The new field of Sustainable Ultradilute Oxidation Catalysis (SUDOC): Integrating health, environmental and fairness performances with technical and cost performances for transformative sustainable water purification.

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Research and development at Carnegie Mellon University's multidisciplinary, internationally-networked Institute for Green Science will be presented that has delivered the most potent homogeneous peroxide-activating catalysts across both chemistry and biology. I will describe the existential threat presented by the low dose adverse effects (lodafs) of everyday-everywhere chemicals and show how our peroxide-activating catalysts help to reduce this threat from water. After 15 years of following the Collins Oxidation Catalyst Iterative Design Protocol to achieve iron-TAML activators (TAMLs) in 1995, we spent two further decades of TAML iterative design, repeatedly advancing the state-of-the-art in the technical performances of small molecule, oxidation enzyme mimics. Then, further insight into catalyst degradation processes led to NewTAML activators (NewTAMLs) and again to record setting technical performances in peroxidase mimicry. I will present the design, mechanisms of action and general utility of TAMLs and NewTAMLs. The relative behavior of NewTAML/peroxide vs ozone in the treatment of micropollutants (pollutants that produce adverse effects at low concentrations) in municipal wastewater will be highlighted. Our experiences in learning how to make homogeneous oxidation catalysts that are certifiably sustainable to the highest levels of contemporary science could be of help in advancing sustainable micro-nanomaterials. The complete iterative design protocol that led to NewTAMLs will be shown pictorially and discussed to illustrate how we figured out how to integrate health, environmental and fairness performances with technical and cost performances into the value proposition of a sustainable chemical. NewTAMLs enable a broad new field of catalysis science that is mated especially to water treatment science called, *"Sustainable Ultra-dilute Oxidation Catalysis"* (SUDOC). The logic and safety evidence behind the choice of this name will be shared.

Sustainable Plastics and the Center for Bioplastics and Biocomposites

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In this presentation, we review the basic concepts and history of bioplastics and biocomposites. We then provide an overview of the current state of the field. While there have been many early developments in bioplastics and examples of biocomposites in the last 60 years, today this technology has gained increased interest with many applications, and there are new products and materials under development and commercialization. The National Science Foundation (NSF) has recently funded an Industry/University Cooperative Research Center (I/UCRC) focused on bioplastics and bioplastics. Designated as the Center for Bioplastics and Biocomposites (CB^2), this center is led by North Dakota State University with site at Washington State University, Iowa State University and University of Georgia. The thrust of this new NSF center will be reviewed along with the center's benefits to the bioplastics and biocomposites industry.

Mainstreaming Sustainability and the Circular Economy Among Materials Researchers

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New materials technologies will play a pivotal role in addressing many of the key challenges our society will continue to face in the coming years, including providing a sustainable supply of energy, water, products, services, transportation, buildings, and public infrastructure. Materials researchers are therefore a key component to enabling such strategies as the circular economy and, ultimately, sustainable development. Yet materials researchers are rarely trained in how to evaluate the life cycle impacts—including energy and other resource implications and environmental and human health effects—of their decisions. Furthermore, they are often siloed from accessing expertise in other fields that play important roles in sustainable development, including other scientific and engineering disciplines, sociology, economics, and policy, as well as from industry.

The Materials Research Society (MRS), a member-driven organization of more than 14,500 materials researchers from over 90 countries around the world representing academia, industry, and government, established an official operating subcommittee in 2016 in recognition of the critical and cross-cutting role of sustainability in materials science. The Focus on Sustainability Subcommittee and its task forces comprise experts in sustainability and materials science across academia, government agencies, national labs, and industry who span four continents and range in experience from graduate students to late career professionals. The subcommittee serves as a hub for planning sustainability programming at each MRS meeting as well as engaging with MRS publications and outreach efforts on sustainability topics.

In this talk, MRS Focus on Sustainability Subcommittee Chair Ashley White will share the details of recent and upcoming subcommittee projects to mainstream sustainability among materials researchers, including strategies to enhance awareness and understanding of sustainability among materials researchers, and training the next generation of materials scientists to incorporate sustainability in their work. Opportunities for partnership with East Asia Pacific researchers and organizations will also be presented.

Sustainable development of Nano-Micromaterials: Reduce, Recycle, Reuse (R3CYCLE)

[1]Tamil S. Sakthivel*, [1]Craig. J. Neal, [1]Aadithya Jeyaranjan, [1]Udit Kumar, [1]Sushant Singh, [1,2]Sudipta Seal.

