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Tuning dielectric properties of polymer nanocomposites by orientation control of 2-dimensional fillers

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Abstract:

2D materials provide unique opportunities to design and develop next-generation materials and technologies for applications in energy storage, electronics, sensors, separations, and so on. In this work, we discuss the application of 2-D materials for enhancing the capacitive energy density of polymer-2D material-based nanocomposites. We demonstrate using layered 2D materials in the polymer matrices, the dielectric strength, dielectric permittivity, and hence the capacitive energy density can be tuned to develop high energy density capacitors. In particular, we show that using layered 2D Mica materials, the permittivity of the nanocomposites increases by ~100% with filler fraction as low as ~2 wt. % and the dielectric strength increases by ~80%, resulting in a ~400% increase in capacitive energy density. Furthermore, we show the dielectric properties of graphene oxide-based polymer nanocomposites can also be tuned by using nanoplatelet orientation control dictated by confinement effects in thin films. We believe these "orientation controlled" 2D nanofillers in polymer nanocomposites can help design futuristic materials with tunable properties.

*We acknowledge financial support from Kostas Research Institute (KRI) at Northeastern University via US Army DEVCOM Soldier Center Contract W911QY-19-9-0011 and NSF DMR 1901127

Biography:

Alamgir Karim is Dow Chair Professor in William A. Brookshire Department of Chemical Engineering at University of Houston. Alamgir Karim's Ph.D. is in Physics from Northwestern University. After a post-doc in Chemical Engineering at University of Minnesota, he worked at the NIST, Gaithersburg, Maryland, as Group Leader of Polymer Blends, Combinatorial Methods and Nanomaterials, and as Goodyear Chair Professor in Polymer Engineering at University of Akron. His areas of research include polymer surfaces, interfaces and thin films. He is Fellow of the American Physical Society (APS), American Association for the Advancement of Science (AAAS) and Neutron Scattering Society of America (NSSA).

Effects of Thermal Aging and Post-Thermal Aqueous Immersion on Carbon/Epoxy Composites

Vistasp M Karbhari, University of Texas at Arlington, Arlington, TX

Abstract: Not available

Bioelectronic Application of Conducting Polymers

Jianyong Ouyang

Department of Materials Science & Enigneering, National University of Singapore

Abstract:

Intrinsically conducting polymers are very interesting materials and can have application in many areas. Recent progress in conducting polymers demonstrated their new important application in important areas such as wearable bioelectrodes for biopotential monitoring. In particular, poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) has gained great attention due to its solution processability, high conductivity, good biocompatibility, good thermal stability, and high transparency in visible range. However, it has very limited stretchability due to the rigid backbone. Here, I will present several novel methods to significantly enhance the mechanical stretchability of PEDOT:PSS. PEDOT:PSS films with a stretchability of >60% and conductivity of >1000 S/cm are obtained. I will then present some of our works in developing intrinsically conducting polymers as conformal bioelectrodes. It is important to continuously monitor the biopotential of patients. Nevertheless, the biopotential signal is sensitive to the contact between the bioelectrodes and skin surface. Although stretchable electrodes can follow the muscle movement, their contact to skin can be affected and this can generate motion artifacts. Here, we will present our work to develop stretchable and adhesive intrinsically conducting polymers. They can always form conformal contact to skin and thus give rise to high-quality signals even during body movement. They can be thus used for long-term health monitoring.

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.

Multifunctional Hybrid Metal Oxide-Polymer Aerogels From Electrospun Nanofibers

Saad A.Khan*, Tahira Pirzada, Vahid Rahmanian

Department of Chemical & Biomolecular Engineering, North Carolina State University Raleigh, NC, USA

Abstract:

Aerogels are high surface area materials, typically nanostructured in nature (mostly mesoporous with some micropores) and consisting of a highly porous (at least 90%) solid network. Their extremely low bulk density, highly porous nature and large surface area make them ideal candidates for diverse applications ranging from thermal insulation, separation and biomedical to acoustics. However, the time intensive nature of the fabrication process involving complicated steps and general lack of mechanical stability in the traditional aerogels present major challenges for their large scale applications in a cost-effective manner. Recently, incorporation of fibrous network has resulted in production of aerogels with improved properties and functionalities. We present a facile approach to fabricate hybrid sol-gel electrospun silica-cellulose diacetate (CDA) based nanofibers to generate thermally and mechanically stable nanofiber aerogels (NFA). Thermal treatment results in gluing the silica-CDA network strongly together thereby enhancing aerogel mechanical stability and hydrophobicity without compromising their highly porous nature (>98%) and low bulk density (~10 mg.cm-3). XPS and in-situ FTIR studies demonstrate development of strong bonds between silica and CDA network which result in the fabrication of cross-linked structure responsible for their mechanical and thermal robustness and enhanced affinity for oils. Superhydrophobic nature and high oleophilicity of the hybrid aerogels present them as ideal candidates for oil spill cleaning while their flame retardancy and low thermal conductivity can be explored in various application requiring stability at high temperatures. We extend our concept to TiO2-PVP aerogels wherein we exploit the photocatalytic ability of TiO2 to other applications.

Biography:

Saad Khan is INVISTA Professor in the Department of Chemical & Biomolecular Engineering at NC State University. Saad joined NC State after finishing his PhD in Chemical Engineering at MIT, and postdoc at AT&T Bell Laboratories. Saad's research interests spans developing functional materials such as aerogels and biodegradable platforms for improved food security to understanding rheological behavior of soft solids and gels. Khan has supervised over 60 PhD students, several postdocs, has over 250 publications and 17 patents. Khan has won several awards including Fellow of the Society of Rheology and RJR Reynolds Tobacco Award for Research, Teaching & Extension.

Impact of Manufacturing Parameters on the Structure Integrity and Biocompatibility of Polypropylene Vaginal/Hernia Mesh Implant

Ahmed El Ghannam

The University of North Carolina at Charlotte, Charlotte, NC

Abstract: Not available

Re-Designing Plastics for Environmentally Responsible End-of-Life – Biobased and Compostable Polymers

Ramani Narayan

Michigan State University, East Lansing, MI

Abstract: Not available

Surface-Functionalized Polymer Membranes for Ultraselective Carbon Capture

Richard J. Spontak[1*], Marius Sandru[2], Eugenia Sandru[2], Liyuan Deng[3]

[1]North Carolina State University, USA

[2]SINTEF Industry, Norway

[3]Norwegian University of Science & Technology, Norway

Abstract:

Climate change, attributed largely to atmospheric CO2, continues to threaten the global environment and its inhabitants. Numerous efforts have endeavored to design membranes to remove CO2 from both industrial processes involving flue gas and natural gas, and have recently emphasized high permeability rather than high selectivity. What if, however, we focused on selectivity instead? In this work, we explore two approaches starting from different ends of the permeation spectrum that are used to fabricate organic membranes capable of CO2 ultraselectivity (i.e., CO2/N2 selectivity > 100). In one instance, the starting point is a sustainable bionanoparticle, micro/nanofibrillated cellulose, which acts as a barrier to gas permeation. Upon addition of a hydrophilic ionic liquid (IL) to coat and separate MNFC fibrils followed by humidified feed gas, a "gate-opening" mechanism can be activated at intermediate relative humidity levels so that CO2 selectively permeates through the hydrated IL. The selectivity levels achieved for such membranes exceed 300. In the primary case considered here, the starting point is a low-selectivity, ultrapermeable (CO2 permeability > 1000 Barrer) membrane that is surface-functionalized to introduce CO2-philic groups. By integrating these components and two different transport mechanisms together, CO2 concentrates on the CO2-philic membrane surface and then quickly permeates through the high-permeability substrate polymer, yielding ultraselective and ultrapermeable membranes that not only defy, and far exceed, the so-called Robeson upper bound but also remain economically viable and process compatible.

Biography:

Distinguished Professor Richard Spontak received his B.S. and Ph.D. degrees in Chemical Engineering from Penn State and UC Berkeley, respectively. He has >300 peer-reviewed journal publications, and his research has been featured on >30 journal covers and cited over 14,000 times. He has been recognized with the ACS Chemistry of Thermoplastic Elastomers and Roy W. Tess Awards, the IOM3 Colwyn Medal, the SPSJ International Award, and the SPE International Award. A fellow of the American Physical Society and the Royal Society of Chemistry, he is a member of the Norwegian Academy of Technological Sciences.

