

ABSTRACT BOOK

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Plenary

Merging Humans and Machines with Polymers

Xuanhe Zhao

Massachusetts Institute of Technology, Cambridge, MA

Abstract Not available

Multidimensional Macromolecules for Energy Conversion: From 1D Conjugated Polymers to 3D Carbon Nanomaterials

Liming Dai

University of New South Wales, Australia

Abstract Not available

Keynote Presentations

Commercialization of Composite Technologies and Products

Presenter* and Co-author names {Raymond Thompson^{1*}, Dustin Nolen², Mike Allen³}

^{1,2}Vista Engineering and Consulting LLC, USA; ³TAN Composites LLC, USA)

Abstract:

The expansion of fiber optic networks is critical for enhancing global communications infrastructure. One product essential to this market is the composite handhold (underground enclosure), designed for the storage and protection of fiber optic cables underground. This presentation examines the technical innovations and strategic approaches essential for introducing new technology and products into this mature market. The product development effort was initiated by identifying key needs and challenges associated with underground fiber optic cable management, such as product installation, environmental integrity, safety, and mechanical properties. The lightweight nature and unique design of the composite handhold significantly reduced transportation and handling costs, enabling quicker and safer installations. A crucial requirement for the product development was surpassing the Tier 15 strength and stiffness rating as per the ANSI/SCTE 77 Specifications for Underground Enclosure Integrity. Advanced engineering tools were utilized, including Finite Element Analysis (FEA), to design a solution capable of withstanding severe underground conditions while facilitating easy maintenance access. Early production runs were subjected to Extensive certification testing affirmed the handhold's compliance with these standards, assessing its strength, rigidity, impact resistance, chemical resistance, and fire safety. The commercialization phase involved securing patent protection, scaling up production capabilities, establishing robust supply chains, and formulating targeted marketing strategies for telecommunications providers and infrastructure contractors. This presentation will delve into the economic and operational

benefits of the composite handhold, illustrating its transformative potential in the deployment and management of fiber optic networks.

Biography:

Thompson received his PhD from Vanderbilt University in 1979. He is an elected Fellow of AWS, ASM and the National Academy of Forensic Engineers. He has 70 refereed technical publications, 13 patents, and edited one book. Thompson served as Professor of Engineering at Clemson and UAB. He founded Vista Engineering in 1999. He has completed over 500 materials engineering projects in 14 states and on 3 continents. Dr. Thompson is active in research through contracts with the DoD, NASA, NIH, NSF and serves national committees in engineering and reviews articles for technical publications in science and engineering.

Engineering Polymer-ceramic Interface in Solid-state Composite Electrolytes of Batteries

Nianqiang Wu*

Department of Chemical Engineering, University of Massachusetts Amherst, Amherst, Massachusetts 01002, United States

Abstract:

This talk deals with the polymer-ceramic interfaces in solid-state composite electrolytes, which are used in Li-ion batteries. As compared to the polymer alone, the chemical structure and microstructure of polymer at the interface have been altered significantly, which has created a Li-ion transport channel at the polymer-ceramic interface. After the ceramic surface has been modified, the interface has been further enhanced for ion transport.

Furthermore, lithium phosphate has been added into the interface, which has further improved interfacial charge transport and charge concentration. This has resulted in higher ionic conductivity of composite electrolyte. This work shows that the polymer-ceramic interface in the composite electrolyte has significant effects on the performance of solid-state Li-ion batteries.

Biography:

Nianqiang (Nick) Wu is currently Armstrong-Siadat Endowed Chair Professor in Materials Science at University of Massachusetts Amherst, USA. He is Fellow of the Electrochemical Society (FECS), American Institute for Medical and Biological Engineering (F- AIMBE), and Royal Society of Chemistry (FRSC). He is named Highly Cited Researcher by Clarivate Analytics (Web of Science TM). He has received the Electrochemical Society (ECS) Sensor Division Outstanding Achievement Award, Benedum Distinguished Scholar Award, Alice Hamilton Award for Excellence in Occupational Safety & Health, and WVU Statler College Outstanding Researcher Award.

Polymer Free Volume and Its Connection to Polymer Dynamics

Phillip Choi

University of Regina, Canada

Abstract Not available

Advanced Molecular Design and Applications of Multifunctional Hydrogels

Jie Zheng

University of Akron, Akron, OH

Abstract:

Hydrogels are emerging as exceptionally versatile materials with vast potential across numerous domains. This presentation will focus on the advanced molecular design and in-depth analysis of multifunctional hydrogels, spanning from basic principles to wide-ranging applications. We integrate theoretical models, empirical studies, and computational simulations to dissect complex molecular dynamics and structural nuances of hydrogels. The session will also introduce cutting-edge approaches to customize hydrogels for targeted uses such as wound healing, adaptive agriculture (smart soils), ant freezing substances, antifouling surfaces, and innovative devices in actuators, sensors, and bioelectronics. The discussion aims to showcase the synergy among theoretical insights, experimental discoveries, and practical design in our research trajectory. This endeavor seeks to elucidate the comprehensive capabilities of multifunctional hydrogels, fostering their applicability in diverse sectors.

Biography:

Jie Zheng serves as the Chair of the Department of Chemical, Biomolecular, and Corrosion Engineering at The University of Akron. He earned his B.S. in Chemical Engineering from Zhejiang University, China, in 1995 and his Ph.D. in Chemical Engineering from the University of Washington in 2005. Following a stint as a research scientist at the NCI, NIH, he joined the University of Akron faculty in 2007, achieving Associate Professor status in 2012, Full Professor in 2016, and Department Chair in 2021. Prof. Zheng's accolades include the NSF CAREER Award (2010), the 3M Non-Tenured Faculty Award (2008), and the Anton Award from the National Resource for Biomedical Supercomputing (2010). He has been honored multiple times with the Outstanding Research Award and the Louis A. Hill Faculty Award at the University of Akron. His research is dedicated to the design and development of innovative bio-inspired, bio-functional, and biomimetic soft materials for varied applications in engineering and biomedicine. Zheng has authored over 280 journal papers, garnering more than 23,000 citations with an h-index of 82.

Bioinspired Self-healing Thermoset Polymers

Guoqiang Li

Department of Mechanical & Industrial Engineering Louisiana State University Baton Rouge, LA 70803, USA

Abstract:

Self-healing and recycling of thermoset polymers have been an immense interest in recent years. For thermoset polymers used in load bearing structures, damage by external loading such as low velocity impact loading may be in the macroscopic length scales. Healing macroscopic damage such as millimeter scale cracks is a challenge. In the past years, our lab has been working on healing macroscopic cracks based on bioinspired strategy by mimicking the self-healing of human skin: close then heal (CTH). In this strategy, macroscopic cracks will be first closed either by constrained shape recovery of compression programmed thermoset shape memory polymer matrix or by embedded tension programmed sutures such as shape memory polymer fibers or twisted and

coiled polymeric artificial muscles, and then healed either intrinsically, for example by reversible covalent bond, or extrinsically, for example, by embedded thermoplastic healing agent. In this presentation, I will introduce the CTH strategy, and will demonstrate the applications of the strategy to several thermoset polymers.

Biography:

Guoqiang Li received his B.S., M.S., and Ph.D. degrees from Hebei University of Technology, Beijing University of Technology, and Southeast University, respectively, all in Civil Engineering. He received his postdoc training in Mechanical Engineering at Louisiana State University (LSU). He is currently the Major Morris S. & DeEtte A. Anderson Memorial Alumni Professor and John W. Rhea Jr. Professor in the Department of Mechanical & Industrial Engineering at LSU. He is also serving as the Associate Vice Provost in the Graduate School. His research interest is in the broad area of engineering materials, manufacturing, and engineering mechanics.

Block Copolymers with Rigid Components – unique Assembled Structures from New Packing Pathways

Tianbo Liu*

School of Polymer Science & Polymer Engineering, University of Akron, Akron, OH 44325 U.S.A.

Abstract:

When block copolymer chains, especially the solvophobic ones, become rigid in solution, their self assembly must undergo different pathways rather than the well-established trends regulated with the packing parameter. By using several types of rigid amphiphilic “block copolymers” containing hydrophilic, nanoscale molecular clusters and rigid, short-chain hydrophobic domains, we demonstrate their intriguing self-assembly behaviors in polar solvents. First, T-shaped spherorod amphiphiles are found to form strictly monodispersed, multilayer onion like supramolecular structures by interdigitating the rods to form the hydrophobic domain. The inter layer distance is strictly fixed and remains unchanged with solvent quality. To achieve so, the rigid rods must adjust their interdigitation angles continuously for different layers. Interestingly, the assemblies reversibly adjust their layer number in response to the environment unexpectedly with more layers in a better solvent. The onions might lose their inner layers when the rods being too long or too short due to geometrical limitations, showing transitions from full to partial onion structures, until single layer vesicles, revealing a new trend of packing for the assembly of rigid copolymers. Spherorod-sphere I-shaped “dumbbell” shaped amphiphiles are found to form hollow vesicular structures in water, even when those thin rods are not bulky enough to fill up a condensed hydrophobic domain, or being fully hydrophilic. We identify that the vesicular assemblies are actually blackberry-type supramolecular structures controlled by electrostatic interaction, aka. counterion-mediated attraction; and no hydrophobic domain is formed. This driving force leads to the formation of very stable, and highly porous surfaces with expected controllable pore size on the assemblies.

Biography:

Tianbo Liu (B.S., Peking University in 1994; Ph.D., Stony Brook University in 1999 with Benjamin Chu) started his independent research career at Brookhaven National Laboratory in 2001. In Jan. 2005 he joined Lehigh University faculty and was promoted to associate professor and full professor. Since Jan. 2013 he has been the A. Schulman Professor of Polymer Science at The University of Akron. He also served as the Department Chair and the Interim Director of School of

Polymer Science and Polymer Engineering. His laboratory focuses on understand the fundamental behaviour of complex solutions hydrophilic macroions, inorganic-organic hybrid materials and other colloidal and biological systems.

Dielectric Polymers Under Elevated Temperatures and High Electric Fields

Qing Wang

Department of Materials Science and Engineering, The Pennsylvania State University, University Park, PA 16802 USA

Abstract:

With unique features including excellent electrical insulating properties, lightweight, mechanical flexibility and scalability, dielectric polymers are universally used for insulation on wires and cables and also enable the development of high-energy-density capacitors for electrical energy storage. However, with exponential increase of electrical conduction under elevated temperatures and high applied electric fields, dielectric polymers are limited to relatively low working temperatures, and thus fail to meet the rising demand for electricity under the extreme conditions present in applications such as advanced microelectronics, electric vehicles and aerospace power electronics. This talk will describe our recent results on the dielectric polymers and nanocomposites designed for high-temperature applications. Specifically, the introduction of inorganic wide bandgap nanofillers into the polymers yields significantly reduced high-field conduction, and consequently, great improvements in the charge discharged efficiency and discharged energy density at high temperatures. The origins of the marked improvement in the high-temperature capacitive performance of the crosslinked polymers are traced to efficient charge-trapping by a range of the molecular trapping centers resulting from the crosslinked structures. This talk will discuss fundamental insights into the tradeoff between dielectric constant and high-field energy loss in dielectrics and the mechanisms that control electrical conduction in polymers at high temperatures under the applied fields.

Biography:

Qing Wang received his Ph.D. in Chemistry from the University of Chicago in 2000. Prior to joining the faculty at Penn State in 2002, he was a postdoctoral researcher at Cornell University. Among other awards, he has received the National Science Foundation CAREER Award, Rustum and Della Roy Innovation in Materials Research Award and Penn State Faculty Scholar Medal in Engineering. His research interests include the development of ferroelectric polymers, electroactive polymers, dielectric polymers and nanocomposites for energy harvesting and storage. Wang is a Fellow of AAAS and IEEE.

Oral Presentations

Fully Solution-processed Polymeric Multilayer Piezoelectric Devices

Yanguang Zhang^{1*}, Shiyu Hu¹, Dongze Wang,¹ Shoude Chang¹, Gaozhi Xiao¹, Jianping Lu¹, Neil Graddage¹, Jun Gao², Tahmid Rakin Siddiqui³, Suprabha Islam³, Chun-il Kim³, and Ye Tao¹

¹ National Research Council Canada, Canada; ² Queen's University, Canada; ³ University of Alberta, Canada

Abstract:

The development of multilayer polymer piezoelectric devices, as actuators, transducers, and energy harvesters, is bottlenecked by the lack of reliable and low-cost fabrication process. Additive manufacturing using solution deposition techniques is simple and cost-effective and represents a promising approach to resolving this scalability issue. Here, we demonstrate the first fully solution-processed polymeric multilayer piezoelectric devices. The key challenge, the effective control of the redissolving issue that would cause severe electrical shorting and inconsistent piezoelectric output, has been overcome by searching for and using a solvent that offers good solubility but extremely slow dissolution for the piezoelectric polymer. The solvent screening methodology has been established and demonstrated. The process parameters have been systematically optimized to maximize the piezoelectric performance of the multilayer devices. The multilayer devices can output a high charge density of 376 $\mu\text{C}/\text{m}^2$, even higher than the record charge density of 250 $\mu\text{C}/\text{m}^2$ achieved by traditional contact electrification-based triboelectric nanogenerators operated in ambient air. The crucial factors for increasing device fabrication yield, namely resistance to short circuits and poling-induced breakdown, have been analyzed. The potential of multilayer devices in practical applications has been demonstrated with a 5-layer device as a direct power source and energy harvester. More importantly, the process developed here is transferrable for cost-effective high-throughput roll-to-roll production. This work thus lays the foundation for the mass production of polymeric multilayer piezoelectric devices and paves the way for their future commercialization.

Biography:

Zhang was born in the Northeast of China, in 1977. He received a B.E. degree in electrical engineering from Jilin University in China in 2000, and a Ph.D. in physics from Queen's University, in Canada, in 2009. He joined the National Research Council Canada (NRC) after his graduation. He has been working on many projects covering the area of organic solar cells, inorganic nanocrystal solar cells, thin-film transistors, organic thin-film memories, piezoelectric and triboelectric nanogenerators. Dr. Zhang is currently a research officer at NRC, focusing on energy harvesting, energy storage, self-powered sensing, and capacitive sensing.

Versatile and Recyclable Conductive Hydrogels for Flexible Electronics

Yaquan Wang and Yao Lu*

Queen Mary University of London, UK

Abstract:

Most hydrogels commonly used in flexible electronics possess a single function and lack long-

term environmental adaptability, making them unsuitable for meeting the complex demands of flexible electronics, particularly under harsh conditions. Furthermore, the use of unrecyclable hydrogels in flexible electronics generates solid-state electronic waste, which negatively impacts the global environment. To address these issues, versatile and recyclable conductive hydrogels with long-term environmental adaptability and mechanical stability have been developed for wearable smart electronics. Two types of recyclable hydrogels were designed and introduced: one through the construction of double-network structures, and the other through the Hofmeister effect and reconstruction of hydrogen bonding. Their mechanical and conductive properties, as well as their anti-freezing and water-retention abilities, transparency, and self-adhesion, were thoroughly discussed. Finally, the potential applications of these hydrogels, such as in strain sensors, triboelectric nanogenerators, and batteries, were explored, particularly under harsh conditions including mechanical deformations and extreme temperatures.

Biography:

Yaquan Wang is currently a Ph.D. student under the supervision of Dr Yao Lu in the Department of Chemistry at Queen Mary University of London, UK. His research is focused on the design and synthesis of multifunctional hydrogels for the applications of flexible electronics, such as strain sensors, triboelectric nanogenerators and batteries.

Machine Learning Optimization for Designing Polymer Based Multilayer Microwave Absorber

V. Subramanian^{1*}, Raghav Dunga¹, R. Kumaran¹, R. Jayaganthan², C.V. Krishnamurthy¹

¹ Microwave Laboratory, Department of Physics, Indian Institute of Technology Madras, Chennai, Tamil Nadu, 600036, India

² Department of Engineering Design, Indian Institute of Technology Madras, Chennai, Tamil Nadu, 600036, India

Abstract:

Microwave absorbers are useful to develop sensors, absorb unwanted radiations, modify antenna patterns, electromagnetic interference shielding, reducing radar cross section etc. Conventional absorbers use pyramidal shaped homogenous materials but have dimensions of the order of tens of wavelength. Paint based absorbers, mainly used for reducing radar cross section, have low absorption values. To achieve more than 90% absorption using flat absorbers with thickness of the order or lower than wavelength, one has to look for multilayer configuration. With the use of polymer based nanocomposites, it is possible to tailor the required properties by carefully choosing the fillers. The order of stacking the individual composites as a multilayer structure requires extensive numerical procedure. To simplify, it is better to utilize the machine learning algorithms to optimize the structure for obtaining the required reflection and absorption. To start with, one might feed the properties of the individual layers to generate a few sets of data and use that data to predict the arrangement of the composites with their thicknesses. In this paper, four different polymer nanocomposites with various fillers are prepared and their individual properties, viz. complex dielectric permittivity and complex magnetic permeability are evaluated experimentally. These data are fed into the machine learning algorithm to predict suitable stacking of the composites along with specific thicknesses to prepare multilayer composites to achieve >98% absorption over the X-band frequency (8 to 12 GHz) region. The present work would help the researchers to save considerable time to prepare the multilayers with desired electromagnetic properties.