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One of the more practical routes towards sustainable industrial practice is the re-use of materials for new applications. Designing recycle and reuse strategies is challenging because, in order for them to be practical, they have to be relatively simple, cheap, fast, and energy efficient. Re-use and re-purposing of materials is especially valuable for costly elements, such as rare earth metals. In the presented work, we demonstrate a paradigm for re-use of cerium oxide nanomaterials (CNPs). In particular, we highlight and characterize the effects of long term-storage of CNP aqueous dispersions on surface catalysis, as well as the efficacy of laboratory-scale material purification via re-crystallization. Specifically, CNPs synthesized in water and stored for > 1 year (over-aged CNPs) were mixed and collected via centrifugation. From here, the particles were dried in air at 70ºC for 48 hrs. followed by digestion in nitric acid at 70ºC. Re-crystallization was performed and repeated thrice followed by washing. Hydrated $Ce(NO_3)_3$ purity was determined via melting point measurements, X-ray diffraction, and X-ray photoelectron spectroscopy. Finally, the re-claimed salts were used to synthesize CNPs by either the thermohydrolysis synthesis method or via hydrothermal reaction. Particles from both methods were characterized (catalytic, structural properties) and compared against the over-aged CNPs. This project demonstrates the utility of closed-loop material use in laboratory settings as well as the potential for high value elements in future, cyclic economies. Also, recovery and re-use of these expensive nanomaterials could speed up commercial application of nanotechnology to a variety of fields, by alleviating worries about nano-waste, whilst also decreasing production costs.

Semiconductor Microelectronics Technology Scaling: Sustainability and Environmental Consideration

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With the change in the traditional IC scaling cadence, the expansive growth of “Big data,” and the pervasive nature of computing in our day-to-day life, rises a paradigm shift in the microelectronics space. Such a fundamental shift manifests itself in multiple different requirements; accelerated and extended product life-cycle expectations, wearable electronics, a varied assortment of IoT devices, and several other developments. This computing convergence is predicted to result in more connected devices and a host of new applications. As such, next-generation electronics will require several new solutions: smaller form factors, lower power consumption, flexible designs, increased memory performance, and ---more than ever--- a sustainable environmental approach. We will present on the state of the industry and our efforts to develop key technology building blocks. In addition, a continued pressure to meet the demand for affordable and environmentally sustainable systems sustainability present an added focuse that needs further collaboration and an increased level of integration throughout the microelectronics industry ecosystem.

Nutrient Mining for 'Nanoagriculture': The Smooth and Bumpy Road towards Sustainability

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Phosphorus (P) is a limited (non-renewable) natural resource which has been used extensively as a plant fertilizer. Phosphate (PO_4^{3-}) rocks are mined to meet the growing demand for P. However, these mines are projected to be exhausted in 60 to 250 years. A major part of the P used in agricultural fields finds its way into surface waters and that leads to eutrophication of the waterbodies. P is also used in a number of industries as raw material and discharged mostly untreated from municipal wastewater treatment plants. Nanomaterials have been effectively used for phosphate recovery from eutrophic lakes, municipal wastewater, and industrial wastes. The recovered phosphate is then used for plant growth and the nanomaterials to fortify fresh crops (spinach and lettuce) with iron. Additionally, profuse biomass growth was observed in the nano-treated plants. There are, however, concerns about the effects of the nanomaterials on plants at the molecular (genetic) level, specifically the affected plant's immune system is affected. To overcome this, new and plant-based nanomaterials are being developed and the new nanomaterials are found to be compatible with specific plants. The major challenges that still remain in this area include the scale-up of the processes and effective use of 'green' technology. (This research is supported by the National Science Foundation, USA, Grant# CBET-1707093).