ORAL

Challenges in the Experimental Characterization and Modelling of Polymers in Industrial Applications

Michael Johlitz* and Alexander Lion

Institute of Mechanics/University of the Bundeswehr Munich, Germany

Abstract:

Polymers and polymer components are highly important in industrial applications such as bearings, seals, bonds, coatings and tyres. Since these components are used in various areas of engineering, it is obvious that they are exposed to different environmental influences such as mechanical stresses, temperature profiles and chemical or biological substances. Therefore, their properties change over time leading to limited operating times. Representative examples are the high-cycle fatigue as a result of the exposure of polymer components to mechanical load collectives, the physical ageing of lacquer coatings, the strain induced crystallization or the thermooxidative ageing of elastomeric bearings in ships and automobiles. In order to estimate the material behaviour of the above mentioned polymers in relation to their field of application, there is a great interest to develop new simulation methods and software tools that are able to consider complex long-term processes in the framework of multiphase continuum mechanics. These models incorporate a number of material parameters which have to be strategically identified through experimental studies. This contribution contains the results of various research projects in the fields of chemical aging, dissipative heating and fatigue strength of elastomers. In addition, the strain-induced crystallization of materials for the tire industry and the thermomechanical calculation of anisotropic seals for the aerospace industry are investigated. First insights into the possibilities of additive manufacturing of elastomers complete the contribution. In addition to the experimental results, this includes meaningful simulations with the developed and adapted models.

Biography:

Michael Johlitz studied civil engineering at the Ruhr-University Bochum, specializing in finite element methods and continuum mechanics. At the end of 2004, he moved to the Chair of Applied Mechanics at Saarland University, where he received his doctorate in 2008 with a thesis in the field of modeling and experimental characterization of bondings. He then went to Munich to work as laboratory head and deputy institute head at the Bundeswehr University, where he habilitated in 2015 in the field of mechanics and wrote a thesis on the ageing and fatigue strength of polymers. He became a Professor for Experimental Mechanics and Material Modelling in 2020. His research interests are in the fields of ageing, fatigue strength, curing and additive manufacturing of polymers.

The Amount of Polymer in a Li-ion Battery

Vincent Battaglia* and Dilni Wellalage

Lawrence Berkeley National Laboratory, USA

Abstract:

The polymer in a Li-ion battery plays a critical role in its performance. To be effective, the polymer must possess a few important properties. It must be able stand up to high oxidation or low reduction potentials. It must be manufacturable in a way that it is able to hold a combination of small (ca. 50 nm) and large (10 mm) particles together for several thousand cycles. And it must adhere the electrode laminate to the current collector (which is usually a foil of aluminum or copper). To maximize the capacity density of the electrode, one would prefer to minimize the amount of binder that is necessary to perform the above functions. In our presentation, we will provide the results of research into determining the effect of battery fabrication procedures and polymer content on electrode properties and battery performance. In our research we discovered that there is a narrow ratio of carbon and binder that is necessary to achieve good adhesion. We also found that for the NCM electrode, if the carbon conductive additive is first mixed with the active material prior to the addition of the binder solution, that one can reduce the binder content to 1.2 % of the dry mass and achieve similar cycleabilty as higher quantities but at a much higher capacity density. Experimental results supporting our conclusions includes adhesion and cohesion testing, SEMs, and electrochemical cycling data.

Biography:

Vince Battaglia heads The Battery Group at LBNL. His research interests are in the fabrication and analysis of battery electrodes. Specifically, his group studies the component ratios, mixing order, and drying temperatures of Li-ion electrodes and evaluates changes to those parameters on the impact of electrode cycling performance. Battaglia has contributed to over 135 publications in refereed journals, holds 10 patents, and has authored 3 textbooks.

Imine-Linked Vitrimers for Circular & Repairable Composites

Philip Taynton*

Mallinda Inc, USA

Abstract:

Imine-linked vitrimers are associative vitrimers with excellent thermomechanical properties, environmental stability, and are simply prepared by condensation polymerization of commercially available precursors. Dynamic covalent bonds such as imines enable post-cure processing, and facile chemical and/or mechanical recycling. Mallinda's imine-linked vitrimers enable mechanical performance on-par with thermoset resins currently used in industries like aerospace and wind energy. The in-mold cure required to produce traditional thermoset composites keeps prices high and production volumes low. Vitrimer composites have the potential to revolutionize composite production by curing the material upstream of part production. The range and flexibility of the imine chemistry allows Mallinda to develop solutions for applications ranging from sporting goods and electronics to wind and automotive.

Biography:

Philip Taynton holds a Ph.D. in chemistry from CU Boulder. His thesis work was recognized for "excellence in graduate polymer research" by the American Chemical Society. His academic publications have now garnered over 1,500 citations. Philip is CEO of Mallinda Inc, which he founded in 2014. He has served as PI on multiple SBIR and collaborative research programs with the NSF, DOE, and USAF. Philip has served as an entrepreneurial lead, and later as an industry mentor in the NSF's I-Corps, and the DOE's Lab-Corps programs. He was a Cyclotron Road (now Activate) Fellow imbedded at Berkely Lab from 2016-2018.

Sustainable Bio-binder from Microalgae for Epoxy-based Composite Materials

Philip Agbo[1], Abhijeet Mali1, Lijun Wang[2], Lifeng Zhang[1]***

[1]Department of Nanoengineering, Joint School of Nanoscience and Nanoengineering, North Carolina Agricultural and Technical State University, Greensboro, NC, USA

[2]Department of Natural Resources and Environmental Design, College of Agriculture and Environmental Sciences, North Carolina Agricultural and Technical State University, Greensboro, NC, USA

Abstract:

As the most prevalent thermoset polymer matrix in the field of polymer composite, epoxy resin and its hardener are mostly from chemical industry and do raise concerns about their sustainability. There is an increasing demand to find ways to make epoxy resin to be somewhat sustainable. Current research on sustainable or green epoxy has limitations such as low mechanical performance and high cost. In this research, we prepared bio-binder from micro-algae through a hydrothermal liquefaction process where microalgae are directly decomposed in water at moderate temperature and pressure and developed composite materials with epoxy resin and bio-binder. Upon our research results, we enabled a game-changing epoxy system and a value-added composite product from sustainable resource. This sustainable development has great potential to remediate environmental concern in polymer material sectors and impact the epoxy composite industry.

Biography:

Lifeng Zhang is currently an associate professor of nanoengineering in North Carolina A&T State University and an adjunct professor in the University of North Carolina at Greensboro. He earned his Ph.D. degree in Fiber and Polymer Science from the University of California at Davis in 2006. Zhang's research interests lie in engineered materials at nanometer scale and sustainable development. Zhang's publications have been cited over 6,400 times by researchers across the world with h-index 45 according to google scholar.

Designing "Green" Hydrogels for Air Moisture Capture

Simeng Li*, Samuel Hernandez, Natalia Salazar

Department of Civil Engineering, California State Polytechnic University, Pomona, California, USA

Abstract:

In the face of deteriorating climate change, water is an increasingly scarce resource for agriculture in arid regions like Southern California. To increase crop's water use efficiency, superabsorbent hydrogels can be applied in agricultural fields as reservoirs for excess irrigation water. In this research, nanocellulose and cellulose derivatives were extracted from crop residues and separated from each other using a stepwise combination of high-intensity ultrasonication, electrospinning, and chemical pretreatment. Nanocellulose-based superabsorbent hydrogels were then synthesized through aqueous solution polymerization and electromagnetic irradiation induced polymerization. Surface properties of the superabsorbent hydrogels were further treated to enhance their hydration properties. Our preliminary results indicate that considerable air moisture was able to be captured by hydrogels when the water vapor density is above 12 g/m3, i.e., at relative humidity > 50% at 77oF and 1 atm under laboratory conditions. Pot studies and field investigations will be carried out using subsurface drip systems to deliver ambient air for its moisture to be captured by and stored in the "green" superabsorbent hydrogels. The success of this study shall provide a sustainable nexus solution to tackle the issues of water scarcity and agricultural waste generation at the same time. The circular flow of carbonaceous materials in agriculture will also contribute to achieving the United Nation's carbon neutrality goal. In addition, air moisture may become an alternative water source with the assistance of superabsorbent hydrogels.

Biography:

Simeng Li is an Assistant Professor in the Department of Civil Engineering at Cal Poly Pomona where he has been a faculty member since Fall 2019. He obtained his Ph.D. and M.Eng. degrees both from the Florida State University, and his B.Eng. degree from the Ocean University of China. His current research interests focus on biomass resources, nutrient management, and waste-to-energy processes. Li has taught a variety of undergraduate and graduate courses; besides, he has developed a funded research program that continually offers experiential learning opportunities to many underrepresented undergraduate and graduate students.

Biobased resins for all-green natural fiber-reinforced polymer composites

Jaehwan Kim*, Bijender Kumar, Dickens O. Agumba, Pooja S. Panicker, Samia Adil and Duc H. Pham

CRC for Nanocellulose Future Composites, Inha University, South Korea

Abstract:

Natural fiber-reinforced polymer (NFRP) composites have gained interest over the past decade because of their low costs, lightweight and environmentally friendly appeal. However, in the NFRP composites, the use of natural fibers is not enough to move the current technological limitations of composites because of their short length, and low mechanical properties. Nanocellulose is known to have high specific strength and elastic modulus. However, its length is too short to form long-fiber. Recently, cellulose nanofibers (CNFs) were formed to a filament by means of wet extrusion. Thus, CNF-based long fiber (CLF) of high elastic modulus should be developed to meet the technological requirement of NFRP composites. This presentation will talk about the story for recently developed nanocellulose-based filament, which has good mechanical strength as well as toughness.