Biography:

Subramanian Venkatachalam completed the post graduation in Physics from The American College, Madurai, India and obtained doctoral degree on microwave studies on semiconductors from Indian Institute of Technology Madras in 1995. He subsequently joined as a Faculty in IIT Madras in 1998 and presently working as a Professor. His research interests are Microwave Non-Destructive Evaluation, Microwave Materials, Microwave Propagation through periodic materials, Dielectric Resonators, Relaxor Ferroelectrics, Polymer Nanocomposites, and Magnetelectric Materials for energy harvesting and microwave applications. He is a Fellow of Academy of Sciences Chennai and Senior Member of IEEE.

Impact of Material Stiffness on the Dynamic Wetting and Deformation of Microstructured Polymer Surfaces

Shawn A. Putnam^{1*}, Thomas Germain¹, Chance Brewer¹, and Fernando S. Proano¹

¹ University of Central Florida, Mechanical and Aerospace Engineering, Orlando, FL 32816, USA

Abstract:

Soft, microfluidics platforms are of growing interest in applications ranging from wearable electronics to flexible spacecraft radiators. This talk presents the limits of fluid wetting and wicking transport on soft-to-rigid materials with microtextured surfaces. For reference, for relatively soft or rigid materials (i.e., Young's moduli $E > 300$ kPa, the wetting and wicking dynamics are found to be independent of the sample stiffness. However, as the stiffness of the soft materials approaches that of human skin (e.g., $E \sim 61$ kPa), viscoelastic dissipation in the bulk and surface microstructures leads to recoil droplet wetting dynamics and reduced to completely damped wicking behaviors. Analytical models and scaling relations are provided for predicting with fair accuracy the inertial wetting and hemiwicking velocities. Yet, at the onset of viscoelastic dissipation, we observe a rapid (sub-millisecond) coupling between the swelling kinetics and elastocapillary effects. Also discussed are our results on the viscoelastic wetting behavior on soft, Ecoflex (61 kPa) samples as a function of applied temperature gradients, cross-link densities, and EcoFlex thin-film thickness, facilitating the subsequent development of refined viscoelastic models of rapid, swelling, deformation, and soft wetting phenomena.

Biography:

Putnam joined the MAE department at UCF in August 2012. Before joining UCF, he was the lead scientist on liquid-solid interface studies in the Thermal Sciences and Materials Branch at Wright-Patterson Air Force Base (Dayton, OH). Dr. Putnam received B.S. Degrees in Physics and Applied Mathematics in 2001 at the University of Minnesota, Duluth. Then, he received his Ph.D. in 2007 from the University of Illinois Urbana-Champaign in Materials Science and Engineering. Dr. Putnam's research is focused on transient energy transport at materials

Non-fully conjugated polymers for efficient and thermally stable solar cells

Donghong Yu^{1*}, Qunping Fan², Wenyan Su² and Ergang Wang²

¹ Department of Chemistry and Bioscience, Aalborg University, Denmark

² Department of Chemistry and Chemical Engineering, Chalmers University of Technology, Sweden

Abstract:

A non-conjugated polymer acceptor PF1-TS4 was synthesized by embedding a thioalkyl segment in the mainchain, which presents excellent photophysical properties like a fully conjugated polymer with a low optical bandgap of 1.58 eV and a high absorption coefficient of $1.28 \times 10^5 \text{ cm}^{-1}$, a high LUMO level of -3.89 eV, and suitable crystallinity. Matched with a polymer donor PM6, the PF1-TS4-based all-PSC achieved a power conversion efficiency (PCE) of 8.63%, which is ~1.5 times higher than that of device based on the small molecule acceptor counterpart IDIC16. Moreover, the PF1-TS4-based all-PSC has good thermal stability with ~70% of its initial PCE retained after being stored at 85 °C for 180 h, while the IDIC16-based device only retain ~50% of it when stored at 85 °C for only 18 h. This work provides a new strategy to develop efficient polymer acceptor materials by linkage of conjugated units with non-conjugated thioalkyl segments.

Biography:

Donghong Yu, obtained his PhD degree in Polymer Chemistry and Physics in 1997, and worked as an Assistant Professor in Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, China until 1998. From 2000, he joined Aalborg University, Denmark, as a Research Assistant Professor, becoming a Tenure-track Assistant Professor in 2001. In 2006, he became tenured Associate Professor

The Nco Cycle: A Two-step Complete Recycling Process for Polyurethanes

Marthe Nees* and Muhammad ADEEL, Lukasz PAZDUR, Matthew PORTERS, Christophe VANDE VELDE & Pieter BILLEN

Intelligence in Processes, Advanced Catalysts and Solvents (iPRACS), Faculty of Applied Engineering University of Antwerp, Belgium

Abstract:

Polyurethanes (PU) are a class of mostly thermoset polymers, produced by a condensation of di-(or poly)isocyanates with polyols (polyfunctional alcohols). Since mechanical recycling leads to inferior products, research into chemical recycling methods is on the rise. The most promising chemical recycling technique is split-phase glycolysis, which results in a polyol phase and a glycol/dicarbamate phase^{1,2}. However, to date, this approach only focusses on the recovery of the polyols, neglecting the recycling potential of the dicarbamate phase, which makes up 10-40 % of the PUR mass. This project aims to extend the existing alcoholysis processes to a two-step process that can recover both polyols and isocyanates. This will be achieved by a subsequent thermolysis reaction after the alcoholysis reaction, applied to the previously ignored carbamate phase to regenerate isocyanates without the use of toxic phosgene gas. Since the carbamate bond is thermally reversible³, the thermolysis-step can take place at relatively low temperatures (ca. 200 °C). This would be a pioneering step forward towards the complete recycling of polyurethanes, as well as the production of PU from recycled materials. As such, both the polyols and isocyanates can be used in the synthesis of new PU. The first experiments of the recycling process using isopropanol were successful in recovering the polyols and a small amount of isocyanates. The thermolysis of the generated isopropyl-carbamate at 275°C for 10 minutes successfully recovered isocyanates with a yield of 32%. Other valuable chemicals were also formed during the process that could be used in various applications.

Understanding Thermal Transport Properties in Polymers

Yanfei Xu^{1,2*}

¹ Department of Mechanical and Industrial Engineering, University of Massachusetts Amherst;

² Department of Chemical Engineering, University of Massachusetts Amherst, United States

Abstract:

Functional polymers have emerged as versatile materials with unique applications in microelectronics, optics, biomedicine, thermotherapy, thermal energy harvesting, and transport. Despite their increasing significance, a full understanding of thermal transport mechanisms in polymers remains challenging. This presentation focuses on recent experimental efforts aimed at advancing our understanding of thermal transport in polymeric materials.

Our research approach involves transforming conventional polymer insulators into highly efficient heat conductors, surpassing the thermal transport capabilities of numerous metals and ceramics. Additionally, we explore how defects can be harnessed to enhance interfacial thermal transport in polymeric composites. These findings provide new possibilities to assist theoreticians in building models to better understand thermal transport and to unlock the full potential of functional polymers across various technological applications.

Biography:

Yanfei Xu joined the University of Massachusetts Amherst in 2019 as an assistant professor in Mechanical & Industrial Engineering, later becoming an adjunct assistant professor in Chemical Engineering in fall 2020. Prior to UMass, she conducted research at Massachusetts Institute of Technology from 2013 to 2018, focusing on transforming polymer insulators into efficient heat conductors. From 2011 to 2013, she contributed to GENIUS projects funded by the European Commission in printable organic electronics, securing prestigious Marie-Curie Fellowships with esteemed institutions and companies, including the Max Planck Institute for Polymer Research and BASF SE headquarters.

Eco-friendly Reinforced Green-plastics from Waste Tires and Renewable Resources

Edu Ruiz^{1*}, **M. Kazeruni**¹, **B. Nohair**³, **S. Kaliaguine**², **H. Sauquet**¹, **L. Chiacchiarelli**⁴

¹. Department of Mechanical Engineering, Polytechnique Montréal, Montréal, Canada

². Instituto Tecnológico de Buenos Aires, Departamento de Ingeniería Mecánica, Buenos Aires, Argentina

³. Composites Development Center of Quebec – CDCQ, Saint-Jérôme, Canada

⁴. Université Laval, Québec, Québec, Canada

Abstract:

National programs to achieve carbon neutrality are ambitious and require significant transformations in manufacturing sectors. In order to meet this goal, industries must shift from current fossil fuel-based materials to adopting more environmentally friendly alternatives that reduce CO₂ emissions throughout the entire life cycle. This research focuses on developing a novel composite material composed of renewable resources and recycled particles from waste tires. Over the past decades, the demand for tires has increased dramatically, leading to a substantial increase in the number of waste tires produced annually worldwide with very limited recycling. Recovering the carbon black

(CB) particles from waste tires (25-30% in weight) is an ecological recycling process that can be sustainable and economically viable. In this work, CB from waste tires is recycled with a vacuum pyrolysis process, resulting in high quality particles that can be incorporated in plastics as fillers for toughness, electrical or thermal conductivity. Therefore, the pyrolytic CB was functionalized through control of air oxidation of the surface to graft acidic oxygen functional groups, providing compatibility with the polymer. Functionalized pyrolytic CB was incorporated in two eco-friendly plastics, a bio-HDPE made from sugar cane and a novel bio-TPU formulated from soy and corn oils, both demonstrating superior quality, mechanical properties and UV resistance. Our focus is an ecologically responsible approach essential to protect the environment from waste tires and fossil fuel plastic pollution, providing the industry a novel green material that can be processed as commercial plastics with equal properties and a very low environmental footprint.

Biography:

Edu Ruiz works in the polymer composites field since 1999 at Polytechnique Montreal (Canada). His research focuses on processing and formulation of composites and reinforced plastics. Has played a role in the development of 3D woven carbon composites for the aerospace and national defense. Has hold a Canadian national research chair in 3D woven polymer composites and 3D woven ceramic composites. Over the last 20 years has developed more than 20 patents in materials and processing and is CEO of a spin-off company to support the industrialization of the research outcome. In recent years, he has focused in green materials to seek for eco-responsible solutions to our most challenging pollution problems.

Extracellular Matrix-derived Biomaterials for Tissue Engineering

Rocio G. Casañas Pimentel*¹, Omar A. González Rodríguez¹, Arturo Aguilar Ramírez¹, Nancy C. Ramírez Guerrero¹, Candido Gómez Lara¹, Ivete B. Arellanes Ovando¹, Ningel O. Gama, Castañeda¹, Eduardo San Martin¹

Instituto Politécnico Nacional / CICATA Legaria, México

Abstract:

Throughout life, various factors can induce severe damage to human tissues, making their restoration or replacement necessary. Donating tissues from another individual or from the same patient does not solve the problem, making the use of synthetic tissues necessary. Some synthetic polymers provide support for cell growth, but not adequately, since biological tissues are complex systems whose natural support material (the extracellular matrix), more than just mechanical support, is a regulator of cell physiology. The extracellular matrix communicates closely with the cells, molecularly and mechanically, while synthetic polymers cannot exert this effect. Natural extracellular matrices have been obtained for tissue engineering; however, the natural extracellular matrix loses its mechanical properties in its production process. The development of biomaterials composed of extracellular matrix added with polymers seems to provide better opportunities for the development of tissue engineering, since they incorporate the bioactive functionality of the extracellular matrix, while they can adjust the mechanical properties suitable for different types of tissue by varying the polymer used in the composite.

Biography:

Rocio Casañas is a researcher at the National Polytechnic Institute, in Mexico; she works on developing materials for tissue engineering and drug delivery systems. She is a biotechnology engineer and specialist in nanotechnology applied to biomedical research.

Development of EMI Shielding materials from Virgin and Post-consumer derived Polymers

Tanyaradzwa S. Muzata

Chemical Engineering Department, Hampton University, USA

Abstract:

This work intends to develop polymer-based composite materials that attenuate electromagnetic radiation pollution. The rapid increase in the production of different numbers of electronic gadgets has greatly benefited mankind. However, one of the shortfalls in developing these gadgets is the production of electromagnetic pollution, leading to electromagnetic interference (EMI). Electromagnetic pollution causes an interruption in the normal functioning of different electronic devices, and it has been reported that it has adverse effects on human health. Designing and developing polymer-based EMI shielding materials made of polymeric materials derived from virgin and post-consumer recycled plastics is paramount to mitigate this pollution.

Biography:

Tanyaradzwa “Tanya” Muzata is an Assistant Professor in the Department of Chemical Engineering at Hampton University. His research mainly focuses on the structure-property relationship of multiphasic polymeric materials, polymer processing, and rheology. He did his PhD in Materials Engineering from the Indian Institute of Science. He was a Post-Doctoral researcher in the School of Packaging at Michigan State University under the supervision of Dr. Muhammad Rabnawaz and Dr. Laurent Matuana before becoming an Assistant Professor at Hampton University.

Application of In-Situ Reaction Monitoring to Achieve Greater Process Understanding

Presenter Michael Hall* and Co-author names {For Ex: (Nancy Jestel1)}

Affiliation (1SABIC, United States)

Abstract:

It has been well demonstrated across different industries that on-line process analytical technology for reaction monitoring can provide chemists and engineers greater understanding of chemical processes. By leveraging data collected from multiple sensors, subtle and/or rapid transitions can be detected that likely would be missed by off-line techniques due to delays associated with sampling and analysis. During this talk, examples are presented where lab scale oxidative coupling polymerizations were monitored real-time by spectroscopic and other sensors. Soft modeling approaches and correlation techniques were employed to extract information from the individual and combined data sets. The process understanding gained from these models was leveraged to make more informed decisions during lab scale process development. Lastly, unresolved analytical challenges in the area of polymer characterization will be presented.

Biography:

Michael holds a BS in Chemistry from the State University of New York at Buffalo. Following his studies, he worked as an Analytical Chemist in the pharmaceutical industry for 16 years. Over that time he gained expertise with a variety of different analytical technologies and is listed as an inventor on four patents. Since 2013 he has been functioning in a lead spectroscopist role for SABIC's Specialties business and served as a global spectroscopy functional team leader. His primary focus is supporting molecular synthesis for customer applications and driving innovations

and advancements in analytical to enable new product development. Michael also serves as a peer reviewer for “Polymer Degradation and Stability”

Polymer Characterization using MALDI-TOF Mass Spectrometry and Tandem Mass Spectrometry

Presenter: Mark Arnould

Affiliation: Bruker Applied Mass Spectrometry

Abstract:

Mass spectrometry (MS) has emerged as an indispensable tool for polymer analysis, facilitating the study of various aspects including polymer structure, composition, end-groups, additives, molecular weight distribution, and degree of polymerization. Its unparalleled sensitivity enables the detection and identification of minor polymer components, synthesis by-products, low-level impurities, and decomposition products. However, traditional MS analysis often relies on coupling with chromatographic techniques such as gas chromatography (GC-MS) or liquid chromatography (LC-MS) to separate complex mixtures prior to mass spectrometric analysis, resulting in a complex and time-consuming process.

To address these challenges, Bruker offers innovative solutions to streamline polymer analysis. Two complementary chromatography-free MS methods, Matrix Assisted Laser Desorption Ionization (MALDI) and Direct Analysis in Real Time (DART), are presented as alternatives to traditional chromatography-coupled MS approaches. MALDI employs a laser to desorb and ionize molecules from a matrix-coated sample target, enabling rapid and direct analysis across various fields including material science, metabolomics, forensics, and environmental analysis. Similarly, DART ionizes samples in open air or solvent-free environments, facilitating direct analysis of solids, liquids, and gases without the need for sample preparation or chromatographic separation. These chromatography-free MS methods offer simplified workflows, expedited analysis, and enhanced efficiency, thus revolutionizing polymer analysis in research and industrial applications.

Biography:

Mark Arnould is a senior applications scientist within the applied markets division of Bruker, concentrating on polymer MALDI-TOF applications. He has over 20 years of experience analyzing synthetic macromolecules using mass spectrometric methods. He received his doctorate the University of Akron in the Wesdemiotis group focusing on MALDI-TOF MS analysis of polymers. After his graduate work he was an NRC post-doctoral fellow at NIST. Mark comes to us after 14 years in industry at Xerox Corporation specializing in MALDI of polymers and GPC. After leaving Xerox, he was a researcher for 3.5 years at Oak Ridge National Lab in the Center for Nanophase Materials Sciences.

Polymeric Scale Inhibitor for Mineral Scale Control

Ping (Peter) Zhang*, Yuning Zhang

Department of Civil and Environmental Engineering, Faculty of Science and Technology
University of Macau, Taipa, Macau

Abstract:

Mineral scale refers to the hard crystalline inorganic solid deposit from the water phase. Although scale formation is very common in natural environment, deposited scale particles can result in serious threats to the integrity as well as safety of various industries. Scale deposition is one of three most serious water-related production chemistry threats in petroleum industry. The most commonly adopted engineering approach to control scale threat is chemical inhibition by applying scale inhibitor chemicals. Aminophosphonates and polymeric inhibitors are two major groups of scale inhibitors. The advantage of polymeric inhibitors over aminophosphonates is that most polymeric inhibitors are phosphorus-free and, therefore, more environmentally friendly. To address the drawbacks of conventional inhibitors, solid scale inhibitor materials have been prepared as an alternative delivery vehicle of inhibitors for scale control. Quite a few studies have reported the laboratory synthesis and testing of scale inhibitor solid materials composed mainly of pre-precipitated metal-aminophosphonate solids. However, limited research has been conducted on the preparation of polymeric inhibitor based solid materials. In this walk, two applications of polymeric inhibitors will be introduced, including inhibitor colloidal materials and controlled release bead materials. These prepared materials further expand and promote our capacity in mineral scale control.