Creating a Circular Economy for Hard Disk Drives: A Shared Vision

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The iNEMI project on Value Recovery from Used Hard Disk Drives (HDDs) is an industry-academia-government lab-NGO partnership whose vision is increasing value recovery from HDDs throughout their useful lives, with an ultimate goal of creating a global, circular economy for HDDs. Hard disk drives have a special role in electronics: they are ubiquitous, having been designed to be replaceable and interchangeable in products as diverse as computers, servers, and sensor/monitoring equipment. In Phase 1 of the project, an iNEMI multi-stakeholder team developed the groundwork and created momentum for a Phase 2 collaborative project to build an integrated, sustainable, adaptive system for value recovery from end-of-use HDDs. This project has been designed and operated based on extensive research on the most effective methods for sustainable management of common pool resources on which many people rely for their livelihoods. Dr. Elinor Ostrom (2009 Nobel Laureate in Economics) laid out a framework for how people and organizations develop voluntary, community-based solutions involving adaptive, self-governing systems that effectively manage common pool resources without the need for government regulations or privatization. We have applied this framework explicitly to HDDs, as a first demonstration. After presenting the Ostrom framework and the results and accomplishments of the project, we will discuss how this framework can be applied to create a circular economy for nanomaterials.

Accomplishing NEW (Nutrient-Energy-Water) Synergies in Microbial Electrochemical Systems for Resource-Efficiency

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Microbial electrochemical technologies offer numerous possibilities for accomplishing resource-efficient and sustainable wastewater treatment. Microbial desalination cells (MDCs), a form of bioelectrochemical systems, allow for simultaneous wastewater treatment (both carbon and nutrient removal) and desalination of saline water with concurrent electricity production. This study reports an investigation of the concept, application and performance of a novel bioelectrochemical nitritation-anammox microbial desalination cell (MDC) for resource-efficient wastewater treatment and desalination. Our preliminary research has shown that using an autotrophic microbial culture containing anammox bacteria as a biocathode or biocatalyst for simultaneous energy generation and wastewater treatment is a feasible option. Two configurations of anammox MDCs (anaerobic-anammox cathode MDC ($AnA_{mox}MDC$) and nitration-anammox cathode MDC ($NiA_{mox}MDC$)) were compared with an air cathode MDC (CMDC), operated in fed-batch mode. Results from this study showed that the maximum power density produced by $NiA_{mox}MDC$ was higher than that of $AnA_{mox}MDC$ and CMDC. More than 92% of ammonium-nitrogen (NH_4^+-N) removal was achieved in $NiA_{mox}MDC$, significantly higher than $AnA_{mox}MDC$ and CMDC. The $NiA_{mox}MDC$ performed better than CMDC and $AnA_{mox}MDC$ in terms of power density, COD removal and salt removal in desalination chamber. This presentation will discuss the microbial population dynamics, wastewater treatment performance trends and energy and electrochemical behavior of anammox bioelectrochemical systems from a long term operation and process control point of view. A detailed account of microbial biofilm analysis for both anode and cathode, process benefits through mass (carbon, nitrogen and salt) and energy balances will be presented. The findings of this research showed that this system is more useful for wastewaters with low C/N ratio to suppress the possibility for growth of heterotrophic bacteria. Future directions for developing sustainable water and resource recovery systems based on anammox bioelectrochemical platform will be discussed.

Lessons from the Institute for Green Science's Catalyst Design Protocol for Designing Nano- and Micro-materials that Are Free of Low Dose Adverse Effects

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Just as nanomaterials present unique and varied promises for new material solutions and technologies, they also present multiple conceivable hazards to health and the environment. In the last twenty years, research has demonstrated that many widely used chemicals, including some fungicides, plastics monomers (e.g. BPA) and additives (e.g. phthalates), flame retardants, drugs, pesticides and personal care product components disrupt the endocrine system's control over development numerous animals. Significantly, such effects typically take place at very low (μg/kg•d) doses, and adverse effects vary non-monotonically with exposure. Recently various nanomaterials, including titanium dioxide, zinc oxide, and gold nanoparticles, have shown that they too can disrupt the endocrine system in animal tests, frequently with non-monotonic dose-response curves. Endocrine disrupting chemicals can affect multitudinous health endpoints, including, inter alia, male and female fertility, vitality and behavior, obesity, and prostate and mammary gland development. Therefore, as with chemicals, it is imperative to ensure that new nanomaterials do not pose a threat to health and/or the environment before commercialization is pursued. As iron-based TAML and NewTAML catalysts became viable for ultra-dilute oxidation processes, the Institute for Green Science, working with the world leaders of endocrine disruption science, helped developed a multistep protocol for designing chemicals free of low-dose adverse effects. The Tiered Protocol for Endocrine Disruption (TiPED), first published in 2013, was developed by a scientific advisory committee of leading green chemists and environmental health scientists. TiPED is designed to detect the ability of a substance to cause low dose adverse effects where endocrine disruption is the best understood mechanism. Taking a five-tiered approach, the protocol starts with simple, fast, and inexpensive assays, including on whole animals. TiPED-assessment of new nanotechnologies would reduce the risk that commercialization will be incompatible with a sustainable future.