On the other hand, resin for NFRP composites should be also environmentally friendly. Here, we report biobased resin suitable for CLF-reinforced polymer composites. Various lignin-based resins were provided: esterified polyvinyl alcohol-lignin blend with a citric acid cross-linker, esterified polyvinyl alcohol-starch bend with the citric acid and vanillin-based epoxy thermosets. The CLF reinforced composites with the various biobased resins demonstrate comparable thermal stability and higher mechanical properties than the resins.

Biography:

Jaehwan Kim is an Inha Fellow Professor of Inha University. He earned his Ph.D. degree from Penn State University, USA. Kim is a fellow of The Korean Academy of Science and Technology, National Academy of Engineering of Korea, and the Institute of Physics. He is the director of the Creative Research Center for Nanocellulose Future Composites, sponsored by the National Research Foundation of Korea since 2003. His research interests are smart materials and devices, including electroactive polymers, power harvesting, soft actuators, biosensors, flexible electronics, nanocellulose multifunctional composites, smart optics and smart food packaging.

Designing polymer based PIC robot arm with machine learning

Seungmin Ji[1], Kwang Young Jeong[1] and Seong S. Cheon[1]*

[1]Kongju National University, Republic of Korea

Abstract:

PIC (Piecewise Integrated Composite) is a new concept for designing a composite structure with mosaically assigning various types of stacking sequences both for in-plane and through-thickness directions in order to improve mechanical properties of laminated composites. Also, machine learning is a sub-category of artificial intelligence, that refers to the process by which computers develop the ability to continuously learn from and make predictions based on data, then make adjustments without further programming. Moreover, these data, are used for training machine learning models, therefore, they are defined as training data. In the present study, the tapered box beam type PIC robot arm for carrying and transferring wide and thin LCD display was designed based on the machine learning in order to increase structural stiffness. Essential training data were collected from the reference elements, which were intentionally designated elements among finite element models, during preliminary FE analysis. Additionally, triaxiality values for each finite element were obtained for judging the dominant external loading type, such as tensile, compressive or shear. Training and evaluating machine learning model were conducted using the training data and loading types of elements were predicted in case the level accuracy was fulfilled. Three types of stacking sequences, which were to be known as robust toward specific loading types, were mosaically assigned to the PIC robot arm. Henceforth, the bending type FE analysis was carried out and its result claimed that the PIC robot arm showed increased stiffness compared to conventional uni-stacking sequence type composite robot arm

Biography:

Seong S. received his Ph.D. in mechanical engineering from KAIST (Korea Advanced Institute of Science and Technology), as a graduate research fellow and completed a postdoctoral fellowship at the University of Toronto funded by GM Canada. Henceforth, he worked as a senior researcher in Hyundai Motor Company and joined Kongju National University. His lab is characterising static/

dynamic and impact behaviours of materials. Currently, he is focused on designing mechanical structures with the application of artificial intelligence as well as investigating impact behavior of materials with evaluating triaxiality.

Computational Approach to Modeling Epoxy Resin Polymers

Jihan Kim[1*]

[1]KAIST, South Korea

Abstract:

In this talk, I will provide our computational approach to constructing and modeling epoxy resin polymers. We have developed our in-house code to model the self-assembly process of the epoxy resin molecules. After construction, we use molecular simulations to obtain various properties such as density, Tg, and Young's modulus. Finally, we have utilized a machine learning approach to obtain these physical properties without the need for molecular simulations and as such, further expediting the process.

Biography:

Jihan Kim is an associate professor at KAIST (Korea Advanced Institute of Science and Technology). He received his B.S. degree in Electrical Engineering and Computer Science (EECS) at UC Berkeley in 1997 and received his M.S. and Ph.D. degrees in Electrical and Computer Engineering at University of Illinois at Urbana-Champaign in 2004 and 2009, respectively. His current research at KAIST focuses on using molecular simulations and machine learning methods to design novel porous materials for various energy and environmental related applications.

Prediction of the Mechanical Properties of a Nano-Polymer Composite using Micromechanical Finite Element Modeling

Deb[1*] **and G. S. Venkatesh**[2]

[1]Indian Institute of Science, India

[2]Visvesvaraya Technological University, India

Abstract:

Microstructure-based finite element models are applied in the current exposition for studying the mechanical behavior of montmorillonite-filled polypropylene nanocomposites. The model has taken into account the randomness and clustering of nano particles. A methodology has been established and demonstrated by assessing the uncertainty in the modulus of a nanocomposite due to randomness of clustered nano particles. Monte Carlo simulation gave the range of modulus values. Mean values of the modulus obtained by Monte Carlo simulation is in agreement with the experimental results, whereas the moduli obtained from simulations when nanoclay clusters are placed near one of the corners of the cell are inferior to experimental results. These simulated results establish the fact that uniform distribution of particles in a matrix is necessary to get optimal results. The micromechanical modeling approach can be useful for the prediction of stiffness modulus of nanocomposites with different nanoclay contents and therefore for material development.

Biography:

Anindya Deb is currently a Professor at the Centre for Product Design and Manufacturing, Indian Institute of Science (IISc), Bangalore. Prior to joining IISc, he had worked with Ford Motor Company (Dearborn, Michigan, USA), SDRC (Milford, Ohio, USA), Caddtech Productivity (Liverpool, New York, USA), Tata Motors (Jamshedpur, India) and University of Michigan at Dearborn, USA. He has published around 200 papers in journals and conferences, and obtained 5 patents and a design registration. He is in the editorial boards and a reviewer of several international journals. He is a Fellow of INAE (Indian National Academy of Engineering) and an SAE (Society of Automotive Engineers) Fellow.

New Type of Conductive Polymeric Material: Magnesium-Carbon Nanotube (CNT)

(Yong-Jihn Kim[1]*, Mairym Vazquez[2], Oscar Marcelo Suarez[3])

Affiliation:([1]Department of Physics, University of Puerto Rico, Mayaguez, , USA, Cutting-Edge Plastics, Calle Balboa 177, Mayaguez, PR, USA; [2]Material Science and Technology, University of Tennessee, Knoxville, , USA; [3]Deaprtment of Material Science and Technology, University of Puerto Rico, Mayaguez, USA)

Abstract:

A new polymeric material, based on magnesium and carbon with transition metals has been developed. This material is lightweight, strong, and durable. By changing the concentrations of ingredients and oxygen, the electrical properties can be tuned easily from highly metallic to insulating. Powder metallurgy permitted to manufacture this material that registered a melting point near 1,200°C. The bulk samples were characterized via x-ray diffraction, scanning and transmission electron microscopy and electrical measures. The highly conductive samples can be shiny, with nanostructures such as nanotubes, nanoclusters, and nano-onions. The shiny samples have modified nanotube structures that may be called magnesium carbon nanotubes. Possible applications of this lightweight material are Li-ion batteries, electrical power transmission and distribution, and in the transportation industry. This research was funded by NSF SBIR Phase I and IB, no. 1315159 and NSF I-Corps, no. 1614159.

Biography:

Yong-Jihn, PhD in Condensed Matter Physics from Seoul National University, postdocs at Harvard and Purdue. Professor in Physics Department at the University of Puerto Rico, Mayaguez Campus, and CEO of Cutting-Edge Plastics; Mairym, BSE in Industrial Engineering from Caribbean University, PR, and MS in Materials Science & Engineering from University of Puerto Rico Mayagüez, PR. Currently PhD candidate in Materials Science & Engineering from University of Tennessee Knoxville, USA; Oscar, MS and PhD in Metallurgical Engineering, Univ. of Wisconsin-Madison, USA. Professor in Department of Materials Science and Engineering at the University of Puerto Rico Mayaguez, PR.

Reactive Extrusion (REX) Affording Block Copolymers Which Enhance Toughness of Biodegradable PLA

Anthony Keyes[1]*, Shilpa Manjure[1] and Alexander Ermlich[1]

[1]Natur-Tec® a division of Northern Technologies International Corporation, United States

Abstract:

Poly(lactide) (PLA) has received tremendous attention from both academia and industry due to its ability to solve environmental problems related to plastic pollution and persistence. However, PLA's inherent brittleness, poor thermal stability, low elongation at break, and poor melt processing prevent its use in a broader spectrum of applications without modification. Herein, we produced a very tough and higher modulus PLA with addition of a difunctional chain-end functionalized flexible polymer facilitated through our patented reactive extrusion (REX) technique. Transesterification utilizing the ester moieties found within PLA led to linear ABA triblock copolymer architectures where PLA served as the terminal blocks while flexible polymers imparted flexibility and toughening as the middle segment. A 100% increase in the notched Izod impact toughness of PLA was achieved with as little as 0.5-1.5 wt. % of the flexible polymer segment. Blends of homopolymer PLA with the triblock copolymer provided impact toughness as high as 7-16 kJ/m2 when crystalized. These materials exhibited flexural moduli higher than both PS and HIPS, with notched Izod impact toughness higher than PS and closer to HIPS. This exceptional improvement in toughness for > 98 wt. % PLA is unique and expected to increase the scope of molded and thermoformed applications.

