial application. In this talk, we will present the current state-of-the-art performance for β-Ga2O3 Schottky rectifiers with above 1 A of absolute forward current and above 2000 A/cm2 current density. Our research work utilizes 3D finite element analysis to simulate the junction temperature distribution and maximum temperature during operation. The maximum junction temperature rise occurs at the center of the contact and range from 270˚C to 350˚C. The impact of device geometry will also be discussed with attempt to fabricate asymmetrical device with intention to maximize thermal distribution of the device and improve electrical performances.

Presenter Name

Nusaiba Zaman

Video Title

The Dissociative Adsorption of O_2 on the Bimetallic Pd_3M_2 clusters ($M = Ag$, Au, Co, Cu, Mn, Ni, Pt and Ru) by Density Functional Theory

Link to Unlisted YouTube Video

https://youtu.be/I61alM3HG3o

Abstract

We use density functional theory to systematically investigate the adsorption and reactivity of oxygen on the bimetallic Pd_3M_2 clusters (M = Ag, Au, Co, Cu, Mn, Ni, Pt, and Ru). This is because small bimetallic clusters with high surface area to volume ratio often offers, higher stability, greater selectivity and sometimes superior activity than the pure metal counterparts [1-2]. We explore different adsorption sites for molecular oxygen, which can be oriented in a vertical or horizontal direction with respect to the cluster, as well as atomic oxygen on these bimetallic Pd_3M_2 clusters. The reaction path for dissociation of oxygen molecule on these bimetallic clusters is studied using the climbing image nudged elastic band method. We will present our result for the calculated energy barriers for O_2 dissociation on these bimetallic clusters and how it changes depending on the composition of the bimetallic clusters. Moreover, we will present the effect of O_2 adsorption on the electronic properties of these Pd_3M_2 clusters. Bader charge analysis will also be performed to probe how the charges are transferred between the molecule and these clusters.

Presenter Name

Elnaz Zeynaloo

Video Title

Nanocarriers Functionalized with LFA-1 I-domain for the Targeted Delivery of Mesenchymal Stem Cells

Link to Unlisted YouTube Video

https://youtu.be/bmkdV5lvzBk

Abstract

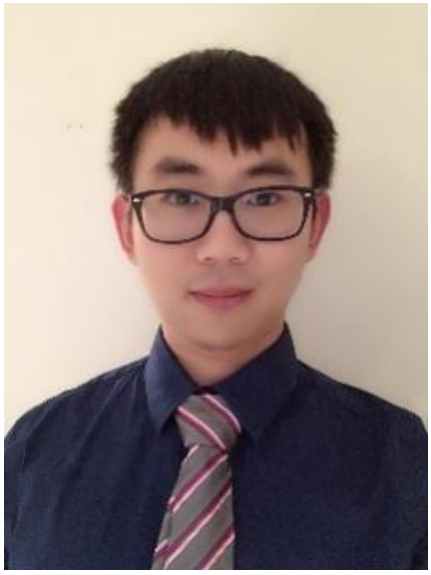
BACKGROUND: Mesenchymal Stem Cells (MSC) have yielded promising results in clinical trials for autoimmune and inflammatory disorders. MSCs are typically administered intravenously, but this strategy has an important limitation: a high systemic cell dose is required to enable homing of a small number of cells at target sites, inflamed tissues, increasing risks and costs. Endothelia in inflamed tissues express high levels of ICAM-1. A natural binding partner of ICAM-1 is LFA-1 I-domain (LFA-1-Id). Targeted delivery of MSC to inflamed tissues is desirable.

AIM: We aimed at engineering nanocarriers functionalized with LFA-1-Id for the targeted delivery of MSC to inflamed endothelia. We hypothesized that MSCs coated with these nanocarriers have increased binding to inflamed endothelia.

METHODS: LFA-1-Id was expressed, purified, and characterized. Functionalized nanocarriers were generated by combining PAMAM Dendrimers with LFA-1-Id. To enable imaging, MSCs and nanocarriers were labelled with fluorescent probes. MSCs were coated with nanocarriers and tested for their binding to inflamed versus non-inflamed endothelium. Cultures of endothelial cells were treated with the proinflammatory cytokine TNFα, to express high levels of ICAM-1, or maintained in non-inflamed conditions. Nanocarrier-coated or naïve MSC were combined with endothelial cultures for 10 minutes, and subsequently washed. Fluorescent imaging and quantification were performed to determine MSC binding.

RESULTS: MSCs coated with functionalized nanocarriers adhered more efficiently to inflamed endothelia *in vitro*.

CONCLUSION: MSCs coated with LFA-1-Id nanocarriers present increased binding to inflamed endothelia. Future analyses will explore nanocarrier-targeted delivery of MSCs in animal models of autoimmunity, to determine homing and therapeutic effects.



Presenter Name

Yiqun Zhou

Video Title

Carbon Dots: From Lab Synthesis to Unique Applications

Link to Unlisted Youtube Video

https://youtu.be/wzIlNuEO5EE

Abstract

Carbon dots (CDs) are a group of relatively new carbon-based spherical nanoparticles (NPs) with diameters less than 10 nm. They are widely present in the nature and can be also synthesized using various carbon-based substances as precursors by either top-down or bottom-up approaches. They are well characterized for tunable surface functionality, excellent photoluminescence (PL), high photostability and water dispersity, good biocompatibility, and nontoxicity. Also, they display different sizes and surface chemistry depending on the preparation methods and precursors applied. Applications of CDs in drug delivery, bioimaging, sensing, optics, photocatalysis, and other nanotechnology fields are rapidly rising due to their aforementioned unique properties. In this presentation, I would like to share with the public that CDs have proved to be promising Lego-like building blocks for the assembly of novel versatile drug nanocarriers to simultaneously fulfill multitasks. Through conjugation of two CD models, black CDs (B-CDs) and gel-like CDs (G-CDs) at a mass ratio of 5:3, the conjugate, B-G CDs inherited functionalities from both CDs with many enhanced properties and a figure-eight shape. In addition, the necessity of high surface primary amine (-NH2) and carboxyl (-COOH) content in the CD conjugation was highlighted. When the mass ratio of B-CDs to G-CDs was decreased, the obtained nanostructures revealed a great potential of CDs as Lego-like building blocks. Eventually, B-G CDs exhibited both properties of bone targeting and crossing the BBB, which are specific properties of B-CDs and G-CDs, respectively. Moreover, the drug loading capacity was enhanced by 54.5% from through CD conjugation.