Catalytic Activity of Silver Nanoparticles Synthesized using Tectona Grandis. Linn F. Leaf Extract in the Reduction of 4-Nitrophenol

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Silver nanoparticles (AgNPs) were synthesized through green route using the aqueous extract of teak leaves. The synthesized AgNPs were investigated for their catalytic activity in terms of reduction of 4-nitrophenol(4-NP) to 4-aminophenol using sodium borohydride as the reductant. 4-nitrophenol (4-NP) is a common precursor of 4-aminophenol (4-AP) which is a potent intermediate for the manufacture of many analgesic/antipyretic drugs. The synthesis conditions were optimized based on the catalytic activity of AgNPs. The AgNPs synthesized in the present work with the different synthesis conditions have exhibited catalytic activity in the reduction of 4-NP and 4-AP has been formed as the product. The optimum conditions for the synthesis of AgNPs were found to be the extract from 10% leaf powder suspension; 10mM $AgNO_3$ (precursor) solution, and $AgNO_3$ solution to extract volume ratio of 1:7. AgNPs synthesized under these conditions took 15 min for almost complete reduction of 4-NP with no induction time. The AgNPs synthesized under the optimum conditions were highly crystalline with the crystallite size of 58.52nm. These AgNPs were fibrous and long tubular structured with the average diameter of 45nm as determined through SEM analysis. The polycaprolactone (PCL) supported AgNPs were also found to catalyze the reduction of 4-NP.The catalytic activity of suspended AgNPs was superior to that of supported AgNPs. The kinetics of reduction of 4-NP using suspended and supported AgNPs followed pseudo first order kinetic model. The AgNPs synthesized using teak leaf extract under optimum synthesis conditions can serve as highly active catalysts for the reduction of 4-NP to 4-AP. A forest waste (teak leaves) has been used as a resource for AgNP synthesis without the use of toxic solvents or high temperature/ pressure conditions. Thus, the process of synthesis is greener, potentially economical and environmental friendly.

Peace Engineering Mindset for a Sustainable Future

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We define Peace Engineering as the intentional application of systemic-level thinking of science and engineering principles to directly promote and support conditions for peace. Peace Engineering works directly towards a world where prosperity, sustainability, social equity, entrepreneurship, transparency, community voice and engagement, ethics and a culture of quality thrive. Engineers have the power to play a vital role in the creative solutions that can radically transform and improve the wellbeing of people and other living systems, day to day.

At the core of Peace Engineering is our planet's sustainable future, which is calling leaders to act in concert from a systems mindset. It is a call to develop solutions differently: that is, collaboratively; integrating transdisciplinary expertise and education programs; simultaneously applying technology solutions while supporting ethics, policy and living systems. And it is a call in the mingled vernacular of civil society, global institutions, and science and technology. Further, beyond addressing today's challenges, we must cultivate together the development of next generation leaders to continue to drive momentum. Peace Engineering is a new disruptive mindset needed to address global challenges and aligned with Industry 4.0. What does peace engineering mean to you? Help us define it.

Peace Engineering through Sustainable Air Quality

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Recently studies have shown that there is a strong correlation between violence and air quality. Therefore, air quality needs to be one of the cornerstones of Peace Engineering. Globally, the transportation sector can contribute up to 75% of the total NOx pollution with no known or effective mitigation solution. There are over 1.2 billion vehicles registered worldwide with the number continuing to grow. SensorComm has developed a real-time IoT-based NOx emissions monitoring system called Wi-NOx™ that is installed at the tailpipe of vehicles for the transportation and smart city segments. Wi-NOx™ is the cornerstone of a global pollution mitigation strategy that provides the unique ability to create alternative revenue sources for cities and municipalities. The **Wi-NOx™** system is designed for fleet, city and transportation managers who are investing in solutions that support operational efficiencies, cleaner air, lower healthcare costs and improved quality of life.

Wi-NOx™ identifies polluting vehicles, supports existing regulations, and establishes the foundation for future incentive programs, while enabling socially conscious smart cities and individuals to effectively practice sustainability and now Peace Engineering.