Biography:

Anthony Keyes received his Ph.D. in the Fall of 2021 from the University of Houston in Polymer Chemistry for his work in block copolymer synthesis which bridged radical and insertion polymerization techniques. During that time, he served as Vice President for his local SPE Chapter where he received awards in the Flexible Packaging Division of SPE, UH Polymer Center of Excellence award, and was a recipient of NSF-GRFP. He joined Natur-Tec® as their Polymer Formulation Engineer and currently works with compostable polyesters which find uses in blown film and injection molded applications.

Catechol-Based Hypercrosslinked Polymer for Fe Adsorption and Its Application in Fenton Catalysis for Wastewater Treatment

Thanchanok Ratvijitvech[1]*

[1]Mahidol University, Thailand

Abstract:

Hypercrosslinked polymers (HCPs) are porous organic polymeric materials obtained from extensive crosslinking of rigid aromatic monomers. Catechol is an aromatic compound, a benzene derivative with two hydroxyl groups at the ortho position. Catechol moiety is a well-known Fe chelating agent. Thus, a hypercrosslinked polymer using catechol as a monomer (Catechol-HCP) was designed to prepare a solid adsorbent with an enhanced Fe adsorption efficiency. The polymer was easily synthesised via Friedel-Crafts alkylation in a large scale with a good yield. With a strong interaction with Fe, the Catechol-HCP demonstrated the higher Fe adsorption ability compared to the HCPs prepared from toluene, phenol, and hydroquinone monomers. Maximum adsorption capacity of

around 40 mg/g or 94% could be obtained. The material could be reused without the loss of efficiency. The Fe-immobilised Catechol-HCP (Catechol-HCP-Fe) was further utilised in Fenton process as a heterogenous Fe catalyst for dye degradation. The prepared material demonstrated a good catalytic activity for methylene blue (MB) degradation. Complete decolouration of 100 ppm MB could be observed within 25 minutes in a neutral pH and room temperature. The Catechol-HCP-Fe could also be reused. By using abundant and low-cost chemicals and simple preparation methods, together with its good adsorption and catalytic property with reusability, Catechol-HCP is considered as an inexpensive material for metal ion nanoconfinement and heterogenous catalyst in Fenton reaction. Thus, Catechol-HCP is a promising candidate as an efficient and inexpensive novel material for wastewater treatment.

Biography:

Thanchanok Ratvijitvech is a lecturer at the Department of Chemistry, Faculty of Science, Mahidol University. She obtained her PhD in Chemistry, working with porous organic polymers, from the University of Liverpool. Her research focuses on the design and synthesis of porous organic polymers as adsorbents, catalysts, sensors and novel applications.

Drastic Improvement in Physical Properties of Oriented Biodegradable Films

Piyawanee Jariyasakoolroj[1,2]*, Rangrong Yoksan[1,2], Noppadon Kerddonfag[3], and Suwabun Chirachanchai[4]

[1]Department of Packaging and Materials Technology, Kasetsart University, Thailand

[2]Center for Advanced Studies for Agriculture and Food (CASAF), Kasetsart University, Thailand

[3]National Metal and Materials Technology Center, The National Science and Technology Development Agency (NSTDA), Thailand

[4]The Petroleum and Petrochemical College, Chulalongkorn University, Thailand

Abstract:

Currently, plastic waste pollution becomes a serious issue of global concern, and several biodegradable alternatives have been continuously developed to replace non-biodegradable plastics, especially single-use items. Nevertheless, each biodegradable polymer has some intrinsic problems, limiting to use in applications such as brittleness of poly(lactide) (PLA), moisture sensitivity and poor mechanical properties of thermoplastic starch (TPS), low tensile strength and opaqueness of poly(butylene succinate) (PBS) and derivatives copolymers, etc. In the past decades, orientation film technology has been extensively studied and well-developed in industrial-scale manufacturing for both commodity and biodegradable plastics. The specific alignments of polymer chains by uni- or biaxial stretching play the key role to drastically enhance puncture resistance and clarity of the oriented films, including controllable gas permeation and shrinkage. Therefore, understanding oriented microstructures and manipulated physical properties potentially contributes to the performance improvement of biodegradable polymers for a myriad of applications, particularly a mono-material packaging. The presentation includes microstructural analyses and consequent film properties of (i) biaxially oriented PLA/modified TPS blend with reduced water absorption and high toughness, and (ii) machine-direction and biaxially oriented PBS and derivative copolymer with related gas transmission, impact strength, and optical properties.

Biography:

Piyawanee Jariyasakoolroj is an Assistant Professor of Packaging and Materials Technology at Kasetsart University. She received her doctorate in Polymer Science from Chulalongkorn University, Thailand. Her recent publications include poly(lactide)/poultry egg shell biocomposite film fabrication for active compound-releasing sachets (Feb, 2021), and the in situ reactive blend of polylactide and modified thermoplastic starch (May, 2021). Her research interests include bio-based and biodegradable food packaging, oriented biodegradable films, and biocomposites for food and non-food applications.

Novel processes for casein fiber and microparticle formation

Ronald Gebhardt*

Soft Matter Process Engineering, Aachener Verfahrenstechnik, RWTH-Aachen University

Abstract:

We report on the manufacturing processes and structural and functional properties of fibers and microparticles made from casein. Special properties that make this milk protein interesting for applications are biocompatibility, biodegradability, bioresorbability, and easy and inexpensive extraction. In addition to its importance as a food protein, casein is particularly interesting as a basic building block for structures used in applications that benefit human health. We have developed gentle processes that take over much of the original, natural functionality of casein for such materials. In bovine milk, four types of casein (aS1-, aS2-, b- and k-casein) form together with calcium phosphates spherical association colloids with average sizes between 50 to 300 nm. These so-called casein micelles are sterically stabilized by a polymer brush consisting of k-casein. An important step of the fiber production process presented here is the enzymatic removal of this protective layer followed by extrusion through a two-substance nozzle into a calcium-rich coagulation bath (Thill et al. 2021). We show what influence the process parameters have on the structure, swelling behavior and mechanical properties of the fiber. In contrast, for the production of microparticles, we use film drying to compress the k-casein surface layer for stabilization (Schulte et al., 2020). The microparticles can be converted by enzymatically added cross-links to microgels. These remain stable during expansion, and swelling and de-swelling cycles can be performed sequentially without decomposition occurring. Ref: Thill et al. 2021, Colloid & Polymer Science, 15, 201; Schulte et al. 2020, Food Hydrocolloids, 105, 105741

Biography:

Ronald Gebhardt has been professor and head of the Chair of Soft Matter Process Engineering within Aachen Process Engineering at RWTH Aachen University, Germany since the beginning of 2017. He started his scientific career as post-doctoral researcher and later junior scientist at the European Synchrotron Radiation Facility, ESRF in Grenoble, France where he worked on the fine structure of biopolymers. He then moved to the Chair of Food Process Engineering at Technische Universität München, Germany as group leader where he investigated structure-function-process relationships in food. Before moving to Aachen, he was professor at the Friedrich-Alexander University of Erlangen-Nuremberg, Germany in biotechnology

Using reactive extrusion to upgrade polymer mixtures in recycling

Christoph Burgstaller[1,2*]

[1]Transfercenter für Kunststofftechnik GmbH, Austria; 2Fachhochschule Oberösterreich F&E GmbH, Austria.

Abstract:

Recycling materials to safe them from landfilling or polluting the environment is getting more important, due to public opinion and raw material prices as well as supply chain issues. One problem with recycling is, that often some residual inseparable materials contaminate a polymer stream, which then cannot be re-used due to issues with rheological and mechanical properties. Therefore, the aim of this work was to investigate the applicability of reactive extrusion in recycling polyethylene based mixtures with polyamide as the contaminants, as these material combinations are very prominent in packaging. As reactants, we investigated pre-fabricated additives as well as the in-situ generation of such grafted polyethylenes in the recycling process. The materials were characterized for their mechanical properties, as well as their melt flow and their morphology. We found, that it is possible to apply reactive extrusion to improve the properties of the material mixtures, so the negative effects can be widely mitigated, and these materials can be re-used for injection moulding or film extrusion. The only property left to address in future projects is to improve phase dispersion even further to reduce opacity in these films.

Biography:

Christoph Burgstaller is the managing director and head of research at the Transfercenter für Kunststofftechnik (TCKT) in Wels, Austria. He has been involved in application-oriented research in the plastics technology sector since 2004 and completed his doctoral studies in chemical engineering at Johannes Kepler University Linz in 2006. He has now led more than 35 research projects with industry participation, which dealt with various topics such as property modification and recycling. He is the head of TCKT since mid-2015 and in addition is a professor for Plastics Engineering at the Upper Austria University of Applied Sciences since October 2021.