Biography:

Ping (Peter) Zhang is an associate professor in Faculty of Science and Technology of University of Macau. He is a professional engineer (P.E.) in State of Texas and a Chartered Chemist (CChem) of Royal Society of Chemistry of the U.K. His research field is Chemical and Environmental Engineering.

Independent Characterization of the Elastic and Mixing Free Energy Densities of Swellable Polymer Networks

Qihan Liu* and Zefan Shao

Laboratory of Soft Materials Mechanics and Manufacturing, University of Pittsburgh, USA

Abstract:

Osmotic pressure is the driving force for the swelling of hydrogels. The hydrogel osmotic pressure can be decomposed into two parts: the mixing part due to polymer-solvent interaction and the elastic part due to polymer chain stretching. While the two parts are distinguished in existing constitutive models, they have not been independently characterized in experiments. Here we report a novel method to independently measure these two components using a fully constrained swelling test. The test allows the crosslink density to be varied at a fixed polymer content, thus varying the elastic part independently of the mixing part. By extrapolating the measurement to a vanishing elastic part, the mixing part is measured. Then by subtracting the mixing part from the measurements, the elastic part is measured. Our measurement shows that the widely used Flory-Rehner model predicts the mixing part accurately for polyacrylamide hydrogels of a wide range of swelling ratios but predicts the elastic part with one order-of magnitude error.

Biography:

Liu is an assistant professor at the University of Pittsburgh. His research engages in multiple aspects of the mechanics and manufacturing of soft materials, with particular focuses on stimuli-responsive adhesion between soft materials and fiber-reinforced soft composites.

Mechano-spectroscopy of Polymers with Nanometer Spatial Resolution

Igor Sokolov^{1*}, Mikhail Petrov¹, Pierre Nickmilder², Philippe Leclère², Nishant Kumar¹

¹ Tufts University, Medford, MA 02155, USA

² University of Mons, Mons, Belgium

Abstract:

We introduce an advanced method for the identification of high-resolution material composition on sample surfaces using atomic force microscopy (AFM) working in sub-resonance tapping Ringing mode. This innovative approach is based on the Ringing mode's ability to collect multiple physical and mechanical property maps with subnanometer lateral resolution. By comparing these maps against a database of known material properties, our method enables the precise localization of different materials within a sample composed of known constituents. Machine learning algorithms, including neural networks and decision trees, are employed to identify materials at each pixel of the AFM image, enhancing the accuracy of material identification. We demonstrate the efficacy of our technique on blends of different polymers, including three distinct polymers: polystyrene (PS), polyvinyl pyrrolidone (PVP), and polyethylene oxide (PEO). We will also compare the advantages and limitations of our method with other spectroscopy techniques, providing a comprehensive understanding of its potential applications in polymer characterization.

Biography:

Sokolov has decades of experience in material science, physics, chemistry, biology, machine learning, in particular, 35 years in atomic force microscopy. He received his B.S. in Physics from St. Petersburg State University (Russian Harvard) and Ph.D. from D.I. Mendeleev Central Institute for Metrology (Russian NIST). Sokolov worked as a research associate at the University of Toronto, as a faculty at Clarkson University, where he achieved the title of full professor and served as director of the NABLAB Center. He is now professor and Gordon Senior Fellow at Tufts University, working on material science for health and engineering.

Optimizing Shape Memory Vitrimers: A Machine Learning Approach to Balancing High Glass Transition Temperature and Recycling Efficiency

Cheng Yan^{1*}, John Konlanb², Patrick Mensah¹, and Guoqiang Li²

¹ Souther University and A&M College, USA; ² Louisiana State University, USA

Abstract:

Shape memory vitrimers (SMVs) have attracted increasing attention in recent years due to their unique ability to recover their original shape upon stimulation and heal sustained damage. Despite this potential, a key challenge in SMV development lies in simultaneously achieving high healing/recycling efficiency and a high glass transition temperature (T_g), which often involves a trade-off between molecular chain mobility and the dynamic covalent bond exchange required for these properties. To address this, we applied a machine learning (ML) framework that incorporates both supervised and unsupervised learning techniques to optimize the complex design space of SMVs. We present a detailed comparison of the mathematical models and their performance, leading to the design of four thermally robust shape memory vitrimers (TRSMVs) with high T_g , enhanced recycling efficiency, and superior shape memory effects. Notably, one of the developed TRSMVs demonstrated exceptional experimental results, with a T_g of 233.5°C, a recycling efficiency of

84.1%, and recovery stress of 33 MPa—closely aligned with ML predictions. This study highlights the potential of ML-driven approaches to advance the design of high-performance smart materials.

Biography:

Cheng Yan is an Assistant Professor in the Department of Mechanical Engineering at Southern University and A&M College. His research focuses on machine learning for polymer discovery, shape memory polymer modeling, and impact mechanics. As first or corresponding author, he has published 15 journal papers and 2 book chapters, with work featured in the ASME Journal of Applied Mechanics, Applied Physics Letters, and ACS Applied Materials & Interfaces. Dr. Yan serves on the Editorial Board of Frontiers in Mechanical Engineering and has reviewed for journals like Advanced Science and Langmuir.

Sustainable Organocatalytic Modification of Biopolymers Such as Cellulose and Nanocellulose

Rana Alimohammadzadeh*, Abdolrahim A. Rafi, Luca Deiana, Armando cordova.

IMD Department, Mid Sweden University, SE-85170 Sundsvall, Sweden

Abstract:

Cellulose is the most abundant biopolymer on the Earth and extracted mostly from lignocellulose biomass. Cellulose and nanocellulose are in the center of attention and research toward them has been carried out in several directions. However, hydrophilic nature of these biomaterials is the main drawback that needs to be improved. In this context, organocatalytic and eco-friendly functionalization of heterogeneous cellulose and lignocellulose fibers has been discovered. Recently, we disclosed an environmentally friendly one pot reaction approach for fabrication and simultaneous functionalization cellulose nanofibers (CNFs) with lactic acid. The esterified CNF is compatible with other polymers and can be used for production of nanocomposites. Moreover, our studies about nacre-inspired nanocomposites using nanocellulose and montmorillonite reveal the improved mechanical property. With a respect to preparing hydrophobic cellulose based materials, we have designed superhydrophobic crystalline nanocellulose (CNC) films, with inspiration from the Lotus leaf, by a novel combination of organocatalysis and self-assembly of CNC. We have also developed aqueous organocatalytic formulations (OAF) for use in fabrication of hydrophobic and superhydrophobic cellulose-based products. In addition, OAF has been applied for fabrication of hydrophobic lignocellulose foams with high mechanical properties that can be used for water decontamination. In another bio-inspired approach betulin, a compound extracted from birch bark, was also employed in aqueous formulations to improve the hydrophobicity and the mechanical dry- and wet-strengths of lignocellulosic papers

Biography:

Rana Alimohammadzadeh has worked in Mid Sweden University since 2015 in organic chemistry group supervised by Prof. Armando Cordova. She has received her PhD in chemistry from MIUN, her academic background is organocatalytic modification of cellulose and nanocellulose. Her study focuses mainly on preparing hydrophobic biobased materials through green chemistry. She aims to develop eco-friendly and industrial relevant technology for fabrication of hydrophobic biobased products. The preparation of organocatalytic aqueous formulation (OAF) for fabrication of hydrophobic biobased product has been patented. Rana received the Young Researcher's Award 2023 from Sweden for her research into hydrophobic materials of cellulose and nanocellulose.

Use of Polymeric Compounds to Enhance the Biological Activities

Koji Matsuoka*

^a Division of Material Science, Graduate School of Science and Engineering,

^b Medical Innovation Research Unit (MiU), Advanced Institute of Innovative Technology (AIIT),& c Health Sciences and Technology Research Area, Strategic Research Center, Saitama University, Sakura, Saitama, Japan

Abstract:

Glycoproteins, glycolipids, and proteoglycans are known as glycoconjugates and these are generally existing on cell surfaces. In biological events, the glycoconjugates play roles not only as carriers of information in cell-cell interactions but as markers of cellular differentiation, aging, malignant alteration, and so on. The oligosaccharide chains of glycoconjugates are, therefore, the third chains of biomacromolecules next to nucleic acids and proteins. Since the saccharide chains have highly complex structures, functions of the glycoconjugates were not completely investigated. Since affinity of a monomeric saccharide chain against the appropriate protein, such as a carbohydrate-binding protein, a lectin and an enzyme, is not so high, multivalent-type sugar substrates were applied in order to enhance the binding affinity, which is so-called "sugar clustering effect". 1) The clustering effect has been expanded to other bioactive substances. 2) In this presentation, our recent progress on design, synthesis, and biological evaluation of our polymer-type substances will be discussed.

Biography:

Koji Matsuoka is a Professor of Material Science, Graduate School of Science & Engineering, Saitama University (SU), Saitama, Japan. He received a bachelor's degree from Seikei University in 1990 and a Ph.D. from Hokkaido University (with Prof. S.-I. Nishimura) in 1995. He did his postdoctoral research at RIKEN, Saitama, Japan. He joined Department of Functional Materials Science, Faculty of Engineering, Saitama University in 1995 as an assistant professor, and was promoted an associate professor in 2001 and professor in 2011. He has published more than 150 research articles and book chapters in organic chemistry and polymer chemistry field.

Hierarchical Nanostructuring of Biopolymers – Strategies and Applications

Ian A. Nicholls

Linnaeus University, Sweden

Abstract Not available

Production of One-dimensional Organic-inorganic Hybrid Polymer Via the Sol-gel Reaction Of 3-Glycidoxypropylmethyldimethoxysilane on a Liquid-liquid Interface

Kei Toyota*

Panasonic Holdings Corporation, Japan

Abstract:

The sol-gel reaction of epoxy-polymerized 3-glycidoxypropylmethyldimethoxysilane (GMDM) and

3-glycidoxypropyltrimethoxysilane (GTM) has been investigated. The epoxy groups in GMDM and GTM polymerize to construct a poly(ethylene oxide) (PEO) structure chain upon the addition of lithium perchlorate, while their methoxy groups remain unreacted. At the liquid-liquid interface between a toluene solution of these epoxy-polymerized substances and an aqueous sodium hydroxide solution, the sol-gel reaction of the methoxy groups proceeds, resulting in the formation of organic-inorganic hybrid materials. These sol-gel reactions are triggered by the hydrolysis of methoxy groups in contact with the sodium hydroxide (NaOH) solution at the liquid-liquid interface. When the methoxy groups in epoxy-polymerized GTM (EP-GTM) are hydrolyzed to silanol groups, they become hydrophilic enough to diffuse into the NaOH solution. Conversely, the hydrolysis of epoxy-polymerized GMDM (EP-GMDM) does not impart sufficient hydrophilicity for diffusion into the aqueous phase due to the presence of hydrophobic methyl groups on each silicon atom. Condensation between adjacent silanol groups occurs, forming siloxane chains. These siloxane chains bond to the PEO structure via trimethylene methylene ether linkages, resulting in a linear ladder-shaped organic-inorganic hybrid polymer (LHBPC) chain. An elastomer was also observed in the toluene solution. This material had a nanoporous structure formed by the connection of nanoparticles. This nanoporous elastomer has the potential to be employed as a thermal insulator.

Biography:

Kei Toyota, a physical chemist, received his doctoral degree in 2001 from Osaka University (Japan), where his research focused on the reaction of aromatic liquids induced by laser breakdown. He then joined Nitto Denko Co., Ltd. (Japan) in 2001 and worked on developing molding compounds for semiconductors. Dr. Toyota worked as a staff engineer at Panasonic group (Japan) from 2007–2022 on the development of novel resin compounds. Since 2023 he acts there as a senior engineer. His current research interest includes the development of unique organic-inorganic materials.

New Poly(ionic liquid)s with different Alkyl Chains for CO₂ Capture

Anamaria Barrera Bogoya^{1*}, Carole Arnal-Herault¹, Danielle Barth², Fabrice Mutelet², Bouchra Belaïssaoui², Luis Pinilla Monsalve², Philippe Marchal², Yuki Tamura³, Yuki Nakama³, Shigetaka Hayano³, Anne Jonquieres¹

LRGP, France; 3Zeon Corporation R&D Center, Japan

Abstract:

In this work targeting CO₂ capture for limiting climate change, a new family of elastomer poly(ionic liquid)s (PILs) having different alkyl chains was studied. They were synthesized by chemical modification of polyepichlorohydrin (polyECH) obtained by living anionic polymerization. PolyECH was quaternized with different 1-alkylimidazoles (alkyl: methyl, n-butyl, and n-hexyl) followed by anion exchange to obtain PILs with TFSI anions. They were characterized by different NMR techniques, SEC, DSC, rheology, and XRD SAXS/WAXS. Their rubbery character was confirmed by DSC and rheology, which is very particular compared to the other PILs reported in the literature for CO₂ absorption. The decrease in the alkyl-chain length contributed to the increase in the T_g. WAXS analyses showed that the shortest alkyl chain induced strong ionic repulsion between the CO₂-philic IL groups while the longest ones were responsible for their screening. The influence of the alkyl chain on the PIL CO₂ sorption was studied with a magnetic suspension balance at 35°C and CO₂ pressures of 1 – 10 bar. The best results were obtained with PIL having methyl chains, followed by those having n-butyl and n-hexyl chains. Therefore, despite the better polymer chain mobility of the PILs with the longest alkyl chains, the screening of their CO₂-philic IL groups reduced their interactions with the CO₂ molecules and contributed to a strong decrease in their

CO₂ sorption capacities. Finally, the CO₂ sorption of these PILs were modeled with the PC-SAFT equation of state, which opens interesting prospects for conceiving new carbon capture and storage (CCS) facilities.

Biography:

Anamaria Barrera Bogoya started her Bachelor studies in Chemical Engineering at the National University of Colombia. Then, she joined a double degree program at ENSIC – Université de Lorraine in France, where she obtained her Bachelor degree in Process Engineering and her Master's degree in the same field. Since 2022, she is preparing a PhD thesis on the development of new poly(ionic liquid)s for CO₂ capture processes, in collaboration with the Japanese company Zeon and the LCPM laboratory at the University of Lorraine.

Injectable Eggshell-derived Hydroxyapatite-incorporated Fibroin-alginate Composite Hydrogel for Bone Tissue Engineering

Piyachat Chuysinuan^{1*}, Thanyaluck Thanyacharoen¹, Supanna Techasakul¹, Sarute Ummartyotin²

¹ Laboratory of Organic Synthesis, Chulabhorn Research Institute, Bangkok, Thailand

² Department of Materials and Textile Technology, Faculty of Science and Technology, Thammasat University, Pathumtani, Thailand

Abstract:

Sodium alginate and polyvinyl alcohol-based hydrogel composite was successfully prepared by freeze-thaw technique. This technique allowed us to prepare hydrogel without any catalyst. The presence of curcumin particle was loaded due to antioxidant activities enhancement. It was adhered at the hydroxyl group throughout hydrogel network by hydrogen bonding. No significant changes of functional group, crystallinity, and thermal behavior were observed because of less amount of curcumin powder. The porous network was created due to freeze-thaw technique. At the initial stage, the swelling characteristic occurred. Water molecule was penetrated into porous network. The role of curcumin particle significantly offered antioxidant activity as reported by DPPH assay, ABTS assay, and FRAP assay. Therefore, as prepared curcumin loaded into sodium alginate and polyvinyl alcohol-based hydrogel composite has the potential for applications such as drug delivery system and nutraceutical food as well as horticulture.

Biography:

Piyachat Chuysinuan has been working as a Research Scientist at laboratory of Organic Synthesis, Chulabhorn Research Institute, Thailand in April 2012. She completed her Ph.D. in Polymer Sciences from The Petroleum and Petrochemical College, Chulalongkorn University, Thailand Development and Promotion of Science and Technology Talents Project Scholarship. Her areas of specialty and research interests include electrostatic spinning of polymers, wound dressings and cell/tissue scaffolding materials for biomedical applications.

Structure and Properties of Pla/Mevoh-Clay Nanocomposite Processed through Candy-floss Spinning and Extrusion

Rathanawan Magaraphan^{1-2*} and Nirmala Devi¹

¹The Petroleum and Petrochemical College, Chulalongkorn University, Thailand

²Center of Excellence in Green Materials for Industrial Applications, Faculty of Science, Chulalongkorn University, Thailand

Abstract:

This work aimed to study the improvement in water transmission through PLA films that is modified by high water and oxygen permeability material like ethylene (vinyl alcohol) (EVOH) and increased physical barrier by clay. In addition, an improvement for its toughness was also included. So the flexible ethylene (vinyl acetate) (EVA) was modified via alcoholysis using alkaline catalyst to obtain ethylene (vinyl alcohol) (mEVOH) which was confirmed by FTIR and XRD. This mEVOH was blended with PLA and PLA-clay masterbatch to composition of 9:1 PLA:mEVOH and 2 wt% clay. It was found that crystallinity of the blend and the nanocomposites were quite low about 2-3% by DSC and DMA results revealed their T_g about 5°C lower than that of PLA. The water vapor permeability (WVP) value of 9:1 PLA-mEVOH was reduced from that of pure PLA by 40% with good toughness improvement by 30%. Incorporation only small amount of PLA-clay 20 wt% masterbatch to achieve 2 wt% clay in 9:1 PLA-mEVOH blend using twin screw mixing, the polymer nanocomposite structure by XRD and TEM showed partial clay intercalation rendering reduction of WVP by 48%. Its toughness was still good; however, elongation was reduced while tensile strength was increased. Employing candy floss spinning to the PLA-clay 20 wt% master batch before preparing 2 wt% clay in PLA-mEVOH blend is to apply high shear force for getting mainly exfoliated structure of clay in the polymer clay nanocomposite. The WVP value was further reduced by 52% and its toughness was enhanced by 1.5 time.