Sub-micron Materials Recovery from Mineral Processing Wastes - A Pathway towards Sustainable Circular Economy

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A ton of primary aluminum produced today generates about four tons of residue called Red mud. This byproduct is generated during the Bayer's processing of bauxite ore. Over three billion tons of this residue has been piled all across the globe causing serious environmental hazard and making aluminum production unsustainable. The residue in 20-40 microns size contains iron oxide as the major constituent in most of the world's reserves of bauxite residue. The utilization and value addition of iron in red-mud is a critical measure for economically valorizing the waste and it eases the process of extracting other valuable non-ferrous components. Thus, a sustainable model for residue treatment contributes to the circular economy of metal production. Two processes will be discussed to convert the residue into valuable products leading to a zero-waste scheme. A gas based reduction involving a mixture of gases CO(g), CO2(g) and N2(g) (diluent) is described in this presentation to convert hematite in red-mud to high value magnetite. Approximately 98% of magnetite could be recovered in the magnetic fraction and the maximum grade of the magnetite achieved was ~60 %. The lower grade of magnetite was attributed to the presence of nanometer scale entities of agglomerated particulates which probably comprised of cation lattice-substitutions for Fe+3 by Al+3 and Ti+3 as evidenced in the STEM images and Mössbauer spectroscopic analyses.

In another process strategy, a hydrometallurgical leaching, precipitation process has been developed for the red-mud slurry to generated magnetite. An organic acid is used to selectively leach Iron, Aluminum and Titanium from red-mud. Iron compounds are selectively precipitated using metallic iron waste. Lastly a high purity magnetite is generated by simply heating the iron compound. Similar processes have also been developed to produce sub-micron size commercial products from fine industrial wastes allowing the industry to drive circular economy towards sustainability.

High-Temperature Wettability Studies for Green Manufacturing of Ceramic and Metal Joints

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Industrial flux-less vacuum brazing offers an environment-friendly alternative to conventional brazing technology to manufacture high-quality ceramic and metal joints. High-temperature classical wettability tests conducted under strictly controlled atmospheric conditions using novel droplet manipulation strategies that permit in-situ opening of the liquid-solid interface offer new insights into interfacial phenomena during liquid-phase joining of self-similar and dissimilar materials. Although extensive data on contact angle in diverse high-temperature liquid-solid systems exist in the literature, the extreme sensitivity of the interfacial phenomena to test conditions dramatically affects the measurement accuracy. A unique experimental complex to characterize wettability at high temperatures (to 2100ºC) developed at Foundry Research Institute at Krakow permits multiple complex functions including ‘pushing’, ‘smearing’ and ‘rubbing’ a spreading droplet on solid surfaces under highly dynamic conditions. This permits examination of surface and subsurface structure of the solid substrate as it gets modified during contact with the liquid. High-temperature wettability test results obtained using the experimental complex on select monocrystalline and polycrystalline substrates such as oxides (MgO, Al2O3, ZrO2) and carbides (SiC, TiC) in contact with molten metallic alloys (Ni, Al) will be presented together with observations on interface microstructure of in-situ opened joints using OM, SEM, EDS, AFM and TEM. The role of surface preparation, alloy composition, type of substrate, and test temperature and atmosphere will be discussed. The applicability of the test outcomes to liquid-phase bonding of ceramics and metals for structural, functional and thermal management applications will be highlighted.

Biogenic and Bioinspired Functional Materials for Sustainability and a more Circular Economy

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The creation, use and disposal of any engineering product carry with it an environmental burden. Materials contribute to it in the production, use and disposal of these products. The minimization of the environmental burden for the whole life-time requires the development and selection of materials that—without compromising product quality—create less toxic by-products, allow a longer life, are more easily recycled, are lighter and less energy intensive, and where possible, use non-critical, renewable or biogenic resources. Presented will be examples for environmentally-conscious materials development and strategies for eco-design through a wholistic approach to materials selection early in the design process.

Design Paradigm for Manufacturing Multifunctional Materials by Using Benign Biobased Precursors

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The design of precursors from renewable sources like biomass is important from both fundamental and commercial perspective. Biomass is an important source for renewable materials where cellulose, hemicellulose, and lignin are the predominant constituents of the biomass. Traditionally, cellulose and hemicellulose are used as precursors for producing commercial materials like paper, sugar, and biofuels. Comparatively, lignin is difficult to valorize as it has complex and heterogenous chemical nature. In literature, it is well established that the valorization rate of lignin is less than 2%. In this presentation, I will present some of the recent developments on fabricating green multifunctional materials by using benign and underutilized precursors like lignin for manufacturing bioplastics, solid lubricants, and porous scaffolds. As an important component of lignin research, I will also present research on the usage of biofibers like wheat straw, and sugar beet pulp as potential reinforcements for lignin matrix composites. Finally, a comprehensive review of current state of different materials by using lignin as a precursor will be also presented.