Process Modeling of Composites Using a Multiscale Framework

Marianna Maiaru[1], Gregory M. Odegard[2*], Sagar Shah1, Michael Olaya[1], Sagar U. Patel[2], Prathamesh Deshpande[2], Khatereh Kashmari[2]

[1]University of Massachusetts Lowell, USA; [2]Michigan Technological University, USA

Abstract:

During the processing of high-performance thermoset polymer matrix composites, chemical reactions occur during elevated pressure and temperature cycles, causing the constituent monomers to crosslink and form a molecular network that gradually can sustain stress. As the crosslinking process progresses, the material naturally experiences a gradual shrinkage due to the increase in covalent bonds in the network. Once the cured composite completes the cure cycle and is brought to room temperature, the thermal expansion mismatch of the fibers and matrix cause additional residual stresses to form. These compounded residual stresses can compromise the reliability of the composite material.

Composite process modeling is greatly complicated by the multiscale nature of the composite architecture. At the molecular level, the degree of cure controls the local shrinkage and thermal-mechanical properties of the thermoset. At the microscopic level, the local fiber architecture and packing affect the magnitudes and locations of residual stress concentrations. At the macroscopic level, the layup sequence controls the nature of crack initiation and propagation due to residual stresses.

The goal of this research is use molecular dynamics (MD) and finite element analysis (FEA) to predict the residual stresses in composite laminates and optimize processing parameters to minimize the residual stress. MD is used to predict the polymer shrinkage and thermomechanical properties as a function of degree of cure. This information is used as input into FEA to predict the residual stresses on the microscopic level resulting from the complete cure process. Experimental characterization is used to validate the modeling.

Biography:

Marianna Maiaru is an Associate Professor in the Department of Mechanical Engineering at the University of Massachusetts Lowell. Her expertise is in process modeling of composite materials. She is the recipient of a Young Investigator Program award from the Air Force Office of Scientific Research, and the DEStech award from the American Society for Composites.

ORAL

Molecular design of highly conductive electrolytes for lithium batteries: Experimental validation of computational prediction.

Ishrat Khan*, Xiao-Qian Wang, Duminda Samarakoon, Zuhair Hawsawi, TaVeion Taylor and Hanif Uddin

Departments of Chemistry and Physics, Clark Atlanta University, Atlanta, GA, USA Email:

Abstract:

First-principles study was carried out on the inclusion of boron centers within oligo(oxyethylene) segments. A model molecule with 3 PEO arms connected with a boron/carbon center was constructed. Calculations were performed for 1:1 (B: Li+) model complexes of the polymer and the salt. The initial search for stable structures was carried out through force-field-based MD to obtain the optimum geometry and characterize the electronic interaction between PEO and lithium bis(trifluoromethanesulfonyl)imide (Li-TFSi). The calculation results reveal a reduction in binding energy between Li+ and TFSI $^{-}$ (~29 Kcal/mol per Li+) after introducing boron-centers. The ionic bond strength between Li+ and TFSI^{-} changes from 133 kcal/mol to 104 kcal/mol after introducing the boron-centers. Furthermore, distance between the TFSI $^{-}$ anion and the polymer decrease from 4.1 Å to 2.6 Å indicating a significant increase in electrostatic interaction between the nitrogen atom of the TFSI $^{-}$. Decrease in the ionic bond strength suggests formation of more mobile Li + i.e. resulting more conductive electrolytes. Experimental validation was carried out by synthesizing tris(methoxypolyethylene glycol boron [(B-(MPEG)3] or triglyme boron. Triglyme boron/LiTFSi show high ionic conductivity around 2.1x10-3 S cm-1 at ambient temperature. The high ionic conductivity is because the boron atom, a strong Lewis acid, interacts with the anion and increases the interionic distance between the anion and the cation. In this electrolyte systems, boron atom facilitates the dissociation of the lithium salt and enhances cationic conduction.

Biography:

Ishrat Khan is Professor Chemistry at Clark Atlanta University, Atlanta, GA 30314. His research interests are in designing and synthesizing/preparing polymers for applications in electronics, materials that can be recovered and repurposed via dynamic covalent bonds etc. Ishrat earned a BA degree from Susquehanna University ad a Ph.D. degree from the University of Florida.

Analysis of Physicochemical Factors on Solute Diffusion through Block Copolymer Organogels

Kenneth P. Mineart*

Department of Chemical Engineering, Bucknell University, USA

Abstract:

Physically-crosslinked gels composed of styrenic triblock copolymers have been used in the past few decades for several consumer applications including cushioning and hydrophobic filler material. This is primarily due to their easily tunable thermomechanical properties and relatively safe components. In recent years, the same class of gels has been considered as potential candidates for transdermal drug delivery materials wherein they could serve as a pharmaceutical reservoir and pressure-sensitive adhesive. A thorough understanding of solute transport through gels, particularly one rooted in fundamental science, is crucial in gauging promise in this application. In order to address the knowledge gap, we have developed a new methodology that enables solute diffusivity through block copolymer organogels to be characterized. After detailing our method, this presentation will provide our findings on the role several factors play in solute diffusivity including block copolymer concentration, molecular weight, and block fractions; solute identity and structure; and solvent viscosity.

Biography:

Kenneth P. Mineart is an Assistant Professor of Chemical Engineering at Bucknell University in Lewisburg, PA, USA. He received his Ph.D. in Chemical Engineering from North Carolina State University in 2016 under the guidance of Richard J. Spontak. Following graduation, Mineart was a National Research Council (USA) Postdoctoral Fellow in the Materials Science and Engineering Division at the National Institute for Standards and Technology (NIST). He joined the faculty at Bucknell University in the fall of 2017. His current research interests are in the areas of molecular self-assembly and structure-property relationships of soft materials.

Hydroxyl mediated catalyst-free dynamic covalent epoxy systems: mechanical, thermal, and adaptable properties and chemical recyclability

Jinwen Zhang

School of Mechanical and Materials Engineering Composite Materials and Engineering Center Washington State University, Pullman, WA, USA

Abstract:

Traditional glycidylether epoxy-amine and epoxy-anhydride resin systems forms stable crosslinked network structures upon curing, and the cured products cannot be reprocessed like thermoplastics and are difficult to be recycled chemically. In recent years, researchers have introduced a series of alternative epoxy resin systems by employing various dynamic covalent principles to allow the crosslinked polymers certain degrees of malleability and self-healing property.

Our group has made a significant effort on developing catalyst-free epoxy vitrimers based on the glycidylether epoxy-anhydride and glycidylester epoxy-amine resin systems. Our approach is to introduce self-catalysis into the reaction system, so both the curing of vitrimer and subsequent transesterification in the crosslinked polymers can take place without external catalysts. It is critical to maintain sufficient hydroxyls and ester linkages in the system to enable adequately fast transesterification and hence decent adaptability. We have demonstrated applications of catalyst-free epoxy vitrimers for composite matrix, room temperature coating and elastomeric materials. We have also investigated the simple and eco-friendly recycling of the epoxy vitrimers via hydrolysis or alcoholysis. The approach and method developed can be conveniently applied to the commercial

epoxy resin systems to achieve new adaptable and recyclable properties while mostly retaining their application performance.

Physical chemistry of anisotropic gel formation induced by phase contact and diffusion

Toshiaki Dobashi[1]*, Yasuyuki Maki[2], Kazuya Furusawa[3] and Takao Yamamoto[1]

[1]Gunma University, Japan

[2]Kyushu University, Japan

[3]Fukui University of Technology

Abstract:

Most gels of our surroundings are isotropic gels, typically such as gels for diapers. This is because they are prepared by homogeneous gelation. On the other hand, gels of parts of our body are anisotropic. Though the mechanism of biosynthesis is quite complex, most biological tissues are prepared from a surface or a point, and the growth is directional. When we have a polymer solution in a finite space, to which a gel-inducer such as cross-linking agent flows in, the gels prepared are often anisotropic. The gelation dynamics of these systems are expressed by a universal form of scaled equations determined by the geometrical conditions of the systems. The dependence of the concentrations of the constituent components on the parameters in the equation, however, depends on the gelation mechanism of each system. In this study, we have examined various types of anisotropic structure formation prepared by using the above principle, such as microencapsulation, aligned one-dimensional coordination polymer formation, and even blood coagulation in the clinical test modeled for deep vein thrombosis.

Biography:

Toshiaki Dobashi is Professor Emeritus at Gunma Universitygraduated at Department of Polymer Science at Graduate School of Hokkaido University in 1982, Ph.D. Toshiaki Dobashi is a President of Japan Society of Biorheology in 2013-2015 and honored with the Oka Syoten award by Japan Society of Biorheology in 2021

Prediction of fluids sorption into polymers using machine learning

Benoit Creton

IFP Energies nouvelles, 1 et 4 avenue de Bois-Préau, Rueil-Malmaison, France

Abstract:

Polymers are nowadays used for many applications, being everywhere in objects that surround us. When put in contact with fluids, chemical exchanges can occur and over time, polymeric materials are likely to lose their initial properties. Anticipating these changes is essential when designing a new material, e.g. to better define limits of use of the polymers. While experimental methods exist to study the sorption of chemicals into polymeric materials, they are time-consuming often requiring thousands of hours to reach equilibrium. During a screening procedure, the systematic use of immersion test experiments to quantify the compatibility of new polymers with new fluids

seems to be unrealistic, and the development and use of robust predictive models should be more appropriate.