Biography:

Rathanawan Magaraphan graduated from University of Akron, USA in 1996 for PhD in polymer Science and MS. in Eng. (Engineering Management); 1993 for MS in Eng. (Polymer Engineering). She got BS in Chemical Technology in 1988 from faculty of Science, Chulalongkorn University, Bangkok Thailand. Her research interest was in the area of polymer clay nanocomposites, rubber and latex technology, biopolymers and bioplastics. Currently she also works on rubber/plastic recycle (devulcanization) and application in new energy.

Mechanical Performance of 3D Printed Fiber-reinforced Polymer Composites

Farzaneh Omidvarnia¹, Ali Sarhadi^{2*}

Department of Wind and Energy Systems, Technical University of Denmark (DTU), Risø Campus, Frederiksborgvej Roskilde, Denmark

Abstract:

3D printing of Continuous Fiber Reinforced Polymer Composites (CFRPCs) offers great potential for manufacturing high-performance composite structures utilized in several industries. CFRPCs' mechanical performance is crucial for their industrial applications. This study aims to examine the mechanical properties of 3D printed glass fiber-nylon composite specimens. Glass fiber-nylon dogbone specimens with different designs of the gripping areas are 3D printed to consider the effect of the gripping design on the following mechanical test results. Dogbone specimens are manufactured using two different procedures: a) Directly 3D printing the final geometry b) 3D printing a plate and then cutting out the final geometry of the dogbone specimens. Micrographs of the specimens' cross-sections are carried out to analyze their microstructure and quantify their polymer, fiber, and porosity phases. Mechanical stiffness and strength of directly printed and cut-

out specimens are quantified using mechanical tensile tests and the results are compared for two specimen types. The results show that the cut-out specimens show higher stiffness, but lower tensile strength compared to the one-step directly printed ones. This study provides insights into the manufacturing quality, and mechanical properties of 3D printed CFRPCs, facilitating their application in high-performance load-bearing structures.

Biography:

Ali Sarhadi has expertise in robotic 3D printing of polymer fiber composites and multi-physics modeling of composite manufacturing processes including polymer composite 3D printing. He has managed several national and EU projects on composite 3D printing, metal arc welding, and corrosion protection of offshore wind support structures. He teaches a course on the manufacturing of advanced composite materials at DTU wind energy department. He is currently supervising several Postdoc and PhD students on polymer composite 3D printing, thermo-mechanical modeling of arc and laser welding of cast irons, and optimization of corrosion protection systems for wind turbine support structures

Controlled Valence Multilobe Particles & Routes to Robust Particle-particle Linking During Self-assembly, Post-3D-printing

John Tsavalas,

University of New Hampshire, Durham, NH

Abstract Not available

Conducting Polymer Sensors for Food Processing and Digestion Monitoring

Jianyong Ouyang

Department of Materials Science & Engineering, National University of Singapore, Singapore

Abstract:

It is of significance to monitor the processing of starch-based foods since they are very popular in the world and their quality strongly depends on the processing conditions. For example, wheat flour rich in starch is often processed through the fermentation and bakery or steaming into bread, and the food quality is strongly affected by the conditions during these processes. Although starch-based food has been popular for a very long history, there is no easily available technology to find the optimal processing time. Starch-based food can experience notable volume expansion during fermentation and steaming or bakery. We develop strain sensors by using poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS), which is a conducting polymer and biocompatible, to effectively monitor the fermentation, steaming and storage of starch-based food. I will also present our recent research works on monitoring the gastric digestion of protein in situ by using PEDOT:PSS. Monitoring the gastric digestive function is important for the diagnosis of gastric disorders and drug development. However, there is no report on the in situ and real-time monitoring of digestive functions. Our work is the first time to demonstrate in situ and continuously monitor the digestion. The signals can be used to understand digestion function, and they can be important for the development of digestive drugs.

Biography:

Jianyong Ouyang received his PhD, master and bachelor degrees from the Institute for Molecular Science in Japan, the Institute of Chemistry of the Chinese Academy of Science, and the Tsinghua University in Beijing, respectively. His research interests include flexible electronics and energy materials and devices. He invented the first polymer-nanoparticle resistive memory, the first hybrid ionic/electronic thermoelectric converter, the first adhesive intrinsically conducting polymers and the first strain sensor for food processing monitoring in the world, and continuously reported world-record conductivities and thermoelectric properties of solution-processable intrinsically conductive polymers and world-record thermoelectric properties of ionic conductors.

Enhancing Cellulose Acetate Films: Impact of Glycerol and Ionic Liquid Plasticisers

Asiya Rezzouq^{1,2*}, Abderrahim Bouftou¹, Doha Belfadil¹, Azzeddine Taoufyk³, Mehdi El Bouchti², Souad Zyade¹, Omar Cherkaoui² and Sanaa Majid¹.

¹ Genie Laboratory of Materials for Environment and Valorization (GeMEV), Ain Chock Faculty of Sciences, Hassan II University, Casablanca, Morocco.

² Laboratory for Research on Textile Materials (REMTEX), Higher School of Textile and Clothing Industries (ESITH), Casablanca, Morocco.

³ Laboratory of Coordination and Analytical Chemistry (LCCA), Department of Chemistry, Faculty of Sciences, Chouaïb Doukkali University, El Jadida, Morocco.

Abstract :

Plastic packaging is widely used, but its pollution is a major environmental problem. Solutions require new sustainable technologies, environmental management, and the use of bio-based polymers as sustainable packaging. Cellulose acetate (CA) is a biobased polymer used in a variety of applications such as the manufacture of plastic films, textiles, and filters. However, it has limitations in terms of thermal stability and rigidity, which necessitates the addition of plasticizers to optimize its use in packaging. Plasticizers are molecules that increase the flexibility of polymers, but their influence on the chemical and physical properties of films (CA) has not been studied in detail. Some studies have focused on mechanical and thermal properties. However, an in-depth analysis is needed to understand the interactions between the additives and the polymer matrix. In this study, the aim is to examine the effect of two types of plasticizers, glycerol (a conventional plasticizer) and an ionic liquid, on the transparency, mechanical, thermal and barrier properties of cellulose acetate (CA) films prepared by the solution-casting method. Various analytical techniques were used to characterize these films, including infrared spectroscopy (FT-IR), X-ray diffraction (XRD), thermogravimetric analysis (TGA), water vapor permeability (WVP), oxygen permeability, scanning electron microscopy (SEM), opacity, transmission analysis and mechanical tests.

Keywords: cellulose acetate, plasticizers, biopolymers, ionic liquid, glycerol.

Biography:

Meet Asiya REZZOUQ, a dedicated PhD student at Hassan II University and the School of Textile and Clothing Industries in Morocco, is passionate about developing innovative biomaterials, derived from textile waste and biomass, for a variety of applications

Insights Into the Behaviors of Polymer-based Structural Solutions in Lightweighting of Transportation Systems

Anindya Deb^{1*}

¹ Indian Institute of Science, Bangalore, India *

Abstract:

Without compromising with customer satisfaction and engineering functionalities, vehicle body structures have to be as lightweight as possible to meet the ever-increasing demands of fuel economy and stringent emission standards for conventional combustion engine vehicles, and mileage targets for battery- and fuel cell-powered electric vehicles. Various forms of reinforced polymers are assuming increasingly prominent roles in contributing towards targets of vehicle weight reduction. Predominantly plastic-based interior trims in vehicles are not only a robust means of saving weight and enhancing aesthetic appeal as well as ergonomic performance, but also often play the not-so-obvious but vital roles of occupant safety countermeasures. It is shown in the present exposition with the aid of test data and CAE (Computer-Aided Engineering), that an A-pillar trim in a car, which is frequently made of a thermoplastic such as polypropylene, can be converted into a more effective head impact safety countermeasure for meeting the US FMVSS-201 safety standard by reinforcing the same with nanofillers, with a potential for further weight reduction. Additionally, to make fuel cell-based electric vehicles, often looked upon as the future of e-mobility, as viable, lightweight compressed-hydrogen storage tanks are necessary. For advanced on-board Type IV storage tanks, the crucial function of a HDPE (high density polyethylene)-based liner for inhibiting hydrogen permeation combined with a high-strength filament-wound fiber-reinforced polymer composite wrap-up is discussed by providing insights into the structural behaviors of the unique lightweight hybrid shell design for burst pressure resistance, and projectile as well as blunt impact failure prevention.

Biography:

Anindya Deb is a Professor at the Department of Design and Manufacturing, Indian Institute of Science, Bangalore. He previously worked with organizations such as Ford Motor Company (Michigan), SDRC (Ohio) and Tata Motors (Jamshedpur, India). His research encompasses diverse areas such as automotive safety design, impact testing and simulation, lightweight materials, electric vehicles, and human body modeling especially in the contexts of crash injury protection and design of medical implants. He has published extensively in specialized engineering journals and conference proceedings. He has obtained four patents and a design registration. He is a Fellow of INAE, and an SAE Fellow.

Biologically Inspired Mechanical Reinforcement of Plastic Bonded Explosives

Matthew J. Herman^{1 *}, John D. Yeager², Erik Watkins³

¹ Los Alamos National Laboratory, USA; ² University of Dayton Eglin Airforce Base, USA; ³ Oak Ridge National Laboratory, USA

Abstract:

Technological advancement is often inspired by nature, promoting scientist and engineers to continually attempt to develop new material systems based on materials found in nature. To strongly bind themselves to a variety of marine surfaces, mussels produce a strong adhesive protein

that is high in dopamine chemical unit concentration. Dopamine is rich in catechol groups at the interfaces, which act as adhesion promoters. Plastic-bonded explosives (PBX) are polymer matrix composites that are highly loaded with micron-scale explosive crystals. A limiting mechanical factor in a PBX is the interface between the polymer binder system and the crystalline explosive. Synthetic dopamine, capable of undergoing self-polymerization under ambient conditions and becoming polydopamine (PDA), has been demonstrated to form controllable nanometer thickness films which has been shown promote the adhesion between the filler and binder system. These films are thought to form a core-shell architecture consisting of a rigid polymer shell over the substrate. PDA film structure and growth must be better understood before it can be applied in general use with high explosive (HE) materials. Neutron reflectometry (NR), performed on the Asterix beamline at the Los Alamos Neutron Science Center, has been employed to demonstrate the controllable nature of PDA film growth and the film's structure. From the NR experiments a material model PDA was constructed to fully explain the structure of PDA and how its controlled growth can be used to modify surface structure and therefor adhesion. Effects of PDA on an inert high fidelity surrogate PBX will be presented.

Biography:

Matthew Herman, a staff scientist at the Los Alamos National Laboratory, is focused on the continual improvement of materials science through innovative research. He holds a B.S in Plastics and Composites Engineering (Western Washington University), a M.S. in Polymer Chemistry (University of Oregon), and a Ph.D. in Materials Engineering from The New Mexico Institute of Mining and Technology. He has been at LANL for ten years and has performed a wide variety of research spanning from materials development for inertial confined fusion fuel capsules to interfacial modification of plastic bonded explosives.

The Application of Activated Carbon in Extracting and Separating Methylene Blue, Alongside Acid Yellow 61, is Facilitated Through the Use of An Inclusion Polymer Membrane

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² Polymers, Biopolymers, Surfaces Laboratory (PBS), CNRS UMR 6270, Faculty of Sciences and Technology, F-76821 Mont-Saint-Aignan, France.

³ ResearchLaboratory on Textile Materials (REMTEX), ESITH Casablanca, Maroc.

Abstract:

In our surroundings, color permeates various aspects of our lives, from attire and food to cosmetics and medications. However, the majority of dyes employed present considerable challenges due to their environmental harm and resistance to breaking down. Notably, methylene blue and acid yellow 61, commonly utilized in dyeing materials like cotton, wood, and silk, fall into this category. Fortunately, there have been advancements in addressing these pollutants, with membrane processes emerging as a noteworthy solution. These methods are lauded for their minimal energy consumption, operational simplicity, and effectiveness in separating components. Additionally, adsorption on activated carbon, a widely adopted technique, complements these processes, particularly excelling in extracting organic compounds from water due to its significant specific surface area without altering its properties. In our research, we delved into two key aspects.

Firstly, we investigated the potential of selectively extracting methylene blue from a mixture containing acid yellow 61 using a polymer inclusion membrane (PIM) composed of PVA. After analyzing the membrane's morphology and porosity, we applied kinetic and thermodynamic models to ascertain permeability (P), initial flux (J_0), association constant (K_{ass}), and apparent diffusion coefficient (D^*). Following that, we determined activation parameters (activation energy (E_a), enthalpy (ΔH_{ass}), entropy (ΔS_{ass})). Finally, we explored the impact of activated carbon on the processes facilitated by the membrane, revealing a significant enhancement. These findings position the membrane developed in our study as a potentially pivotal player in the realm of membrane separation.

Biography:

Saad Oukkass, a doctoral candidate in his fifth year specializing in chemistry and valorization, focuses his research on membrane technologies. His primary interests lie in affinity membranes and their utilization for the environmentally friendly treatment of pharmaceutical effluents. Saad has actively participated in numerous national and international conferences, showcasing his contributions to the field.

Energy Absorption and Compressive Analysis of 3D Printed Dual-material Auxetic Structures

Zafer Kazanci^{1*} Ross Johnston¹

¹Advanced Composites Research Group, School of Mechanical and Aerospace Engineering, Queen's University Belfast, UK

Abstract:

Auxetic cellular structures enhance certain mechanical properties due to their negative Poisson's ratio under load. This study explores and compares the impact of using multiple materials for auxetic and conventional lattice structures. For each geometry, a single-material PLA structure and two dual-material structures, namely PLA-Nylon and PLA-Thermoplastic Polyurethane (TPU) are tested. A numerical model was developed to simulate these complex multi-material cellular geometries under quasi-static loading. The numerical model is validated with experimental testing for both PLA and PLA-TPU. The study concluded that for applications requiring single loading cycles, such as crashworthy structures, single-material structures performed best by absorbing the most energy. However, for multiple loading cycles, multi-material structures were more effective due to elastic buckling, compared to plastic buckling in single-material structures.

Biography:

Zafer Kazanci is a Senior Lecturer and Aerospace Engineering Programme Director at Queen's University Belfast, UK, where he also leads the Advanced Composites Research Group (ACRG). His research focuses on the dynamic behavior of composite structures, numerical modelling, mechanical metamaterials, additive manufacturing and crashworthiness.

Significantly Boosted Photoelectrochemical Water Splitting performance by Plasmonic Enhanced Semiconducting Oxide@MOF Composite Photoelectrodes

Professor Fang Xie

Department of Materials and London Centre for Nanotechnology, Imperial College London, UK

Abstract:

A light responsive metal-organic framework (MOF) could potentially play significant role in enhancing photoelectrochemical water splitting performance. Here we present some examples of MOF ZIF-67 and MIL-125 based composite photoelectrodes with boosted device performance and the role of MOFs. The first example is plasmonic enhanced hematite@ZIF-67 photoelectrodes. Hematite as a catalyst for photoelectrochemical water splitting offers huge potential, due to its high chemical stability, great abundance, and low cost. However, the low water oxidation kinetics and poor charge transportation have hindered progress towards the manufacture of practical water splitting devices. To tackle these problems, a visible light responsive MOF ZIF-67, and optimised plasmonic Ag nanorods were incorporated into hematite nanostructures to form a three-component heterojunction photoelectrode. The designed photoanode showed dramatically improved light harvesting in the visible range and enhanced charge transport. A mechanistic investigation allowed the deconvolution of the enhanced performance pathways. First, the Hematite@ZIF-67 core-shell p-n junction enables facile charge carrier transfer between ZIF-67 and hematite. In addition, ZIF-67 also provides active sites for water oxidation and boosts surface oxygen evolution reaction (OER) kinetics. Guided by finite-difference time-domain (FDTD) modelling, Ag nanorods with optimised aspect ratio were incorporated between ZIF-67 and hematite. The Ag nanorods facilitate broadband light absorption and surface charge injection, induced by near-field excitation enhancement and plasmonic resonance energy transfer (PRET) pathways. The design and addition of ZIF-67 and Ag nanorods result in superior performance for a hematite-based photoanode for photoelectrochemical (PEC) water oxidation. Another example based on MIL-125 will also be discussed during my talk.

Biography:

Fang Xie's research is in the area of plasmonic materials with a particular emphasis on the role of plasmonic and nanoscale properties in enhancing devices for healthcare and energy applications. The work from her research group combines numerical modelling, system design and fabrication, and testing and characterisation – carried out correlatively. Building interdisciplinary teams and worldwide collaborations with leading research institutions, she leads an interdisciplinary research group; currently three PDRAs and 12 PhD students working across applied nanomaterials science and engineering. She has a research portfolio of over £12 M from a range of sources.