Computational Modeling – Relevance and Binding Insights in Aptameric Biosensors for Critical Diseases and Economic Viability

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Nano and micro engineering, biological materials and systems require fundamental understanding at different length and feature scales. Computational models have provided molecular level insights in engineering and biological applications. A contributing factor to strengthen global circular economy is consistent and early detection of critical diseases (e.g. cancer, Traumatic Brain Injuries, etc.). This can improve treatment efficacy benefiting patients and society. Detection of critical diseases is feasible by identifying specific biomarkers (that can be molecular changes in specific ligands and proteins) correlating to disease specific bio-chemical changes in human body. Biosensor based diagnostics is not only dependent upon identified biomarker, but also on selecting a bio-receptor that recognizes disease specific biomarker. E.g., Interleukin 6 (IL6) is a protein biomarker in immune-mediated inflammatory diseases (IMID); S100B is a calcium binding protein in traumatic brain injuries and neurodegenerative diseases.

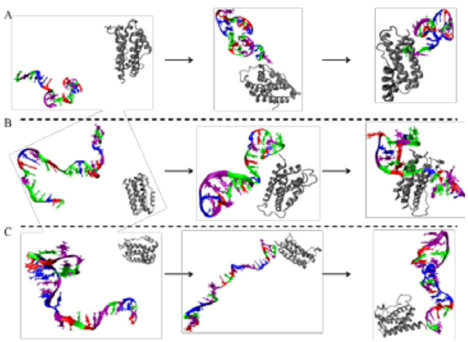

Figure: Binding progression in three IL6 Aptamer - Protein Systems

Aptamers are short nucleic or peptide strands that bind to specific biomarker target molecules. They are small, chemically stable and have a high binding affinity on par with or better than antibodies for use as bio-receptors. This is due to ability of binding to a biomarker protein. Wet-lab methods for identifying specific aptamers are time consuming, and do not provide any binding insights. Detailed insights from computational modeling through natural progression of a biomarker protein – aptamer binding elucidates key features of orientation and location of associated aptamer for binding. These are not readily feasible from wet lab experiments, and influence efficacy of aptamers for diagnostic and theranostic biosensors, and their economic viability. This presentation will highlight our recent computational modeling and simulation investigations for IL6 and S100B biomarker and associated aptamers. Enabling technologies and molecular insights from computational models have a critical role for clinical biosensor developments, applications, and economic cost factors benefiting society, and current interlinked global economy.

Aerosol particles as micro/nanomaterial catalysts in the atmosphere

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Aerosolized particles play critical roles in the atmosphere by acting as nanomaterials that catalyze heterogeneous gas–surface chemical reactions, and in nucleating ice from supercooled cloud droplets. These heterogeneous reactions recycle nitrogen oxides that are major ozone precursors, activate halide oxidants into photolabile forms, and convert biogenic organic vapors into secondary organic aerosol. Heterogeneous ice nucleation and the resulting cloud glaciation have dramatic effects on the evolution and life-cycle of mixed phased clouds. Glaciated clouds are the major source of precipitation over land and this perturbation of cloud microphysics and their radiative properties by atmospheric particles represent the most uncertain drivers of anthropogenic climate change.

I will present my group's research into the heterogeneous chemistry involving nitrogen oxides such as N_2O_5, chloride salts, and the chlorinated gases produced such as $ClNO_2$ and HCl that we recently demonstrated can occur in the complex chloride-containing biomass burning aerosol produced by wildfires. This represents a large and previously unrecognized source of pollutants and free radical oxidants to the atmosphere with significant implications for air quality, climate change, and cycling of trace atmospheric reactants. We also discovered that new mineral nanomaterial phases produced by the combustion event are a principle source of the variable ice nucleants that are often emitted by biomass burning. The reasons behind the observed enhancement of the ice nucleation ability of these particles following simulated atmospheric photochemical aging will be discussed.