Over the past decades, our group has devoted efforts to the field of Chemoinformatics, and more specifically to the development of models based on machine learning approaches – quantitative structure-property relationships (QSPRs) that relate fluids/materials properties to descriptors [1]. The compatibility of materials with fuels' components is of major concern in the transport industry especially as the fuel composition varies according to its origin, within a year, or even with the consideration of renewable molecules. Machine learning approaches have been successfully used to model the amount of fuel ingress into a polymer by considering only the structure of the entities involved [2,3].

[1] Creton B. Molecular informatics 2017, 36, 1700028.

[2] Villanueva N., Flaconneche B., Creton B. ACS Combinatorial Science 2015, 17, 631-640.

[3] Creton B., Veyrat B., Klopffer M.-H. Fluid Phase Equilibria 2022, 556, 113403.

Biography:

Benoit Creton (ORCID: 0000-0002-3287-877X) received his M.Sc. degree (2002) from the University of Rennes 1, France, and his Ph.D. degree (2006) in molecular simulation from the University of Science and Technology of Lille, France. He then joined the "Thermodynamics and Molecular Simulation" group at IFP Energies nouvelles as an R&I engineer. His current research focuses on the use of Chemoinformatics tools from multiscale molecular simulation to machine learning based methods, to predict property values for fluids and advanced materials. He has been the author of more than 50 publications in international Journals and conferences, visit its Google Scholar page for details.

Mechanistic Origins of Low-Temperature Bonding in Solid Polymers

Ajay Vallabh and Nikhil Padhye

Department of Mechanical Engineering University of New Hampshire, USA

Abstract:

A new phenomenon of bonding solid-state glassy polymers, in time on the order of a fraction of a second, at ambient temperatures, well-below the bulk glass transition temperatures (Tg), has been recently reported by our team. We discovered that compressive plastic deformation of polymer films, held in intimate contact, triggered requisite macromolecular acceleration, and subsequent chain interpenetrations to cause interfacial bonding. In this work, we elucidate the mechanistic origins of this new type of deformation-induced bonding (DIB) by deploying large-scale molecular simulations. Solid-state glassy samples, based on coarse-grained Kremer-Grest model (well known to phenomenologically represent linear and amorphous polymers), with Tg ≈ 0.445uo/kb, are constructed by quenching the equilibrated molecular melts. Plane-strain plastic compression of glassy samples (up to 30%), at approximate temperatures of 0.3uo/kb, reveal that local dilatations (volume fluctuations) strongly correlate with the heterogeneously enhanced molecular mobility within the microstructure, and enable the interpenetration of polymer segments, or formation of new entanglements across the bonding interfaces. Our molecular simulations are found to be consistent, in terms of qualitative trends, with the prior laboratory experiments, and importantly

rule out the effects of naturally existing enhanced molecular mobility, owing to lowering of glass-transition temperature at the free surface of a glassy polymer, at temperatures well-below Tg.

CO2 to Plastic: Integrating Chemical Catalysis and Biological Conversion of Carbon Intermediates into Polyhydroxyalkanoates

Richard Hamilton, Marcus Bray, Kent Rapp, Michael Betenbaugh and Marina Kalyuzhnaya

Abstract:

Due to the high demand for renewable materials, there is significant motivation for researchers to uncover new methods to produce polymers from renewable substrates. Polyhydroxyalkonoates (PHA) are natural polymers, produced by many microbes as a carbon and energy storage compound. The microbial polymers have been studied since the early 1920s and are often described as a biodegradable solution to fossil materials. However, PHAs vary structurally, and only a few, such as medium chain length polymers (mcl-PHA) demonstrate plasticity and stability properties required by modern manufacturing. Here we present a novel platform for the production of mcl-PHA utilizing genetically modified Methylotuvimicrobium alcaliphilum (Strain 20ZR), a methane- and methanol-consuming bacterium. The microbe has a unique capability to accumulate intracytoplasmic membranes, and thus has a high carbon flux into cellular fatty acids (up to 12% gCDW). Two key enzymes for PHA synthesis, enoyl-CoA hydratase (phaJ) and mcl-PHA polymerase (phaC) from Pseudomonas aeruginosa PAO1 were integrated to optimize the conversion of the fatty acids into mcl-PHA. The resulting traits accumulate up to 14% mcl-PHA per gCDW of biomass. Continued research is being conducted to further optimize the system for increased efficiency and yields as well as the utilization of CO2-derived carbon feedstocks.

Oil Recovery by Polymer Flooding and Green Opportunities

Rosangela B. Z. L. Moreno*

University of Campinas, Brazil

Abstract:

Climate change has demanded the replacement of fossil fuels with green energy sources. However, the transition is not easy. Although renewables' contributions to the energy matrix have increased, total consumption has also increased. Therefore, the way ahead requires pushing the oil exploitation routines to better practices even more. A rise in petroleum prices supported the development and implementation of advanced oil recovery strategies in the past. Nowadays, climate change and environmental guidance have also forced the improvement of those techniques. In this scenario, polymer flooding (PF) is considered a promising EOR method. That is because PF can improve oil recovery while allowing field water management. The method proved suitable for sandstone and carbonate reservoirs, light and heavy oil, homogeneous and heterogeneous formations, onshore and offshore fields. Many factors have contributed to that, such as understanding the polymer flow and stability mechanisms, laboratory data acquisition and integration improvement, history matching between small-scale simulation and core flooding, and upscaling to field-scale modeling and production forecast. New polymer types synergized by surfactants, nanoparticles, and low salinity water can optimize the oil recovery method. Water-polymer alternate or viscous grading

injection schemes overcome injectivity problems. This presentation aims to bring an overview of those concepts and processes to instigate the discussions about green opportunities for oil recovery and petroleum exploitation.

Biography:

Rosangela Barros Zanoni Lopes Moreno holds a degree in Civil Engineering (1989), a specialization in Petroleum Engineering (1990), a Master in Petroleum Science and Engineering (1993), and a Ph.D. in Mechanical Engineering (2000), all from the University of Campinas (UNICAMP). She is an associate professor and coordinates the Laboratory for Oil Reservoirs at the School of Mechanical Engineering - UNICAMP. Rosangela is highly interested in Petrophysics and Fluid Flow, Well-Reservoir Coupling, and Oil Recovery, especially Chemical EOR. She coordinated eight projects and participated in nine ones. She guided 30 graduate candidates until the conclusion and published more than 100 papers.

Study of High Near IR Reflective Materials Based on Crosslinked Composite Nylon 6 Fibers

Gwomei Wu* and Sheng-Jen Lin

Institute of Electro-Optical Engineering, Chang Gung University, Taoyuan, Taiwan, R.O.C.

Abstract:

The novel high solar light reflectance of nylon 6 fiber was prepared by using a twin screw thermal compounding method and a conventional melt-spinning technique. The crosslinking composite nylon 6 master batches were obtained by compounding a tri-functional crosslinker, such as tri-allyl isocyanurate (TAIC), to improve not only the mechanical strength but also the filler distribution, forming a three-dimensional inter-penetrating networks (IPNs) structure. The dark color powders free of halogen and heavy metals were used to reflect near infrared (NIR) from solar light to suppress the heat transmittance. The formation of a cross-linked nylon 6 gel was found during melt spinning process in this study and the novel cross-linked nylon 6 fibers were successfully prepared at 275oC. The composite nylon fibers were further knitted into cloth by a circular weaving machine. The reflectance of the clothes was analyzed by a UV-vis spectroscopy. The results indicated that the higher reflectance capabilities of near infrared and ultraviolet for nylon 6 jersey fabric membranes were obtained while the higher contents of the added TAIC cross-linkers in the nylon 6 fibers were used. The results suggested that the composite nylon 6 fibers could be an ideal candidate for near IR reflective materials.

Biography:

Gwomei Wu holds a Ph.D. in Materials Science and Engineering from the University of Delaware, U.S.A. He has been affiliated with Chang Gung University for more than 25 years. His research interests include energy materials, electro-optical semiconductors, display technologies, and photonic crystals. Sheng-Jen Lin received the Ph.D. in Chemical and Materials Engineering from Chang Gung University. He published several patents in energy materials, polymeric membranes, and electrochemical system.