Mimicking Proprioception: Polyaniline/Hydrogel Hybrid Systems as Self sensing Macromolecular Motors

Yahya A. Ismail^{1*}, Lijin Rajan¹, Madari P.Sidheekha¹, Aranhi K. Shabeeba,¹ and Toribio F. Otero²

{For Ex: ¹Advanced Materials Research Center, Department of Chemistry, University of Calicut, Kerala-India; ¹Group for Electrochemistry, Intelligent Materials and Devices (GEMDI), Universidad Politécnica de Cartagena, C/ Carlos III, s/n, Cartagena, , Spain

Abstract:

For the last several decades, the scientific community has been trying to develop proprioceptive devices capable of sensing their surroundings by themselves. The best way to design such motors is to get an insight from natural muscles and understand the biological functions by realizing that they are comprised of macro molecular motors and involves electrochemical reaction. Through exploiting their unique electrochemical reactions conducting polymers (CPs) have the potential

to self-sense their surrounding without the need of any additional connectivity which makes CPs capable of closely mimicking natural muscles. While working, the composition of CPs changes under electrochemical reaction control, and can function as multi-step macromolecular motors through driving the polymer chain reactions. We present the results from Polyaniline/hydrogel hybrid films and microfibers that are considered as model materials of the biological muscles in order to check how the reaction involving those macro-molecular machines adapts to, respond to and senses the working thermal, chemical or electrical conditions: the reaction self-awareness. The involved events – electric pulse, polymer chain conformational movements, ions and composition changes etc. mimic similar events in biological cells. The electrical energy and electrical charge are proved to be the sensing parameters. This opens an unexplored world of research for developing biomimetic polymeric sensing motors or proprioceptive devices (artificial muscles, super capacitors, batteries, smart windows, smart membranes, drug delivery, neuron interface etc.). We argue that any electrochemical device based on polyaniline reactions will be multifunctional - one actuator and several sensors working simultaneously- with only two connecting wires.

Biography:

Yahya is currently a faculty member in the Department of Chemistry, University of Calicut, India. He earned his PhD in Chemistry for his research on conducting polymers from AMU, Aligarh, India. He was awarded the CRI fellowship, leading to a postdoctoral tenure at the National Center for Bio-artificial Muscles, Hanyang University, South Korea. His current research is centered on biomimetic properties of conducting polymer-based artificial muscles and sensors, supercapacitors and structural electrochemistry. His academic journey includes roles such as Reader in Chemistry at the University of Calicut since 2005. He served as the Head of Chemistry Department at the University of Nizwa, Oman, and subsequently as Head of the Basic Science Department and Chairperson of the University Research Council at Asharqiyah University, Oman, from 2008 to 2016 and as a Visiting Research Professor at the Center for Electrochemistry and Intelligent Polymers, Technical University of Cartagena, Spain. Returning to India, he took on the role of Head of the Department of Chemistry, University of Calicut from 2019 to 2023.

Mixed Matrix Membranes Based on Polyvinylidene Fluoride (Pvdf)/Nanoclay Composites: Structure-properties-performance Relationship

Rund Abu-Zurayk

The University of Jordan, Jordan

Abstract:

The objective of this study was to examine the effect of two types of nanoclay composites (Ag-Nanoclay and ZnO-Nanoclay) at different loading percentages (0, 1, and 3wt%) on the properties and performance of mixed matrix membranes made of Polyvinylidene fluoride (PVDF)/Nanoclay composites. Nanoclay composites were synthesized using green methods, characterized, and embedded into PVDF matrices using a solution casting process to prepare a set of membranes. The prepared mixed matrix membranes were subjected to various analyses using advanced techniques such as X-ray diffraction (XRD), Scanning Electron Microscope (SEM), Atomic Force Microscopy (AFM), and contact angle measurements. In addition, tensile properties testing, antibacterial properties testing, and pure water flux testing using a dead-end cell were also carried out.

The study findings indicate that both types of nanoclay composites positively impact the properties and performance of PVDF membranes. The incorporation of nanoclays composites into PVDF

membranes significantly enhances their mechanical strength, antifouling properties, and water flux rates. However, the study results suggest that ZnO-Nanoclay composites outperform Ag-Nanoclay composites. The study further investigates the relationship between the structure, properties, and performance of the mixed matrix membranes. As such, this study provides valuable insights into developing mixed matrix membranes with improved properties and performance by integrating nanoclay composites.

Biography:

Rund Abu-Zurayk holds a Ph.D. in Mechanical Engineering from Queen's University Belfast (UK) and is an Associate Researcher of Materials Engineering at Hamdi Mango Center for Scientific Research (HMCSR). Previously, she was the Director of the Nanotechnology Center at The University of Jordan. Dr. Abu-Zurayk's research interests lie in water and wastewater treatment, specializing in photocatalytic degradation, adsorption, and polymeric membrane filtration. Additionally, she focuses on the processing and characterizing of polymer nanocomposites and their applications. Dr. Abu-Zurayk has over 50 published articles in international journals and conference proceedings, demonstrating her professional expertise.

Hybrid Combination and Characterization of Pla/ Peg 4000 Nanofiber Prepared with the Sbs Method and Calf Leather for the Improvement and Development of the Material Structure of Percussion Instruments Belonging to Traditional Music Culture

Çağatay GÜNGÖR¹, Tuğba GÜNGÖR ERTUĞRAL^{2*}

¹ Interdisciplinary Cultural Heritage Management, Graduate Education Institute, Çanakkale, TURKEY.

² Faculty of applied sciences, Çanakkale Onsekiz Mart University, Çanakkale, TURKEY.

Abstract:

In traditional music culture, percussion instruments are produced from animal leather and the structural properties of leather are important in acoustic quality. Materials with a structure and timbre character suitable for making percussion instruments are calf, camel and goat leathers. The type of animal determines the pattern of knitting in the leather, which contains bundles of collagen fibers. In traditional culture, the moisture retention capacity of the leather, dryness or annealing is done by lubrication, collagen should not shrink and this prevents tearing with brittleness. On the other hand, as the number of molecules of the material increases, the number of displaced molecules increases and the sound wave becomes larger, that is, the number of moving molecules determines the size of the sound wave. Just as calfskin is biodegradable, Poly (lactic acid) (PLA) and Poly(ethylene glycol)(PEG) are also biodegradable materials, and PEG has a hydrophilic structure and can improve the material properties of calfskin. In this study, hydrophilic nanofiber supported hybrid leather material was produced in two stages in order to improve the sound quality and material strength of percussion instruments made of calf leather. Firstly, nanofibers containing 10%, 20%, 30% PEG 4000 respectively, PLA and Polyvinyl acetate (PVAc), were prepared by the solution blow spinning (SBS) method, which is a practical, economical and safe system that does not require high voltage. In the second stage, the hybrid material was produced by pressing nanofiber and 1.58 mm thickness calf leather at 50°C and 120 kg/cm² pressure for 2 min. The molecular structures of the prepared nanofibers and hybrid materials were determined by fourier transform infrared spectroscopy (FTIR), and their thermal properties were determined by differential scanning calorimeter (DSC) and thermogravimetric analysis (TGA). The morphological structures were visualized by scanning electronmicroscopy (SEM). To determine the acoustic properties,

vibration recordings of the nanofiber-leather hybrid material were measured with accelerometer and mechanical properties were measured with tensile, breaking elongation and elasticity modulus tests. Tg temperature showed that the material was heat resistant. SEM images showed that the nanofiber structures exhibited a proportional distribution among the collagen fibers in the hybrid material structure, and there were fewer interfibrillar gaps with a tight fiber texture. FTIR results show the characteristic feature of the material. The average tensile strength was measured at 65.96 N/mm², the elastic modulus at 298.87 N/mm² and the % elasticity at 61.58. Sound signal samples were taken from the leather stretched on a mechanical tensioning device with the help of a microphone and accelerometer. Test result of examining the fundamental frequency and its inherent frequencies during the proportional adaptation, attack, extension and damping process; It has been shown that nanofiber-leather hybrid material sound samples are of relatively higher musical quality than calf leather sound samples.

Machine Learning Optimization for Designing Polymer Based Multilayer Microwave Absorber

Umar Raza

University of Connecticut, Department of Mechanical, Aerospace, and Manufacturing Engineering, Storrs, CT, USA.

Abstract:

Electro-ionic polymer actuators are one of the emerging soft prosthetics and robotics that have showcased highly attractive applications such as artificial muscles and sensors in recent decades. While ongoing efforts are focused on wearable and short-term use biomedical applications, long-term in-vivo operations remain a challenge. In this talk, we investigate the effect of a biocompatible polyisobutylene (PIB) encapsulation, modified to match the elastic modulus with the soft actuator membrane. An electrolyte-filled porous PVDF-co-HFP membrane is sandwiched by active PEDOT: PSS electrodes, followed by the 7 mm thin PIB, which allows the safe underwater actuator operation. The polyisobutylene (PIB) encapsulation demonstrated exceptional water vapor barrier properties, with a WVTR of 610 mg m⁻² day⁻¹, a value approximately 400 times lower than that of its counterparts. Actuation durability tests are designed to measure lifecycles with different encapsulations in different environments, including deionized water, phosphate-buffered saline (PBS), and simulated oceanic conditions. Remarkably, the encapsulated electro-ionic polymer actuator yields durable performance in the PBS biofluid solution over 100,000 cycles, demonstrating their reliability and robustness. Moreover, actuation includes substantial bending displacement against varying voltages (\pm AC & DC) from 0.1-3.5V and frequency ranges from 0.1-10Hz. Such development can lead to chronic working implantable biomedical devices that function reliably within the human body over extended therapeutic timescales.

Biography:

Umar Raza received his BS and MS degrees in Mechanical Engineering from the University of Engineering and Technology (JET), Lahore, Pakistan in 2017 and Korea Advanced Institute of Science and Technology (KAIST), South Korea in 2021 respectively. Now he is a PhD degree candidate in the School of Mechanical, Aerospace and Manufacturing Engineering in UCONN, USA. His current research interests include the development of nanocomposites for the encapsulation of flexible stimuli-responsive soft biocompatible implants.

Monitoring Tomato Sauce Freshness with Biodegradable Labels Containing Thymol and Red Cabbage Anthocyanin

**Abderrahim BOUFTOU^{1*}, Kaoutar AGHMIH¹, Saâd OUKKASS¹, Fatima LAKHDAR²
Said GMOUH³, Sanaa MAJID¹.**

¹ Laboratory of Materials Engineering for the Environment and Valorization (GeMEV), Faculty of Sciences Aïn Chock, Hassan II University of Casablanca, 5366, Casablanca, Morocco.

² Laboratory of Marine Biotechnology and Environment, Faculty of sciences, Chouaib Doukkali University, BP 20, El Jadida 24000, Morocco.

³ Laboratory of Engineering and Materials (LIMAT), Faculty of Sciences ben m'sik, Hassan II University of Casablanca, 7955, Casablanca, Morocco.

Abstract:

Colorimetric labels were developed using cellulose acetate (CA) as a base matrix in the presence of red cabbage anthocyanins (ANT) as a natural colorant and thymol as an active agent. CA/THY/ANT labels with different concentrations of ANT were prepared using the solvent evaporation method, to control food freshness and improve shelf life. The prepared labels were characterized by FTIR, SEM and other techniques. Anthocyanin-rich red cabbage extract confers to the labels a clear, stable and reversible color response in a pH range between 2 and 12, and average antioxidant properties. Thymol was added to the label as natural food preservative. The antibacterial properties against the pathogens tested were improved, without affecting the clear coloration of the labels and their response. To validate the use of these labels as an indicator of tomato sauce freshness, application tests were carried out on natural tomato sauces. The labels showed improved sensitivity to pH changes and a beneficial effect on the acidity and color of tomato sauce during storage. The labels also revealed a reduction in the bacterial load in the tomato sauce during storage at different temperatures and a possibility of reuse, by regeneration of the initial color. These results confirmed the possibility of using these new smart label to control freshness and extend the shelf life of foods.

Biography:

Abderrahim Bouftou is a dedicated researcher and doctoral candidate at the Laboratory of Materials Engineering for Environment and Valorization. His research focuses on the development of active and intelligent food packaging using biopolymers. With a passion for sustainable materials, Dr. Bouftou aims to contribute to the advancement of environmentally friendly packaging solutions. His work delves into the intersection of materials science and food technology, exploring innovative ways to enhance packaging functionalities and reduce environmental impact. Driven by a commitment to creating a more sustainable future, he actively engages in the exploration of biodegradable and bio-based materials for cutting-edge packaging applications. Mr. Abderrahim Bouftou's research reflects his dedication to pushing the boundaries of knowledge in materials engineering and promoting sustainable practices in the field of food packaging.

Preparation and Characterization of Dialdehyde Starch by New Method in Acidic Conditions

Doha BELFADIL^{1*}, Abderrahim BOUFTOU¹, Asiya REZZOUQ¹, Souad ZYADE¹ and Sanaa MAJID¹

¹ Laboratory of Materials Engineering for the Environment and Valorization (GeMEV), Faculty of Sciences Aïn Chock, Hassan II University of Casablanca, 5366, Morocco

Abstract:

The awareness of the potential negative effects of low molecular weight synthetic cross-linking agents stimulated rapid studies on their natural, non-toxic, and safe substitutes. The most promising for biomedical applications in this context, is dialdehyde starch, as it is non-toxic, widely available, biocompatible, and inexpensive.

Dialdehyde starch was produced by a one-step synthesis of acid hydrolysis and oxidation using starch as a raw material and sodium periodate oxidizing agent. The process of oxidation of starch was carried out at different reaction times.

The dialdehyde starch (DAS) was characterized by Fourier transform infrared spectroscopy (FT-IR) to determine its structure. In addition, the percentage of aldehyde content of DAS oxidized was also determined. The results showed that the starch was successfully oxidized and the longer the reaction time, the higher the percentage of aldehydes in the DAS. The mechanical properties of the chitosan films cross-linked with DAS were also investigated.

Biography:

Doha BELFADIL is a Third-year PhD student at the Laboratory of Materials Engineering for the Environment and Valorization (GeMEV), Faculty of Sciences Ain Chock, Hassan II University of Casablanca Morocco. Her current field of research is green chemistry, waste recovery, and biopolymers.

Virtual Presentations

Keynote Presentations

Extending the Possibilities of Polymer Synthesis by the use of Macromolecular Substitution

Harry R. Allcock* and Chen Chen

Department of Chemistry, The Pennsylvania State University, University Park, Pennsylvania

Abstract:

The properties of polymers can be extended considerably by the post-polymerization linkage of organic side groups to an inorganic polymer chain. This provides an access route to several hundred new materials that were not available through the conventional methods of polymer synthesis. Examples will be given of the preparation of phosphazene- polymers with characteristics appropriate for biomedical, aerospace, or electro-optical uses.

Biography:

Harry Allcock is an Atherton Professor of Chemistry and Chemical Engineering at the Pennsylvania State University. Chen is an Associate Research Professor at the Pennsylvania State University.

Perspectives for an 'All-circular' Plastics & Carbon Economy

Reinhold W. Lang,

Johannes Kepler University Linz, Austria

Abstract Not available

Effect of Organoclay Fillers on Durability of Pultruded Composites

Vistasp Karbhari,

University of Texas at Arlington, Arlington, TX

Abstract Not available

Oral Presentations

Molecular Dynamics Simulations of the Adsorption of Lysine-based Oligopeptides on Double-stranded DNA for Gene Delivery Purposes

Giuseppina Raffaini^{1*}, Gabriele Candiani¹

Department of Chemistry, Materials, and Chemical Engineering "Giulio Natta", Politecnico di Milano, Piazza L. Da Vinci 32, 20131 Milano, Italy

Abstract:

The adsorption process of oligopeptides on double-stranded DNA due to intermolecular interactions is an interesting topic in chemical biology and bioengineering. Molecular modeling can help to investigate at the atomistic level the adsorption and possible self-aggregation process of small chiral molecules on the DNA chiral architecture [1,2] such as the adsorption of oligopeptides. In this theoretical work, Molecular Mechanics (MM) and Molecular Dynamics (MD) simulations are performed to study the interaction strength and the conformational properties of three different poly-Lys-based dithio-peptides (Cys-Lys_n-Cys) with n=6,10,14 adsorbed on a double-stranded DNA structure. In the initial adsorption stage, all oligopeptides adsorb onto the DNA surface with favorable interaction energies. We highlight that the two longer oligopeptides follow the double-stranded DNA architecture better and show more favorable interaction energies as compared to the shorter ones. After MD run at room temperature, Cys-Lys₁₄-Cys shows the most favorable interaction energy with the DNA fragment and good adhesion with its main chain, wrapping the outer surface of the DNA structure. Furthermore, the adsorption of two oligopeptide fragments is studied. The adsorption and self aggregation process take place on double-stranded DNA surface, as recently shown in a theoretical study related to chiral [5]-Aza[n]helicenes (n=5,6) [1,2].

Biography:

After classical studies Giuseppina Raffaini received Ms Sc. in Chemistry at the Università degli Studi di Milano, the postgraduate diploma in "Advanced School in Polymer Science Giulio Natta", the Inter university Master in Biomaterials, in 2005 the PhD in Materials Engineering at Politecnico di Milano. In.

An Efficient Delivery System Based on Poly Lactic-co-glycolic Acid for Antioxidant Nanoformulations

Emiliano Laudadio

^a Department of Life and Environmental Science, Polytechnic University of Marche, Ancona, Italy

^b Department of Science and Engineering of Matter, Environment and Urban Planning, Polytechnic University of Marche, Ancona, Italy

Abstract:

The development of antioxidant systems represents an important issue in the biomedical field. In this concern, we developed a biosystem based on the polylactic glycolic acid (PLGA) copolymer, able to convey a lipophilic derivative of Epigallocatechin gallate, which was obtained by adding a saturated aliphatic chain of 18 carbon atoms in the para position of gallic acid (EGCG-C18). To obtain a stable nanoantioxidant, polyvinyl alcohol (PVA) and 1,2-distearoyl-sn-glycero-3-phosphoethanolamine-poly(ethylene glycol) (DSPE-PEG2000) were selected as polymeric and lipid stabilizers, respectively. The physical and antioxidant properties of each system were studied using a combined in-silico and experimental approach. The self-assembly process of the components with the polymer matrix was investigated through atomistic molecular dynamics (MD) simulations, focusing on the insertion of EGCG-C18 within the polymer carrier. Transmission electron microscopy (TEM) and dynamic light scattering (DLS) showed that the nanoparticles (NPs) were smaller in presence of DSPE-PEG2000 than those treated with PVA, and this is due to the formation of an antioxidant lipid shell on the polymer surface, as evidenced by infrared (IR) spectroscopy results. Furthermore, the two different stabilizers strongly influenced the distribution and the orientation of the C18-EGCG in the polymer matrix, since the not polar interactions between C18-EGCG and PLGA oriented the phenolic groups of the polyphenol towards the solvent providing the ability of the NPs to scavenge hydroxyl radicals. Finally, the ability of nanoantioxidants to protect human dermal fibroblasts from cell death induced by oxidative stress was tested, revealing the high protective capacity of these new NPs against oxidative damage.