Our development of single-particle and single-droplet analytical techniques to study the chemical behavior of microparticles and their reactivity will also be presented. This includes the use of laser-based single-particle mass spectrometry, microfluidics, and aerosol optical tweezers. We will present new analytical capabilities using aerosol optical tweezers to determine in real-time and with high accuracy the physical and chemical properties of complex biphasic core-shell droplets and the pH of either phase. We are using this new measurement capability to investigate the critical role that pH plays in controlling phase separations and particle morphology, which in turn control the mechanisms and kinetics of the heterogeneous chemical reactions the particle interface can facilitate.

Green synthesis of Bioleached Laterite Iron Nanoparticles (GBLFeNP) using *Azadirachta indica* leaves and evaluation of its catalytic role in Fenton's oxidation of dicamba

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Iron from laterite was successfully extracted by bioleaching method using a novel isolated bacterial strain *Acidithiobacillus Ferrooxidans* BMSNITK17 (Accession No. MG27180). Green bioleached laterite iron nanoparticles (GBLFeNP) was synthesized using *Azadirachta indica* leaves. Synthesized nano iron particles were characterized by X-ray diffraction method and surface characterization was done with electron microscopy technique. FTIR analysis were made to identify the functional group in the extracted leaf extract.

Dicamba, a chlorobenzoic group of herbicides used to control woody and broad leaf weeds in the agriculture pose toxicity to fish and other aquatic life deteriorating water quality on its contamination of water source. Treatment of this herbicide hence is of much concern to environmentalist.

In the present study the catalytic role of synthesized green bioleached laterite iron nanoparticles (GBLFeNP) was examined for the Fenton's degradation of dicamba. 96.62 % of degradation efficiency was found with nano iron particles being a catalyst within 90 minutes of treatment. COD removal was monitored during the study confirms the better oxidation rate. Study confirms the usage of green synthesized bioleached laterite nano iron as a catalyst in the Fenton's treatment with both increased efficiency and faster rate of degradation of dicamba.

Electromechanical response from as-electrospun fiber mats of nonpiezoelectric polymers

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Electromechanical micron/submicron polymer fibers are promising building blocks for wearable pressure sensors and energy harvesters because the fibers are mechanically flexible, lightweight, and their mats are breathable. These electromechanical fibers normally consist of piezoelectric polymers, including poly(vinylidene fluoride), poly(vinylidenefluoride-co-trifluoroethylene), and poly(L-lactic acid). In this paper, we demonstrate the electromechanical properties of electrospun fiber mats consisting of nonpiezoelectric polymers, such as amorphous poly(DL-lactic acid) (PDLLA), poly(methyl methacrylate) (PMMA), and atactic polystyrene (PS), whose films do not normally show piezoelectricity. Electrospun micron/submicron fiber mats consisting of PDLLA, PMMA, and PS exhibit electrical actuation for their mat thicknesses depending on both the polarity and magnitude of the applied voltage, similar to the inverse-piezoelectric effect of piezoelectric materials. The evaluated apparent piezoelectric d constant (d_{app}) reached as high as 3.75×10^{-8} m/V for the PS fiber mat. The d_{app} value of the PS fiber mat was also measured with a quasi-static method. The evaluated d_{app} shows high values of 950 –1400 pC/N with applied loads of 0.05–0.28 N. Several characterizations of each fiber mat and the application of a theoretical model revealed that the fiber mat's electromechanical properties result from the bipolar and unevenly-charged as-electrospun fiber mats. The high d_{app} values are attributed to the very soft (Young's modulus < 10 kPa) and modestly-charged nature of each fiber mat. These findings will pave the way for the development of soft, lightweight, and breathable wearable pressure sensors and energy harvesters from a variety of materials with high electromechanical performance. [Ref] T. Nobeshima et al. J. Nanosci. Nanotechnol. 16, 3349 (2016); T. Nobeshima et al. Jpn. J. Appl. Phys. 57, 05GC06 (2018); Y. Ishii et al. Smart Mater. Struct. Accepted on 1 July, 2019.