Tuning the properties of multicomponent polysaccharide/peptide selfassembled macroscopic membranes

Ronit Bitton[1*]

Ben-Gurion University of the Negev, Israel

Abstract:

Hierarchically organized self-assembled peptides and polyelectrolytes that form macroscopic membranes at liquid-liquid interfaces can serve as a platform for 3D cell culture. However, controlling their structure and mechanical properties is imperative to tailor their characteristics to meet specific requirements. We recently reported on the formation of planar and spherical membranes (sacs) at the interface of a cationic β-sheet peptide PK(FK)5P (PFK) aqueous solution and a negatively charged aqueous alginate solution. Utilizing small-angle X-ray scattering (SAXS) and scanning electron microscopy (SEM), the system was found to form either a fully developed membrane structure with three distinct regions, including characteristic perpendicular fibers (as seen in the figure below), or a non-fully developed contact layer lacking these standing fibers. The morphological differences were found to strongly depend on the peptide age, membrane geometry, and membrane incubation time, which influence both the peptide's intrinsic alignment and the reaction-diffusion process taking place at the interface. A three-stage mechanism was suggested, and critical parameters affecting the membranes development process were identified. Aiming to expand the versatility of this platform, we formed self-assembled membranes with PFK and other polymers (e.g., HA, I-carrageenan, PSS). Remarkably, membranes made in the same conditions exhibited different morphologies. Here we present the effect of the polymer characteristics on the structure and mechanical properties of PFK/polymer self-assembled membranes and examine the validity of the three-stage mechanism to their formation.

Biography:

Ronit Bitton received her B.Sc. in Chemical Engineering in 1997 from the Technion- Israel Institute of Technology. She obtained her M.Sc. (2003) and her Ph.D. (2007) in Biotechnology also from the Technion under the supervision of Havazelet Bianco-Peled. After a postdoctorate in the group of Sam Stupp at Northwestern University (2008-2011), she joined the Department of Chemical Engineering at the Ben-Gurion University of the Negev, where She is also a member of the Ilse Katz Institute for Nanoscale Science and Technology. Her research focuses on an experimental investigation of hierarchical (nano-, micro-) structure and properties of complex multicomponent biomaterials.

Bio-based flame retardant self-stratifying coatings

Maude Jimenez[*1,2], **Charlotte Lemesle**[4], **Severine Bellayer**[1], **Sophie Duquesne**[1], **Mathilde Casetta**[1], **Anne-Sophie Schuller**[3], **Julien Molina**[*4]

[1]Univ. Lille, CNRS, INRAE, Centrale Lille, UMET - Unité Matériaux et Transformations, Lille, France

[2]Institut Universitaire de France (IUF), 1 rue Descartes, Paris

[3]Laboratory of Macromolecular Photochemistry and Engineering (LPIM), University of Haute Alsace, Mulhouse, France

[4]Mäder Group, Parc de la Haute Borne 60 Avenue Halley, Villeneuve d'Ascq, France

Abstract:

This work aims at designing bio-based flame retardant self-stratifying coatings for railway applications. This process provides a multifunctional coating in one application step, offering an alternative to conventional multi-layer coating process as it meets current environmental and industrial constraints, such as reduction of waste production, electricity consumption and cost. In this study, self-stratifying coatings based on different bio-based epoxy and silicone resins were designed. The main parameters influencing the stratification process were investigated and revealed that the nature, surface energy and polarity of the resins, as well as the solvent volatility, curing temperature and nature of the cross-linking agent have an impact on the degree of stratification. Flame retardant agents were incorporated in the formulations without affecting the stratification. Finally, a comparative Life Cycle Assessment was carried out to quantify the environmental impact of the self-stratifying process using bio-based resins compared to the conventional oil-based multilayer process.

Biography:

Maude Jimenez is Professor at Lille University (France) to develop surface treatments for flame retardant applications, but also for biomaterials, glass treatments and antifouling applications. She works on the design and understanding of mechanism of action of various surface treatments (coatings, plasma, layer-by-layer, sol-gel, etc.) and she is looking at potential solutions to overcome ageing issues and improve their environmental print. Jimenez has published about 100 papers in peer-reviewed journals. Finally, she got in 2019 the distinction of Junior member of Institut Universitaire de France (IUF) for her research in surface treatment engineering. She is also editor of Journal of Materials Sciences.

A biomimetic silicone hydrogel polymer material for contact lenses

James Wu* and George Yao

Alcon, USA

Abstract:

Purpose: A new silicone hydrogel (SiHy) material was designed through surface modification of a cross-linkable 2-methacryloyloxyethyl phosphorylcholine (MPC) polymer for long-term ocular performance. The surface properties of this MPC polymer-modified lens were characterized under hydrated condition to reveal its unique surface structure and superior surface properties in lubricity and softness.

Methods: The lens material and MPC surface was characterized using a combination of high-resolution Environmental Scanning Electron Microscopy (ESEM) and Atomic Force Microscopy (AFM). The surface lubricity and softness of this new SiHy contact lens with and without the surface modification of MPC polymer were characterized via tribometer and AFM nanoindentation, respectively. All analysis were conducted in either 100% relative humidity or aqueous solutions to maintain lenses at hydrated status, mimicking on-eye conditions.

Results: Compared to the SiHy base material without surface modification, a layer of hydrated MPC polymer was clearly visible on the top of this surface modified contact lens under STEM. This MPC surface structure was further revealed by the combined AFM phase image and ESEM image of the cross-section of this new contact lens. In addition, the coefficient of friction (CoF) of the

SiHy material was significantly reduced by the super-hydrophilic MPC polymer layer. The surface of this MPC polymer modified contact lens was significantly softer than the surface of SiHy base material.

Conclusions: A new SiHy contact lens with MPC polymer surface modification was successfully developed. The unique characteristics of this MPC polymer surface were demonstrated by its distinctive polymer layer structure, superior lubricity, and ultra-softness, which may be expected to achieve outstanding on-eye performance.

Biography:

James Wu, PhD is a Chemist and has worked at medical device and pharma industries for more than 20 years. He currently leads R&D Analytical Chemistry and Material Characterization department at Alcon developing new characterization methodology for polymeric materials and surfaces.

Generalized Protein Adsorption Mechanism on Polymer Nano-Film Surface

Maya K. Endoh[1], Daniel Salatto[1], Zhixing Huang[1], Yashasvi Bajaj[1], Jan-Michael Y. Carrillo[2], Dmytro Nykypanchuk[3], Tadanori Koga[1]

[1]Department of Materials Science and Chemical Engineering, Stony Brook University

[2]Center for Nanophase Materials Sciences and Computational Sciences and Engineering Division, Oak Ridge National Laboratory

[3]Center for Functional Nanomaterials, Brookhaven National Laboratory

Abstract:

We recently found the unique yet universal structure and dynamics of polymer chains adsorbed on solid planar substrates via physisorption. This result highlights the vital roles of nanometer-thick adsorbed layer in protein anti-fouling properties. In this presentation, we report protein-repellent properties of ultrathin polymer films that are considered to be of structural origin and generalizable across homopolymer systems regardless of the polymer kind (such as amorphous/crystalline polymer or hydrophilic/hydrophobic polymer).

The conventional methods to control the protein fouling resistance at the solid surface are to modify the chemical interaction of the surface or to develop special surface structures, and polymer has been greatly used. Our research results suggest a novel method by utilizing the nano-architecture of polymer absorbed layer. Ultrathin polymer films with different thicknesses (h) ranging from 2 to ~100 nm were prepared on silicon substrates, and fluorescein-labeled bovine serum albumin (BSA) and human plasma fibrinogen are chosen as model proteins, which have significant differences in their size, shape, and internal stability. The protein resistance is found regardless of a complex interplay of interactions among a polymer and substrate. Molecular dynamics simulations identified a correlation between protein adsorption and highly packed conformations of polymer chains. In addition, the simulation explains the absorption behavior of polymer chains in dense layer, which will be discussed in this presentation. These experimental and computational findings detail an insightful mechanism behind the structuredriven protein-repellent properties of polymer structures under nanoconfinement over surface chemistry.

Biography:

Maya Endoh is a research professor at Stony Brook University. She attended Kyoto University, Japan, where she completed her Ph.D in polymer physics under the direction of Prof. Emeritus Takeji Hashimoto. She worked at National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory till NSLS ceased its operation. She currently focuses on the structure characterization at polymer surface and interface and polymer rheology.

Probing the diffusion, adhesion and migration of Polymers at Interfaces

Mesfin Tsige

School of Polymer Science and Polymer Engineering, The University of Akron, Akron, OH

Abstract:

There is a tremendous need for a greater understanding of the properties of matter at surfaces and interfaces at the nanometer scale mainly driven by the unprecedented impact of nanoscale materials in current industrial products. It is well known that matter behaves in complex ways and exhibits exotic properties at nanometer length scales. However, understanding the behavior of matter at such length scales at buried interfaces using experimental methods has in general been very difficult. Computer simulations have proven very useful in predicting properties of novel materials yet to be synthesized as well as predicting difficult to measure or poorly understood properties of existing materials. In my group, we use multiscale modeling and simulation methods and theoretical approaches to interrogate the behavior of small molecules and polymers at surfaces and interfaces. In this presentation, I will discuss how we use computational modeling methods to study the structure and dynamics of molecules at buried interfaces. I will also highlight the effects of confinement and other constraints on the mechanical and thermodynamic properties of polymers.