Biography:

Emiliano Laudadio received the Ph.D. degree (summa cum laude) from the Polytechnic University of Marche (UnivPM), Ancona, Italy, in 2016. Since 2018, he has been a Researcher of Chemical Fundamentals of Technologies with the Department of Materials, Environmental Sciences and Urban Planning, UnivPM. He has co-authored over 70 peer-reviewed articles, a chapter of the book "Frontiers in Computational Chemistry," one patent, and he presented more than 30 conference papers. His main research areas are in-silico atomistic methods based on density functional theory, semiempirical approaches, and Molecular Dynamics simulations on natural and synthetic solid and liquid systems.

Adsorption of Rhodamine B Dye Using N-isopropylacrylamide and Acrylic Acid-based Superporous Hydrogels-adsorption Isotherm and Kinetics Studies

Hemant Mittal^{1,2}, Vaneet Thakur³, Ali Al Alili¹, Saeed M Alhassan²

¹DEWA R&D Center, Dubai Electricity & Water Authority (DEWA), P.O. Box 564, Dubai, United Arab Emirates

⁴Department of Chemical Engineering, Khalifa University of Science and Technology, PO Box 127788, Abu Dhabi, United Arab Emirates

³Department of Applied Sciences, CT Institute of Engineering, Management and Technology, Shahpur Campus Jalandhar, Punjab, India

Abstract:

This research work reports the synthesis of superporous hydrogels (SPHs) using N-isopropyl acrylamide (NIPAM) and acrylic acid (AA) via gas-blowing and foaming technique and their adsorption behavior to remove rhodamine B (RhB) dye from contaminated water. Synthesized polymer was characterized using different characterization techniques like

SEM and FTIR. The adsorption process for the removal of RhB showed pH dependency. The adsorption process followed Langmuir isotherm and pseudo-first-order kinetics models. Furthermore, adsorption thermodynamics studies predicted the spontaneity and endothermic nature of the adsorption process. SPH showed the capability to be used successively for the five cycles of adsorption-desorption without much alteration in the performance. Therefore, the synthesized adsorbent can be efficiently used to purify dye-contaminated wastewater.

Bio-based Plastic Polymers in a Circular Economy

Sung Hee Joo, Ph.D

Department of Engineering & Engineering Technology Metropolitan State University of Denver, Colorado

Abstract:

The manufacturing of conventional chemical polymers has been sustainably increased, leading to a significant pileup of plastic waste—one of the primary contributors to climate change. Bio-based plastic polymers, or biodegradable plastics (bioplastics), represent potential alternatives to conventional plastic polymers; however, few studies have fully investigated the drawbacks of bio-based plastic polymers, including their environmental safety, potential toxicity, biodegradability in a landfill, and cross-contamination in plastic recycling streams. The overarching goal of this paper is to analyze the pros and cons of bio-based plastic polymers and provide suggestions on how to overcome shortcomings of their application from the perspective of a circular economy. One of the emerging challenges facing bioplastics is safe disposal management, because most treatment facilities are not designed to accommodate bioplastic waste, causing cross-contamination from undegraded bioplastic polymers. The best practice in dealing with bio-based plastic wastes is to apply a circular economy concept, where residual and waste streams are explored as valuable raw materials by applying suitable tactics. Such examples include chemical recycling of biomass-driven plastics, closed carbon cycles by harvesting carbon dioxide (CO₂) using photosynthesis, and applying biodegradable polymers to manufacturing consumer products as an alternative to chemicals-based plastic products. Environmental impacts and economic perspectives have often been neglected, yet they need to be included as one of the criteria for further evaluation of exploiting bio-based plastic polymers. This paper focuses on addressing the challenge of applying bioplastic wastes into valuable raw materials, socio-economic and environmental impacts, and recycling strategies.

Development of Jute-Epoxy Biocomposites using the Epoxy/Thiol-Ene Photopolymerization Technique

Ricardo Acosta Ortiz *

Centro de Investigación en Química Aplicada, Saltillo, Mexico

Abstract:

In this study we report the preparation of biobased composites using thiol-modified jute cellulose fiber as reinforcement material, combined with a polyether-polythioether crosslinked matrix. The matrix is derived from an epoxy/thiol-ene photocurable system which includes an epoxy resins

such as the diglycidyl ether of bisphenol A , a curing agent of tetraallyl-functionalized ditertiary amine, a crosslinking agent such as the pentaerythritol tetrakis (3-mercaptopropionate) and dimethoxyphenyl acetophenone as radical photoinitiator. The biocomposite was prepared using the vacuum-assisted resin transfer molding technique (VARTM). Subsequently, the assembled material was photopolymerized using a UV lamp emitting light at 40 mW/cm². The UV chamber maintained a temperature of 85°C during the process, resulting in the formation of the biocomposite within just 30 min under the specified conditions. The material was characterized by Dynamic Mechanical Analysis(DMA), Scanning Electron Microscopy (SEM), Thermogravimetric Analysis (TGA) and mechanical analysis. Comparing the mechanical properties of the biocomposites, we observed that the thiol-functionalized jute fiber exhibited superior performance compared to the non-functionalized fibers. This improvement can be attributed to the enhanced adhesion between the cellulose fiber and the polymeric matrix. Additionally, we investigated the impact of polythioethers content in the crosslinked co-network finding that the biocomposites with lower concentration of flexible polythioethers displayed higher modulus and glass transition temperatures (T_g).

Biography:

Ricardo Acosta Ortiz studied chemistry at the State University of Coahuila in Mexico and graduated as BSc in 1985. He then joined the chemistry research group at the Applied Chemistry Research Center (CIQA). He received a PhD degree at the Manchester Metropolitan University, UK in 1995. After one year postdoctoral fellowship supervised by Prof James Crivello in the Rensselaer Polytechnic Institute in Troy, NY in 2000 he obtained the position of senior researcher at CIQA. He has published more than 60 research articles. His research interests are all types of photopolymerization including the thermal and mechanical analysis of photopolymers.

Controlling Differentiation of Human Adult Stem Cells Using Bioactive Disordered Cues on Polymer Surfaces

Yujie Zhang¹, Murielle Remy¹, Thierry Leste-Lasserre², and Marie-Christine Durrieu^{*1}

¹ CNRS, Bordeaux INP, CBMN, Univ. Bordeaux, UMR 5248, Pessac , France

² INSERM, PUMA, U1215, Neurocentre Magendie, Univ. Bordeaux, Bordeaux, France

Abstract:

The development of bioactive polymer platforms for isolating pure cell populations from adult stem cells holds promise for advancing cellular mechanism understanding, drug testing, and tissue engineering. New methods have emerged to synthesize bioactive micro- and nanostructured materials capable of directing stem cell fate. We introduce a novel method for randomly micro- or nanopatterning any protein/peptide onto scaffolds using spray technology. Our goal is to investigate the impact of arranging bioactive micropatterns (ordered vs. disordered) on polymers to guide human mesenchymal stem cell (hMSC) differentiation. The spray technology efficiently coats materials with controlled, cost-effective bioactive micropatterns in various sizes and shapes. BMP-2 mimetic peptides were covalently grafted, individually or combined with RGD peptides, onto activated polyethylene terephthalate (PET) surfaces. The study explores different peptide distributions and combinations. Four surfaces were homogeneously functionalized with these peptides (M1 to M4 with varying peptide densities) and six surfaces with disordered micro- and nanopatterns of peptides (S0 to S5 with different pattern sizes) were synthesized. Fluorescence microscopy assessed peptide distribution, followed by hMSC culture for 2 weeks, evaluating osteogenic differentiation via immunocytochemistry and RT-qPCR for osteoblast and osteocyte markers. Cells on uniformly peptide-functionalized surfaces exhibited cuboidal forms. Surfaces S4

and S5 showed dendrite-like formations resembling osteocyte morphology. S5 showed significant overexpression of osteoblast (OPN) and osteocyte markers (E11, DMP1, and SOST) compared to control and other micropatterned surfaces. Despite having an equivalent peptide quantity to homogeneously functionalized surfaces, S5's distinct peptide distribution resulted in enhanced osteogenic differentiation of hMSCs.

Biography:

MC Durrieu is an INSERM Research Director at Bordeaux University (France) and Deputy Director of the Health Sciences and Technologies Department. She is a steering committee member of the Institute of Chemistry & Biology of Membranes & Nanoobjects and coordinates the Chemical Biology & Supramolecular Chemistry (CBSC) team, focusing on chemistry, biology, and materials science. She also leads the 3BIO's Research group "BIOdevices, BIOmaterials & BIOengineering." Her research has produced 133 articles. She holds 6 patents and has signed exclusive licenses with Teknimed Co. (2015) and Exostatics (2023), where she is the CSO.

Revisit Model-experiment for High-pressure Solidification of Polymers

Séverine A.E. Boyer^{1*}

CNRS:

Abstract:

The Hoffman & Lauritzen theory [1,2,3] is a theory of polymer crystallization based on explaining the formation of chain-folded crystals in polymers. The kinetic theory calls the concepts of surface nucleation and focuses on the energetics of formation. The rates of stem deposition are competitive, stem nucleation versus surface substrate completion. In this work is proposed to extend the discussion of this theory by including the effect of the pressure. Statement pressure dependences are discussed, i.e. the growth and the transport terms.

An Approach of Functionalizing PTFE/Nafion Compatible Composite Membrane for Proton Exchange Membrane Fuel Cell

Anima B. Bose

Associate Professor

Department of Engineering Technology University of Houston Houston, TX , USA

Abstract:

In recent years, PTFE reinforced composite polymer electrolyte membrane drawn consideration to addressing some of the longstanding issues associated with the SOA membrane for electrical devices and green-hydrogen consumption demand. For enhancing the compatibility of interfacing hydrophilic H⁺ conducting polymer with reinforced layer, PTFE was modified with dopamine (DA)/sulfonated dopamine (SDA) and evaluated. The PEMFC performance of ds-PTFE/Nafion showed a maximum power density of 1670 mW cm⁻² in H₂/O₂ conditions and 614 mW cm⁻² in H₂/air conditions at 70 oC and 100% RH, which were 52.1% and 35.5% higher than those of plain Nafion membrane, and 110% and 36.4% higher than those of the unmodified-PTFE/Nafion membrane under the same testing conditions. The durability of ds-PTFE/Nafion exhibited a significantly higher than that of PTFE/Nafion operated at 0.2 A and 90 oC with 30%RH under the same testing protocol. Collectively, these results indicate that PTFE requires better interfacing correction for boosting the toughness of PEMFC and PEMWE device development.

Cyclodextrin Polymers as Sorbents For Pfas

Pavlina Konopacova¹, Christopher Hobbs¹, Michal Rezanka^{1*}

Department of Nanochemistry, Institute for Nanomaterials, Advanced Technologies and Innovation, Technical University of Liberec, Studentska, Liberec, Czech Republic

Abstract:

Per- and poly-fluoroalkyl substances (PFAS) are compounds which are commonly referred to as “forever chemicals” due to their innate chemical and thermal stability. PFAS are useful in a wide variety of applications. However, due to their stability and frequent use over the past 7 decades, PFAS are recurrently found as widespread contaminants in the environment within waters and soils. The widespread contamination of PFAS is compounded with their intrinsic toxicity and bioaccumulation.

There are numerous strategies currently employed for remediation of PFAS, however, these have many disadvantages including slow or low adsorption kinetics along with low affinities to various shorter-chain PFAS. An auspicious insoluble polymer composed of cyclodextrin (CD) has been proposed to overcome many of these shortcomings.

Cyclodextrins serve as excellent hosts for hydrophobic compounds, enabling efficient trapping of contaminants in water. The presentation will focus on preparation of insoluble cyclodextrin polymers and various cross-linking agents will be evaluated for their efficacy in binding PFAS. The results will find practical application, especially in the operation of wastewater treatment plants and in the quaternary treatment of wastewater.

Biography:

Rezanka earned his PhD in Organic Chemistry from Charles University (Czechia) in 2012, focusing on cyclodextrin derivatives. He continued at the Technical University of Liberec (Czechia) and was on a work internship at the University of Oxford (UK) in 2013/2014. In 2020, he became head of the Department of Nanochemistry at the Technical University of Liberec, specializing in cyclodextrins and materials chemistry. His research is focused to nanomaterials for water treatment, emphasizing cyclodextrin-modified nanomaterials' potential for pollutant degradation and environmental applications.

Glutaraldehyde Treated vs Decellularized Donkey Pericardium as Select Resources to Manufacture Percutaneous Heart Valves

Robert Guidoin, Mark Nutley, Ze Zhang, Lu Wang

Université Laval and Centre de Recherche du CHU, Quebec, Canada, University of Calgary, Calgary, Canada and Donghua University, Shanghai, China

Abstract:

All medical devices, more specifically implants can fail. Patients shall be more and more involved in the decision procedure about the selection of the implant to restore the biofunctionality of a failing organ. The patients cannot be only a processed entity, but a real participant. In the meantime, the clinical staffs must be aware of the legitimate and sometimes unrealistic expectations of their clients. They must offer their patients what is the best to treat their illness. A sound evaluation of the patient cannot be overlooked. In the meantime, clinicians and engineers have to team up to

promote innovative and more efficient implants whereas the exact role of basic research deserve more attention. After implantation, unexpected events are unavoidable. There is a necessity to investigate adverse events, not to blame but prevent their repetition. Alan Murray and Bertil Jacobson's motto: "Primum non nocere" must be given more audience, no one should be harmed while seeking care. The patient safety culture is the way to go. It is achievable through strong leadership, clear policies, data driven improvements, competent and compassionate health professionals, patient centered care.

Every instance of a patient harm is a tragedy and it becomes a double tragedy if steps are not taken to ensure that the same never happen again. More affordable value based healthcare will be delivered without sacrificing quality. However the risks cannot be underestimated with siloed data bases. The data foundation must built to faster the customer awareness and the lethargic adoption of new techniques.

A cardiovascular implant drives high quality patient outcomes, alleviates pain, restores health, expands life and quality of life. Its design must fulfill the needs for the functionality to be replaced. This requires the collaboration between the clinicians who know the needs of the patients and the scientists and engineers who know material science and the biology.

The Regulatory Agencies have set up various approaches to address adverse events. More specifically, the FDA developed a commitment for innovation and safety. However, the bureaucratic approach of the FDA still keeps the implantology in the limbo. As the percutaneous techniques to deploy implants are expanding exponentially for obvious reasons, the importance of organisations such as ECRI cannot be overlooked. But it is not sufficient to develop patient awareness and the role of organisations such as the Patient Safety Movement will continue to expand.

A Coupled ex-situ/in-situ Approach to Investigate Ionomer Membrane Performances and Durability for Fuel Cell Application

Assma El Kaddouri^{*1}, Mylène Robert¹, Meriem Daoudi¹, Guillaume Etienne¹, Jean-Christophe Perrin¹, Jérôme Dillet¹, Kevin Mozet¹, Olivier Lottin¹

¹Université de Lorraine, CNRS, LEMTA, 54000 Nancy

Abstract:

It is well known that the reference ionomer used in low-temperature proton exchange membrane fuel cells (PEMFC) is perfluorosulfonic acid (PFSA). This ionomer has been the subject of numerous studies highlighting its degradation mechanisms [1-7], which over the years has led to improvements in its formulation for better mechanical and chemical resistance. Despite these improvements, the degradation of PFSA membrane is still one of the factors holding back the large-scale deployment of PEMFC. Therefore, it remains important to progress in the understanding of the degradation mechanisms occurring during fuel cell operation, which - despite the considerable amount of work carried out - are not fully understood yet and may be challenged as membrane formulations, membrane/electrode assemblies, and operating conditions evolve.

A coupled in-situ/ex-situ approach dedicated to ionomer membranes for PEMFCs has been developed at Université de Lorraine and LEMTA laboratory, to study their durability, performance and degradation mechanisms. The in-situ approach enables to measure the membrane's performance in fuel cell operation under controlled parameters, and to monitor the performance over the course of targeted Accelerated Stress Test (AST). On the other hand, the membrane is also

characterized by ex-situ approach in order to assess its functional properties, but also to better analyze its degradation mechanisms. Ex-situ degradation consists in studying the membrane alone in an environment mimicking fuel cell environment. This allows either to decouple the stresses on the membrane (chemical and mechanical stress) and/or to study the synergy between them, while setting aside the complexity of the system surrounding the membrane during fuel cell operation.

This approach is presented through the results of several research projects, focusing on PFSA and sPEEK membranes [8-12].