On the potential of low-cost manufacturing of natural nanolaminate (MAX and MAB) Phase

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There is an urgent need of high-performance materials which can used for demanding applications like solid lubrication, refractoriness, corrosion resistance, wear resistance, among others. Non-oxide ceramics like MAX and MAB phases have emerged as important tools for materials selection. As a brief background, MAX and MAB phases are naturally nanolaminated ternary compounds, where M is Early Transitional Metal, A is group A element, and X can be C and/or N, and B can be Boron. These solids are conductive, soft, and machinable, and have the potential to be used in multifunctional applications. Conventionally, these ceramics are prepared by powder metallurgy methods where the precursors are cold pressed, and then sintered in inert environment like Ar. For the large-scale deployment of these materials, it is important to explore and document lost cost method for designing and manufacturing. In this presentation, some of the exploratory research in literature on low cost manufacturing of these materials will be reviewed, for example the removal of Ar during the manufacturing process which is used for creating shielding environment during the manufacturing step. Thereafter, the manufacturing process of MAB phases like MoAlB, Mn_2AlB_2, and Fe_2AlB_2 will be presented. The microstructure, phase content, and composition of these phases will be evaluated and compared with literature.

On the Design of Smart Manufacturing Approaches for Designing Environmentally Friendly Materials

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Sustainability has become an important topic research for this century. Recently, National Academy of Engineering (NAE) has come up with 14 Grand Challenges. Different schools are developing Global Challenge Scholar's Program (GCSP) to incorporate some of the key elements of grand challenge in the educational program. Some of the important elements of the GCSP program are: "(a) A creative learning experience connected to the Grand Challenges such as research or design projects, (b) Authentic experiential learning with clients and mentors that includes interdisciplinary experience in fields such as public policy, business, law, medicine, ethics, and communications, (c) Entrepreneurship and innovation, (d) Global and cross-cultural perspectives, and (e) Development of social consciousness through service-learning "[1]. In this presentation, we will present the recent progress in undergraduate (UG) research as an integral component of GCSP in the grand challenge areas of Carbon Sequestration Methods, and Water purification/harvesting. More particularly, we will present the development of novel green materials by carbonating $Ca(OH)_2$-lignin composites by cold pressing and additive manufacturing methodologies. The decomposition, microstructure, and mechanical behavior of these composites will be presented. In addition, the antimicrobial behavior of these composites will be also presented.

Reference:

http://www.engineeringchallenges.org/File.aspx?id=15680&v=c29105cb

Synthesis and Characterization of Novel Biocomposites by Using Customized Hemp and Sorghum Fibers as Reinforcements in PLA matrix

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Emergence of bioplastics derived from renewable sources have been increased as strong contenders to traditional petroleum-based plastics because of environmental safety and economic challenges. PLA (Polylactic Acid) is a promising example of thermoplastic biopolymer which is currently being studied for different day to day functional applications as well as medical applications. In literature, it has been demonstrated that mechanical, tribological, and physical properties of biopolymers can be improved by adding fibers. The main objective of this study is to investigate the effect of thermal treatments on the chemical nature of reinforcement fibers and as result their effect on the mechanical and tribological behavior of these composites compared to natural fibers. In this presentation our focus would be preliminary studies on designing Hemp and Sorghum fibers matrix systems by sieving and then pyrolysis at 300, 500, 700, and 900 ^{o}C in inert Ar atmospheres. These bio composites will be then fabricated by hot pressing the required volume fractions of PLA and sieved or pyrolyzed fibers. Detailed microstructural studies by SEM (scanning electron microscopy) will be also presented. Antimicrobial, tribological and mechanical behavior of composites designed by reinforcing them with tailored pyrolyzed fibers will be compared with PLA-Hemp and PLA-Sorghum composites as capabilities of PLA for being a wide application material requires all these characteristics. It is expected that these novel biocomposites can be used in multifunctional industrial applications.

Design and Development of Circular Economy concept on the Recovery of Materials from Waste

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The generation of waste is rapidly increasing, and it creates pollution, health problems and so on. Among the wastes, solvents are generated in huge quantities from industrial wastes. Solvents recovered from waste is becoming very popular, which not only recover and reuse the costly solvents, but also eco-friendly and curtail the rising production costs in many industries such as petrochemical and pharmaceuticals. Pervaporation method has been widely used for a variety of separations such as azeotropic mixtures, close-boiling mixtures, heat-sensitive mixtures, isomers, and volatile removal from fermentation broth. Polymeric- and ceramic membranes are used in the pervaporation (PV) process. When compared to the former, ceramic membranes are promising material due to their relatively high chemical- and thermal resistances. Ceramic membranes made from Metal–organic frameworks (MOFs) have attracted considerable interest due to its diverse pore size tunability, fascinating topologies and extensively studied for solvent recovery process. In this presentation, the use of ceramic membranes for the solvent recovery is highlighted.