Biography:

Assma EL KADDOURI is associate professor at the University of Lorraine (UL) and at the laboratory of Energy and Applied and Theoretical Mechanics (LEMTA). She holds a PhD in materials science, mechanics and electrochemistry from University of Grenoble (2014). After a post-doctoral position studying the impact of a compressive stress on water sorption and diffusion in ionomer membranes for fuel cells at LEMTA, she obtained an assistant professor position at the UL in 2015. Her current research concerns the study of the morphology, chemical structure, water properties of the membrane and membrane/electrode assemblies (MEA) and the link to performances degradation occurring during fuel operation. Since September 2022, she is the General Chair of International Summer School HYDROGEN NANCY (held each 2years at Nancy – France).

Multifunctional Hydrogels Developed from Natural Resources

Wen Zhong*

University of Manitoba, Winnipeg MB Canada

Abstract:

Hydrogels are highly hydrated, porous, and soft materials with a touch similar to that of the human skin and have therefore attracted extensive interest in the development of advanced materials for wound care, scaffolds for tissue engineering and wearable biosensors. Natural polymers, including proteins and polysaccharides, have been receiving increasing attention recently as sustainable materials for the development of a wide variety of applications. Natural polymers extracted from plants or animal products provide great biocompatibility and biodegradability, which are highly desirable in the biomedical field. However, applications of hydrogels based on natural polymers have often been limited by their mechanical properties and capacity to provide multiple functions. Our recent work has been focused on developing multifunctional hydrogels from natural resources, including nanocellulose, starch and egg white.

Biography:

Wen Zhong obtained her PhD degree in Textile Engineering in Donghua University (China) in 2002 and had her postdoc training at the Department of Biosystems Engineering in the University of California, Davis. She joined the Department of Textile Sciences at the University of Manitoba in 2005 and the Department of Biosystems Engineering in 2015. She has also been affiliated with the Department of Medical Microbiology. Her research expertise is in the areas of biomaterials, nanotechnology and biosensors. She published in high impact journals like Science Advances, ACS Nano, Advanced Materials, and Advanced Functional Materials.

Intracellular Metal Enhanced Fluorescence for Highly Sensitive Cell Analysis Using a Hydrogel-based Microarray

Huiyan Li*

University of Guelph, Canada

Abstract:

Protein quantification in intact cells can provide important information on cellular activities. Immunocytochemistry has been widely used for protein detection from intact cells, but the assay is semi-quantitative, and requires a relatively large amount of cells which is not always available. Flow cytometry is another common method for cellular protein detection. The assay is quantitative, but signal acquisition requires a flow cytometer that suffers from potential clogging and compromised data quality due to cell debris and clumps. Also, a flow cytometric assay typically needs hundreds of thousands to millions of cells and cannot be used for imaging of cellular proteins. In this work, we have developed a highly sensitive and simple-to-implement platform for simultaneous intracellular protein imaging and quantification from a small number of intact cells. We characterized the 3D structure of the cell-containing alginate hydrogel droplets immobilized on a glass slide using a confocal microscope. The images showed that the average height of the droplets were approximately 300 microns, with a diameter of approximately 1500 microns. Further, we compared the size and concentration of the gold nanoparticles for optimal intracellular metal enhanced fluorescence, and found that smaller sizes of gold nanoparticles provided higher fluorescent signals. Using HSP70 protein, we determined the minimum number of cells required.

Biography:

Huiyan Li obtained her B.Eng from Harbin Institute of Technology, China. She then moved to Canada and completed her M.A.Sc at the University of Victoria. She received her PhD in Biomedical Engineering at McGill University. After a postdoc training in UVic-Genome BC Proteomics Center, Dr. Li joined the Biomedical Engineering group as a research fellow at Harvard Medical School – Massachusetts General Hospital. In 2020, Dr. Li joined the University of Guelph and started her research lab. Her research focuses on developing micro- and nano-technologies for the study of health and diseases. Her work has been published in top peer-reviewed journals and has been highlighted in major scientific magazines.

Use of Biopolymers as Candidate Flocculants in Thickeners in Mining Operations using Molecular Simulation Approach

Jeison Romero¹, Nickolas Jimenez¹, Gonzalo R. Quezada^{1*}

¹Escuela de Ingeniería Civil Química, Facultad de Ingeniería, Universidad del Bío-Bío, Concepción 4030000, Chile.

Abstract:

In the present work, molecular dynamics was used to study the use of natural polymers as flocculant. To this end, cellulose, alginate and chitosan polysaccharides were modeled to understand the molecular interaction of the groups that these polymers have with quartz surfaces, the main mineral in copper tailings. The modeling was carried out in Gromacs where the polymer was described by GAFF force field, while the quartz surface was described by CLAYFF. The system consisted of a rectangular box with periodic edges, the volume of that box was about 500 nm³,

where the z-direction is 10 nm long. In this space, the surface was placed as a slab and the polymer immersed in an aqueous solution was placed on it. The results indicate that the highest affinity was observed for cellulose where the mere presence of cellulose hydroxyl groups can generate an adequate interaction with the quartz surface. Then chitosan was the second to show adsorption where the presence of amine groups generates less attraction than hydroxyl groups. Finally, for alginate, the lowest adsorption was shown where its carboxylic groups, having a negative charge, generate repulsion. These results give an insight into how different surface groups of saccharide-like polymers have or do not have an affinity with a quartz surface. Different challenges still need to be taken for the development of flocculants; this is a first work to understand how the adsorption mechanism using naturally occurring polymers could be in the mining industry.

Biography:

Gonzalo R. Quezada is an Academic at Escuela de Ingeniería Civil Química, Universidad del Bío-Bío, Chile. He completed his PhD studies in Engineering Sciences with a major in Chemical Engineering and has been awarded "Initiation into research" at the University of Concepción. He recently led the projects Fondecyt 3200978 and currently 11240299. He has published more than 40 papers in various journals. His teaching disciplines include mining operations and computer tools.

The Analysis of the Transcriptional Profile of *Pseudomonas* LFM046 in Different Culture Conditions for Biopolymers / PHAs Production

Juliana Cardinali-Rezende^{1*}, Caroline Sayuri Yamada¹, Mariana Galvão Ferrarini², José Gregório C. Gomez³, Marie-France Sagot², Alexander Steinbüchel^{4,5}

¹ LGEM- Federal University of ABC, Center for Natural Sciences and Humanities, Brazil

² ERABLE Team, Inria Grenoble Rhône-Alpes, Université de Lyon, Université Lyon, France

³ University of São Paulo, Institute of Biomedical Sciences, Bioproducts Laboratory, Brazil

⁴ Westfälische Wilhelms-Universität Münster, Germany

⁵ Environmental Sciences Department, King Abdulaziz University, Jeddah, Saudi Arabia

Abstract:

The *Pseudomonas* LFM046 have been utilized as biological platform to produce biodegradable polymers such as polyhydroxyalkanoate (PHA). The full genome of this strain was obtained (Cardinali-Rezende et al. 2015 and 2020) and the annotation of their genes were refined to enhance the quality of the genome scale metabolic model that has been constructed. This strain produces a polymer of medium-chain-length 3-hydroxyalkanoates (PHAMCL). The objective of this proposal was to perform the analysis of the transcriptional profile of *Pseudomonas* sp. LFM046 in different culture conditions. The analysis of the transcriptome allowed a qualitative and quantitative evaluation of the expression of the genes involved in the metabolic pathways of glucose and fructose degradation: Pentose-Phosphate pathway, Entner-Doudoroff pathway and Embden-Meyerhof-Parnas pathway. *Pseudomonas* sp. LFM046 growth on fructose slower than on glucose and the PHAMCL produced after 5h of cultivation was twice higher than using glucose. PHA monomer compositions changed during the time of culture. RNAseq was carried out and 75% of cleaned reads were successfully mapped to its genome. The transcriptional profile from this strain has been analysed considering the genes differentially expressed in the different conditions tested. These results will be important to guide the development of new strategies to design the future experiments to improve the efficiency of the conversion of glucose or another carbon sources into PHAMCL.

Biography:

Cardinali-Rezende is a professor at Federal University of ABC in Brazil, coordinating the Laboratory of Genetics and Metabolic Engineering. His research focuses on identifying microorganisms for waste treatment and studying bacterial metabolism to produce bioproducts like polyhydroxyalkanoates - PHAs. She is Biologist, Specialist in Industrial and Environment Microbiology, MSc. and PhD. in Genetics by Federal University of Minas Gerais -UFMG. Part of its doctorate was at Universidad Autónoma de Madrid, Spain. Dr. Cardinali-Rezende was guest researcher at University of Lisbon-Portugal (2015) and at University of Münster, Germany (2017); and Post Doc at University of São Paulo – USP (2014 – 2022).

Origin of Life: tRNA is an Ordered Rna Polymer at the Inception of Life

Zachary Frome Burton^{1*} and Lei Lei²

¹ Department of Biochemistry and Molecular Biology/Michigan State University, MI, USA

² School of Biological Sciences/University of New England, Biddeford, ME, USA

Abstract:

On Planet Earth, the meaning of life is embedded in conserved transfer RNA (tRNA) sequence. Through chemical coevolution, tRNA is the molecule that taught itself to code. About 4 billion years ago, type I and type II tRNAs emerged by a common and known chemical process from RNA repeats and inverted repeats of known sequence. Type II tRNA has a longer variable loop than type I tRNA, and type II tRNA was a processing intermediate to type I tRNA. It was surprising that the initial sequence print for tRNA was so highly ordered and so well conserved. Because tRNAs evolved from ordered RNA precursors, the 3¹ nucleotide minihelix tRNA evolution theorem fully describes type I and type II tRNA evolution to the last nucleotide. By duplication and mutation, tRNAomes (all of the tRNAs of an organism) evolved. The genetic code coevolved with tRNAomes, first proteins, tRNA modification systems, aminoacyl-tRNA synthetases (the enzymes that charge tRNAs with their cognate amino acids) and ribosomes. Once tRNA chemically evolved, it was essentially inevitable that life would emerge. Once the genetic code evolved, life emerged. If life were to begin on another moon or planet, a genetic adapter as good or better than tRNA would have to chemically evolve. A genetic adapter better than tRNA, made of RNA or another chemical, would be difficult to imagine, synthesize or evolve. The evolution of tRNA was solved as a simple coding puzzle

Biography:

Zachary Burton received his Ph.D. from UCLA in 1980, working in the laboratory of Dr. David Eisenberg. Burton did his first postdoc with Dr. Richard Burgess at the University of Wisconsin. Burton's second postdoc was with Dr. Jack Greenblatt at the University of Toronto. Burton was a professor at Michigan State University for 30 years. He has many publications. About the time he retired, Burton determined how tRNA evolved. This was a surprising discovery. From this revelation comes a new understanding of the evolution of aminoacyl-tRNA synthetases, tRNA modifications, the genetic code and the origin of life.

Neutrally Buoyant Ergonomic Segmented Glass-Ceramic Composite Chocobar K4 Diving Suit with Superior Thermal Protection

Emil P Kartalov,

Abstract Not available

Study Concerning Nitrogenated Heterocycles Compounds Anchored to Titanium Dioxide Particles Used as Fillers in Several Polymer Matrices: Thermomechanical Behavior

Javier Vallejo Montesinos^{1*}, Luis Roman Rosas Orta¹, Gustavo Rangel Porras¹, Esthela Ramos Ramírez¹, Ramon Zarraga Nuñez¹, Claudia Martínez Gómez¹ Jorge Alejandro Alegría Torres² and David Contreras López³

¹Departamento de Química, Universidad de Guanajuato, Noria Alta s/n, Guanajuato, Gto., 36050, México.

²Departamento de Farmacia, Universidad de Guanajuato, Noria Alta s/n, Guanajuato, Gto., 36050, México.

³Departamento de Ingeniería Química, Universidad de Guanajuato, Noria Alta s/n, Guanajuato, Gto., 36050, México.

Abstract:

In the present work, we study the effect of anchoring of various nitrogenous heterocycles (phthalimide, indanone, L-proline, and 7-hydroxy-4-methyl-2-oxo-2H-chromene-8-carbaldehyde (4 μ 8C) to titanium dioxide particles, which was used as a filler for polylactic acid and polypropylene matrices. The resulting materials were analyzed regarding their non-isothermal crystallization kinetics and mechanical properties. Considerable improvements were found in terms of crystallization rate and mechanical properties such as elongation percentage, tensile strength, and Young's modulus once the resulting compounds functionalized with 4 μ 8C, indanone, and phthalimide were compared concerning compounds made with unfunctionalized titanium dioxide. Indicating a possible favorable interaction of the movement of the chains (especially polypropylene ones) with the modified surface of these nitrogenous heterocycles

Biography:

Vallejo has a Ph.D. in Polymer chemistry and is currently a Researcher at Universidad de Guanajuato, specializing in organosilicon polymers, surface modification, physical chemistry, and polymer chemistry with skills and expertise in polysiloxanes, alumina, material characterization, physical chemistry, materials, sulfates, polymers, nanomaterials, GPC, polymer composites, functionalization, polymerization, nanocomposites, composites, polymer nanoscience, nanoparticles, surface properties, nanomaterials synthesis, polyethylene and polypropylene.

Starch odification and its characterization

Claudia Romero*

Instituto Politécnico Nacional, Centro de Desarrollo de Productos Bióticos, Departamento de Desarrollo Tecnológico, Yautepec, Morelos, México

Abstract:

Synthetic plastics are used for many purposes because they have great mechanical properties and have a very low water permeability but are not biodegradable. This is causing environmental problems because there are no effective methods to get rid of them. For that reason, researchers

are seeking alternatives for materials that can have similar properties like plastics but that can be environmentally friendly. In nature it can be found raw materials such as proteins, carbohydrates and lipids that can be used to elaborate biodegradable films so they can be used to preserve foods and when its function has ended, they can be disposed without causing pollution. Starch is the commonly used agricultural raw material, since it is a renewable source, inexpensive, widely available, and relatively easy to handle. Waste from the fruit industry such as mango can be used. In addition, using mango kernel to obtain starch can give added value. Extraction methods can modify the properties of the starch, so several methods can be evaluated to check the ones that give better characteristics. Starch is generally sensitive to environmental humidity, and it is necessary to also evaluate some additives to improve their properties. Some additives can change hydrophobicity of the starch or can cause crosslinking. Once the properties of the films are evaluated it could be assigned some use in food preservation.

Biography:

Claudia Romero have a food engineering degree, master's degree in food science and a PhD in food technology. Claudia Romero have been director of several projects from my research center and from CYTED. Claudia Romero have written some articles and chapter books. Claudia Romero have supervised bachelor's, master's, and doctorate students. His research area is the development of biodegradable films, its characterization and the application to preserve fruits and vegetables.

Silver Nanowires in the Xylem/ Phloem of Plants to Improve Electrical Conductivity

Ana Beatriz Morales Cepeda,

Tecnologico Nacional de Mexico, Mexico

Abstract Not available

Extraction and Analysis of Carboxycellulose Nanofibers from Untreated Plant Fibers Using Updated TEMPO-mediated Oxidation

Priyanka Sharma,

Western Michigan University, Kalamazoo, MI

Abstract Not available

Self-Assembling of Xanthan Gum and Vermicompost Tea for Agricultural

Laura Romero-Zeron^{1*}

¹ University of New Brunswick, Canada

Abstract:

The worldwide application of synthetic fertilizers is causing negative effects on the environment and human health. Therefore, there is a renewed interest toward the development and evaluation of organic fertilizers. Vermicompost tea (VCT) is currently gaining more attention as an eco-friendly liquid organic fertilizer. VCT contains micro- and macro-nutrients, hormones, plant enzymes, organic chelating agents, and a microbial consortium that promotes plant growth and sustainability

against pests and diseases. In this work, it was hypothesized that blends of Xanthan Gum (XG) and VCT would result in solutions of improved structural strength. To test this hypothesis, an oscillatory rheological evaluation was conducted, in which XG solutions were prepared in distilled water, tap water, and VCT. The concentrations of XG studied ranged from 0.1 to 0.4 wt%. The effect of the maturity of the VCT on the rheological properties of the XG-VCT solutions was also evaluated. The rheological stability of the XG-VCT solutions was evaluated for a period of 21 days. Phytotoxicity tests were also conducted.

Experimental observations demonstrated that the XG-VCT blends display a stable gel-like rheological performance and self-assembling. It was also observed that self-assembling is directly related to the VCT maturity. Phytotoxicity tests verified the benefits of the XG-VCT blend on seed germination. Therefore, the XG-VCT solutions exhibit superior structural strength compared to the baseline VCT. The improved rheological behavior of the XG-VCT solution allows speculating that these blends would provide a more uniform and effective application directly to the soil or as a foliar application.

Biography:

Laura Romero-Zeron, is a professor in the Chemical Engineering Department at the University of New Brunswick, Fredericton, Canada, since 2004. Her research experience includes remediation of hydrocarbon contaminated soils, selective adsorption of pharmaceutical drugs using biomass, recycling and upcycling of plastic waste, evaluation of biocatalysis to produce biodiesel, recovery and identification of biosurfactants, formulation and rheological evaluation of polymer-surfactant self-assembling systems, evaluation of synthetic and biopolymers functionality, and pyrolysis of biomass waste to produce bio-additives. Romero-Zerón has published more than 71 scientific papers including six book chapters, edited two technical books, and co-authored a technical book.

From Photodegradation and Photopolymerization to Photoinduced Charge Redistribution in Tightly Packed Polymer Models

Dmitri Kilin,

North Dakota State University, Fargo, ND

Abstract Not available

Feasibility Study on the Application of Pectin to Pharmaceutical Additives

Takehisa Hanawa^{1*}, Chihiro Ozawa¹, Chika Iwami¹, Kaoru Hirose¹, Yayoi Kawano^{1,2}

¹Faculty of Pharmaceutical Sciences, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba, Japan.

²Graduate School of Pharmaceutical Sciences, Nagoya City University, 3-1 Tanabe-dori, Mizuho-ku, Nagoya, Japan

Abstract:

To investigate the feasibility of applying pectin as a pharmaceutical additive, we focused on it as an adsorbent to prevent pollinosis; we focused on the two types, low- and high-methoxy pectin, and investigated its properties for application in nasal mucosa-protective preparations. A film adhesion test was performed, and the number of fluorescent microspheres (FMs) adsorbed to the pectin layer was prepared using a hydrophilic polyvinylidene fluoride filter, and mucin was

quantified by fluorescence. High-methoxy pectin (HMP) caught more FMs than low-methoxy pectin (LMP)($p < 0.05$). The quartz crystal microbalance with dissipation monitoring revealed that HMP adhered more to mucin than LMP. The concentration of HMP did not affect adhesiveness. Furthermore, from evaluating the adsorbency of FMs on pectin and mucin, HMP shows higher adsorbency than LMP ($p < 0.05$). From these results, it could be concluded that pectin with an HMP had stronger interactions with mucin than LMP and could be applied to the nasal formulation to prevent pollinosis.

Biography:

Hanawa has been engaged in research and education as a professor in the Faculty of Pharmaceutical Sciences at Tokyo University of Science since 2012. His research area of expertise is formulation engineering, and he is using this expertise to study methodologies for the nanoparticulation of poorly water-soluble pharmaceuticals using a simple method of pulverization. In recent years, he has also focused on hydrogel formulations to develop semi-solid formulations for wound healing.

Innovations in Nanoparticle-containing Gas Separation Membranes

Masafumi Yamato^{1*} and Hiroyoshi Kawakami¹

¹Tokyo Metropolitan University, Japan

Abstract:

In response to the urgent need for greenhouse gas emission reduction, CO₂ separation, utilization, and storage (CCUS) has emerged as a critical solution. However, the high cost of CO₂ separation poses a significant obstacle. To address this challenge, membrane separation employing polymers of intrinsic microporosity (PIM) is gaining traction for its potential cost-effectiveness. Mixed matrix membranes (MMMs) combining organic and inorganic fillers are being actively explored to enhance PIM membrane gas separation properties. Our research focuses on developing non-porous silica nanoparticles modified with organic compounds. These surface-modified nanoparticles are incorporated into PIM-1, yielding MMMs with exceptionally high gas permeability. This innovation holds promise for advancing CO₂ separation technologies, offering a more economical and efficient approach to combating global warming and achieving net-zero emissions targets by 2050.

Biography:

Yamato, Tokyo Metropolitan University graduate of 1992, served as assistant professor there before earning his Tokyo Institute of Technology doctorate in 1998. Specializing in solid-state NMR, WAXD, dielectric relaxation spectroscopy, and thermal analyses for polymer assessment, he's renowned for his work on aromatic polyesters' local motion. Pioneering magnetic science, he's advanced magnetic orientation and position control of diamagnetic materials. Since 2018, his focus shifted to polymer gas separation membranes, successfully developing composite membranes with surface-modified silica nanoparticles, resulting in remarkably high CO₂ permeability.

Metal-like Lustrous Films Based on Organic Oligomers Using Oligo (3-alkoxyselenophene)

Satoru Tsukada*

Department of Materials Science, Graduate School of Engineering, Chiba University, Japan

Abstract:

Traditional metal-like luster paints use metal effect pigments, such as flaky aluminum or zinc powders dispersed in a binder resin solution with colorants. However, these metal flakes pose issues such as corrosion, color migration, increased paint weight, electromagnetic shielding, and environmental pollution. In response, metal-free organic materials exhibiting metal-like lusters have been developed to address these problems. We have developed a gold-like luster film based on oligo(3-methoxythiophene) obtained *via* chemical polymerization of 3-methoxythiophene. Additionally, we synthesized oligo(3-alkoxythiophene) with various substituents and explored their effects on film properties, achieving metallic glossy films with varied color tones.

So far, we have studied only thiophene derivatives. We thought that heterocyclic compounds containing other elements could be used to fabricate metallic glossy films with properties different from those of thiophene derivatives. In this study, we focused on selenophene, a high-period analogue of thiophene. Selenophene, with its smaller HOMO-LUMO gap, larger atomic radius, and higher polarizability compared to thiophene, is expected to exhibit distinct glossy film properties. Our study highlights the potential of selenophene-based materials in developing advanced metallic luster films.

Biography:

Satoru Tsukada was born in Tokyo, Japan, in 1983. He graduated from Saga University in 2007 and earned his Ph.D. from The University of Tokyo in 2012 under the supervision of Prof. Hiroshi Nishihara. He was then appointed as an assistant professor at Tokyo University of Science in 2012 and at Hiroshima University in 2017. Since 2019, he has been an assistant professor at the Graduate School of Engineering at Chiba University, where he joined Prof. Hoshino's group and became a PI in 2023. His current research interest lies in creating metal-like luster materials without metal flakes and developing functional materials using organic synthesis techniques.

Poster Presentations

Surface Modification and Antimicrobial Properties of Cellulose Nanocrystals and its Impact on Crystallization of poly[(R)-3-hydroxybutyrate]

Anil Nalluri,^a Dong Kwon,^b and Nadarajah Vasanthan^{*a}

^aDepartment of Chemistry, Long Island University, Brooklyn, NY

^bDepartment of Biology, Long Island University, Brooklyn, NY

Abstract:

The focus of this study is to modify cellulose nanocrystals (CNC) with antimicrobial properties and examine the effect on polymer film. A novel and simple surface modification of cellulose nanocrystals (CNC) was performed by chloroacetylation and subsequent reaction with tertiary amines to form quaternary ammonium modified CNCs. The acetylation of CNC and quaternary ammonium modified CNCs was confirmed using IR spectroscopy and solid state NMR spectroscopy. The ¹³C NMR spectrum of quaternary ammonium modified CNC (mCNC) showed several additional resonances ranging from 14.5 ppm to 58.0 ppm compared to ¹³C NMR spectrum of pure CNC, suggesting that alkyl chains have been added to the pure CNC. The disc diffusion method confirmed that quaternary ammonium modified CNCs with a chain longer than ten carbons are effective antimicrobial agents against *Staphylococcus aureus* and *E. coli* bacteria. Pure CNC and

quaternary ammonium modified CNCs with an alkyl chain length of ten or less were not able to inhibit bacteria growth. A biodegradable polymer, poly[(R)-3-hydroxybutyrate] (PHB), with CNC and mCNC were prepared by solvent casting. Surface modification of CNC alters the polarity and increases their dispersion in the PHB matrix. It was shown that the addition of CNC resulted in an increase in crystallization rate and total crystallinity of PHB, whereas addition of mCNC showed a decrease in rate of crystallization and crystallinity of PHB due to an increase in dispersion in the PHB matrix. This effect can be attributed to a well-organized network frame of mCNC inhibiting the crystal growth of PHB polymer by plasticizing effect.

Influence Cage Nanofillers, on Fire Hazard, Including Toxicity of Gaseous Destructs, Emitted during Thermal Decomposition of Polyurethane Foam

Przemysław Rybiński^{1*}, Arkadiusz Głowacki¹

Institute of Chemistry, The Jan Kochanowski University of Kielce, Poland;

Abstract:

Currently, in order to develop a new intumescent, flame retardant system for PUR, organic phosphorous compounds, also in synergism action with silsesquioxanes are studied. Compounds based on phosphorus have several advantages such as low toxicity, no releasing of poisonous halogen gases as well as producing low amounts of smoke during combustion. In order improving homogenous as well as insulator properties of carbon layer which is created during thermal decomposition of PUR, phosphorus compounds are join with silsesquioxanes. Silsesquioxanes are polyhedral structures of the general formula $(RSiO_{1.5})_n$, where R is virtually any organic substituent or a hydrogen atom, and n is an integer, in most cases equal to 6, 8, 10 or 12. The silsesquioxane core is regarded the smallest obtainable fragment of crystalline silica. The dimension of the silsesquioxane molecule is within 3 nm. It supposes that crystalline silica may stabilize and increasing homogeneous carbon residue after thermal decomposition of polymer composites.

In our work we studied influence of silsesquioxane fillers, also in a synergistic system, with halogen-free flame retardant compounds, on reducing the fire hazard of polyurethane foams. The obtained test results clearly indicate that the used silsesquioxane compounds, especially with connection with organic phosphorus compound reducing the fire risk expressed in the parameters HRRmax, THR or SDmax. The used flame retardant non-halogen system also reduce the amount of toxic gases emitted during decomposition of PUR, especially NO_x, HCN, NH₃, CO and CO₂.

Biography:

Przemysław Rybiński. University: Jan Kochanowski University of Kielce Poland. Specialist in: Polymer Composites, polymer materials and science. Conducts research related to reducing the fire risk of polymer materials. He studies the thermal stability of polymer composites, reducing their flammability and the toxicity of gaseous decomposition emitted during their thermal decomposition.

Scale up of High Temperature Polyimide and Polyolefin Dielectrics, Film Processing and Testing

Mohak Desai^{1*}, Jiahao Mao², Jing Hao¹, Miko Cakmak², Yang Cao¹, Greg Sotzing¹

¹Institute of Materials Science, ¹University of Connecticut, USA,

Abstract:

Dielectric polymers used in electrical and electronic systems require withstanding high electric field and elevated temperature. o-polyoxachloronorborene (o-POCINB) and polyetherimide (PEI) are two such polymers chosen for scaling up as they have demonstrated excellent dielectric performance at high electric field and high temperature (between 150°C to 200°C) operating range. These polymers have also high enough molecular weight to be able to make entanglements in polymer chains. Polymer samples were used for mechanical testing and solution processing for film casting. The large-scale polymer films would undergo further extensive dielectric testing. The o-POCINB Thermal, mechanical and dielectric properties of these polymers showed the possible melt processibility when synthesized at a larger scale. Scaling up of these polymers would help in understanding cost, evaluation of morphology and structure property relationship with dielectric and thermal properties for high energy density capacitors and other energy storage devices. Replacement of biaxially oriented polypropylene (BOPP) for capacitor application is very important especially at operational temperature above 100°C with potential impacts over broad range of NAVY applications in pulse power and marine electronics.

Biography:

Mohak Desai is a 3rd year PhD student in the Polymer Science program at the University of Connecticut. He also the vice president of SPE-UCONN chapter. He recently won the SPE Connecticut section scholarship award and polymer science pre-doctoral fellowship award. I have worked as a research chemist in Sherwin Williams Paints, Cleveland, Ohio prior to joining my doctoral studies at UCONN. He done master's in polymers and coatings technology from Eastern Michigan University, USA and integrated master's in applied chemistry from S. V. National Institute of Technology, India. His goal is to find a connection between academia and industry to solve real world issues of polymer science at a larger scale.

Extracellular Matrix-derived Biomaterials for Tissue Engineering

Rocio G. Casañas Pimentel¹, Omar A. González Rodríguez¹, Arturo Aguilar Ramírez¹, Nancy C. Ramírez Guerrero¹, Candido Gómez Lara¹, Ivete B. Arellanes Ovando¹, Ningel O. Gama Castañeda¹, Eduardo San Martín¹

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Abstract:

Throughout life, various factors can induce severe damage to human tissues, making their restoration or replacement necessary. Donating tissues from another individual or from the same patient does not solve the problem, making the use of synthetic tissues necessary. Some synthetic polymers provide support for cell growth, but not adequately, since biological tissues are complex systems whose natural support material (the extracellular matrix), more than just mechanical support, is a regulator of cell physiology. The extracellular matrix communicates closely with the cells, molecularly and mechanically, while synthetic polymers cannot exert this effect. Natural extracellular matrices have been obtained for tissue engineering; however, the natural extracellular matrix loses its mechanical properties in its production process. The development of biomaterials composed of extracellular matrix added with polymers seems to provide better opportunities for the development of tissue engineering, since they incorporate the bioactive functionality of the

extracellular matrix, while they can adjust the mechanical properties suitable for different types of tissue by varying the polymer used in the composite.

Biography:

Rocio Casañas is a researcher at the National Polytechnic Institute, in Mexico; she works on developing materials for tissue engineering and drug delivery systems. She is a biotechnology engineer and specialist in nanotechnology applied to biomedical research.

Assessment of the Effect of Different Composites on the Photon and Neutron Shielding Capabilities of Polyurethane Using Geant4 Toolkit

Hanan Akhdar*

Department of Physics, Faculty of Science, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh 11623, Saudi Arabia

Abstract:

Geant4 is a Monte Carlo simulation based toolkit that imitates real life interaction of particles with matter. It has been widely used in investigating the radiation-shielding properties of different materials. Polyurethane (PU) plays an important role in medicine due to its properties. In hospitals, it gets exposed to radiation when patients undergo radiotherapy treatments. In this study, Polyurethane's photon and neutron shielding capabilities will be investigated. The performance of PU and PU doped with different weight fractions (5, 10, 15, 20 and 25 wt.%) of composites (Al, Fe₃O₄, ZnO, TiO₂, Ag and Au) as a shielding material against photons and neutrons using the Monte Carlo-based simulation toolkit Geant4 within a wide range of energies of both photons and neutrons from 10 keV to 20 MeV will be compared.

Biography:

Hanan Fawaz Akhdar, an associate professor at the physics department, College of Science, Imam Mohammad Ibn Saud Islamic University, Riyadh, KSA. Received her PhD in nuclear physics in 2018 from King Saud University. Her research interests include nuclear physics, radiation, detectors and Monte Carlo simulation.

The Use of Pectin as a Biomedical Application Biopolymer

Luísa Rodrigues Molina Dona' ^{1*}, Dayane Batista Tada², Lilia Müller Guerrini³

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Abstract:

Pectin is a biopolymer present in the plant cell wall and commonly extracted from citrus peel. Its application as a biopolymer has been shown potential due to its biodegradability. This work addresses the use of pectin with a 60% degree of esterification in the development of wound healing membranes produced via gel-casting with a 70 mg/mL gel. The membrane exhibited good solubility and gelation capacity in water (4 – 100 mg/mL), high thermal stability (~224°C), high hydrophilicity (contact angle ~38°) and stability at room temperature (~25°C). Additionally, they demonstrated ultraviolet light absorption, good adhesion properties and non-toxicity up to 10 mg/mL (≥70% cell viability in L929 cells). Quercetin, a natural compound with potential regenerative

properties, was incorporated to enhance the membranes' functionality. Quercetin induced cell proliferation at concentrations between 0.5 and 5 $\mu\text{g}/\text{mL}$ in prolonged exposure assays, increasing L929 cell viability by 3–10 %. The concentration of quercetin in an aqueous extract ($\sim 2.5 \mu\text{g}/\text{mL}$) was determined by UV-Vis and, although quercetin has low solubility in water, immobilizing it within the pectin matrix overcame this limitation. Pectin was dissolved directly in the extract at 70 mg/mL to form dry membranes into petri dishes for further analysis. Dissolution studies of the pectin membrane in a one-directional way generated curves that, when modeled using the Korsmeyer-Peppas equation, revealed simultaneous diffusion, relaxation and erosion mechanisms in the initial phase and, at the final phase, the process was dominated by Fickian diffusion, both in the absence and the presence of quercetin.

Biography:

Luísa Rodrigues Molina Dona' is PhD student of the Biotechnology program of Universidade Federal de São Paulo, master on Materials Science and Engineering by the same institution and graduated on Chemical Engineering by Instituto Mauá de Tecnologia. She studied the use of polymers as a pharmaceutical control release agent on her scientific initiation, worked with polyurethanes for different industries sectors and her master's research was focused on vegetal extracts nanoencapsulation with biopolymers to cancer treatment, becoming orientated to the biomedical materials study field.

Polyethylene Oxide – polyvinylidene Fluoride Blends

Mircea Chipara* and **Lydia Morales, Parinaz Amaniabdomalaki, Alexandro Trevino, Karen Lozano, Jefferson Reinoza, Dorina Chipara**

The University of Texas Rio Grande Valley, Edinburg, TX, USA

Abstract:

Blends of polyethylene oxide (PEO) and polyvinylidene fluoride (PVDF) were obtained by dissolving each polymer in an adequate solvent (chloroform, dimethylacetamide). The solutions were homogenized by extended stirring and then mixed. The solvent was removed by vacuum at room temperature. The as-obtained films were hot pressed at about 100 oC. Samples of various weight ratios PEO/PVDF have been obtained. The films were measured by differential scanning calorimetry using a NETZSCH instrument. Each sample was subjected to 3 identical heating/cooling cycles ranging from -75 oC to 200 oC. This preliminary step aimed to remove the potential residual stresses thoroughly. Subsequent measurements at various heating/cooling rates ranging from 5 to 50 oC/min were performed. The research focuses on the melting and crystallization temperatures as a function of heating/cooling rates and composition. Lorentzian-like functions have fitted the as-obtained melting and crystallization peaks. This approach allowed for estimating the width of the melting and crystallization processes. The dependence of the melting and crystallization widths on the heating rate and composition is discussed in detail. Wide Angle X-Ray Scattering data were obtained by using a Bruker Discovery 8 spectrometer. These results provided additional data regarding the crystal structure of PEO-PVDF. Tentatively, the degree of crystallinity was calculated for each component. The research was also focused on the beta phase content in the PEO-PVDF blend. This phase exhibits ferroelectric features.

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