Biography:

Mesfin Tsige is a Professor in the Department of Polymer Science at the University of Akron, Ohio. He received the Ph.D. degree in condensed matter physics from Case Western Reserve University, Cleveland, Ohio in 2001 and then went to Sandia National Laboratories at Albuquerque, New Mexico as a postdoctoral fellow. After four years of postdoctoral research, he joined the faculty in the department of Physics at Southern Illinois University at Carbondale, Illinois achieving the rank of Associate Professor before moving to the University of Akron in 2010. Tsige's group research interest is focused in the area of interfacial science.

Perovskite Solar Cells Fabrication Assisted by the Use of Antisolvents

Banashree Gogoi[1] and Terry L. Alford[2]*

[1]School of Molecular Sciences, Arizona State University, AZ, United States

[2]School for Engineering of Matter, Transport and Energy, Arizona State University, AZ, United States

Abstract:

The active perovskite layer is critical in determining the solar cell's efficiency in organic-inorganic lead halide perovskites. The appealing physical properties of the perovskite layer, such as tunable bandgaps, high carrier mobility, high absorption coefficients, extensive range of optoelectronic applications, etc., make it one of the most critical layers. High-quality perovskite films can be obtained by several approaches, such as one or two-step sequential spin-coating deposition, thermal evaporation, and, more recently, antisolvent treatment.

Recently the use of antisolvent treatment in triple cation perovskite solar cells (TCP) has gained popularity because of its outstanding photovoltaic stability and performance. In addition, the antisolvent-assisted crystallization method is considered adequate for achieving high-quality crack-free TCP films. We fabricated perovskite layers with Formamidinium, Methylammonium, and Cesium (FAMACs) cations assisted by antisolvent crystallization. The four antisolvents were Isopropyl alcohol (IPA), Chlorobenzene (CB), Ethyl acetate (EA), and Toluene (TL). Devices treated with EA in the volume ratio of 1:4 showed a power conversion efficiency of 15.5% compared to other devices giving high-quality crack-free perovskite film. We also considered two mixtures of antisolvents, EA with CB and EA with IPA, in different ratios to fabricate the perovskite layer. Here EA acted as a solvent to dissolve excess perovskite precursor due to its polar nature; while, CB and IPA enhanced the crystallization by reducing the solubility of the perovskite precursor. As a result, the device fabricated using 25% CB in EA showed improved film quality and enhanced grain size compared to the other compositions.

Biography:

Terry Alford serves as the Associate Director of the School for the Engineering of Matter, Transport and Energy. Additional responsibilities include overseeing the materials science and engineering M.S. Online Graduate Program and creating the new Semiconductor Processing Certificate (online and face-to-face). His research spans organic solar cells, contacts to diamond semiconductors, and materials characterization. He is a former Member of Technical at Texas Instruments and a Senior Member of the National Academy of Inventors. He has authored or co-authored over 300 archival-refereed publications, two books, and four volumes of e-book monographs to support online course delivery, and ten patents.

3D Printing of Carbon Based Electrodes by Projection Micro Stereolithography for Energy Storage Applications

Mariana Desireé Reale Batista[1]*, Swetha Chandrasekaran[1], Bryan D. Moran[1], Miguel Salazar de Troya[1], Adam Carleton1, Manhao Zeng[1], Thomas Roy[1], Anica Pinongcos[2], Dun Lin[2], Zhen Wang[3], Ryan Hensleigh[3], Joshua Kuntz[1], Victor A. Beck[1], Daniel A. Tortorelli1, Michael Stadermann[1], Yat Li[2], Rayne Zheng[3], Marcus A. Worsley[1]

[1]Lawrence Livermore National Laboratory, USA

[2]University of California Santa Cruz, USA

[3]University of California Los Angeles, USA

Abstract:

Supercapacitors are essential contributors to the implementation of sustainable energy. Their

high cyclability and rapid charge/discharge times make supercapacitors attractive for consumer electronics, automotive and aerospace industries. Although these devices show potential to achieve power density metrics, improvements in energy density are needed. To address this, we are investigating better materials, architectures, and additive manufacturing techniques to print electrodes that simultaneously increase energy density and maintain their high-power density. An electrode with optimum performance was designed by topology optimization and printed by projection micro stereolithography using different photocurable polymers, starting with PR48 (a commercially available resin). The printed electrodes were converted to carbon electrodes through pyrolysis at 1000 °C and characterized by cyclic voltammetry (CV) and galvanostatic charge/discharge (GCD) tests. PR48 optimized electrodes were compared to PR48 electrodes printed as cubic lattice structures previously shown to improve capacitance and rate capability. The results show that our optimized electrodes perform better in GCD and CV tests and have higher capacitances. To further improve performance, we synthesized a resin by combining graphene oxide (GO) into TMPTA polymer. Electrodes printed with 3 wt% GO/TMPTA have higher capacitance retention compared to PR48. This work demonstrates the benefits of using topology optimization to design electrodes and materials development to improve the functional properties of 3D printable resins.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC.

Biography:

Mariana is a postdoctoral researcher at the Lawrence Livermore National Laboratory. Her research interests include additive manufacturing of carbon-based electrodes, aerogels for radiative cooling applications and fiber reinforced polymer composites. Mariana graduated summa cum laude with a B.S. in Mechatronics Engineering and received an M.B.A. in Administration and Business Management, both from Universidade Salvador. She earned her Ph.D. in Materials Science and Engineering from Michigan State University, where she combined natural and synthetic materials to create multifunctional composites. During her doctoral studies, Mariana interned at Ford, developing hybrid cellulose composites and at NASA, working with nanotechnology for sensor development.

Mass manufacturing of High Precision Micro-Optical Components through X-Ray Lithography and Determined Chain Scission of Polymers

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[3]Karlsruhe Institute of Technology (KIT), Institute of Microstructure Technology (IMT), Postfach 3640, D-76021 Karlsruhe, Germany

Abstract:

Lithographic, high-volume manufacturing of micro/nanocomponents of optical quality have two main shortcomings, a limited number of structure gray levels that can be generated and/or long manufacturing time. Current conventional approaches using multiple lithographic patterning and etching steps, or single pencil beam systems couldn't address these issues. We present here a highly scalable manufacturing method for micro/nano optical components that showcase the manufacturing of 1800 discrete gray levels in a 4 µm thick polymer layer and in chips size of 20 mm2 repeated 148 times over 4-inch wafer diameter, in a single exposure run. We introduce key structuring parameters and discuss the importance of precise dose control deposited as one of the crucial components of this process. We discuss the requirements of low polymer sensitivity to X-ray radiation as well as the selection of PMMA over chemically amplified photoresist. We report on bulk, thick polymer layers as well as spin coated thin polymer layers providing the freedom to fabricate these micro-components as a substrate free chip or embedded on transparent or opaque substrates, subject to application. Key to our method is the parallel manufacturing of these micro-components on wafer scale which enables mass manufacturing to cater for large quantities required for consumer electronics or original equipment manufacturers (OEM) for industrial applications. We showcase the use of manufactured micro-components embedded into analytical devices such micro-spectrometers and/or multispectral imagers. Our process enables significant device cost and size reduction, providing a competitive edge in the market.

Biography:

Kalaiselvi is currently a Senior research fellow at National university of Singapore. She has 16 years of experience in X-ray, UV lithography and VisNIR, FTIR spectroscopy. She has successfully delivered a number of industrial and academic projects for MIT(USA), Intel(USA), SIIX(Japan) etc., and other renowned research institutes and has several publications and patents. She received awards during her PhD studies for excellence in research and demonstrated X-ray lithography using miniature plasma-based x-ray source. Her major work focusses on development of 3D micro-manufacturing technology using Synchrotron. She is also a business consultant for process transfer from research to industrial manufacturing.

3D Printing of Thermosetting Polymers and Composites *via* Frontal Polymerization

Mostafa Yourdkhani[1,2]* and Morteza Ziaee[1]

[1]Department of Mechanical Engineering, Colorado State University, USA; [2] School of Advanced Materials Discovery, Colorado State University, USA

Abstract:

Thermoset polymers and their composites have been traditionally used in many applications due to their good combination of mechanical properties, thermal stability, and chemical resistance. Adoption of thermosetting materials in additive manufacturing (AM) for rapid creation of prototypes or development of parts with complex geometries, however, has been limited by the long and energyintensive curing processes often required for curing the monomer. Here, we present a novel AM technique to address the existing limitations with thermoset printing and manufacture thermoset parts with various functional properties. In our approach, we use direct ink writing (DIW) technique to controllably deposit a thermosensitive ink and simultaneously cure and solidify the ink after it exits the printing nozzle via frontal polymerization. As a result, we can create freeform structures with no postcure step, which is difficult or impossible to achieve using other printing techniques. We also tailor the functional properties of the printed parts by controlling the composition, reactivity, and rheological properties of inks. As a result, we can print thermoset

parts with tunable mechanical properties from stretchable, elastomeric parts to stiff polymers to fiber-reinforced polymer composites.

Biography:

Mostafa Yourdkhani is an assistant professor in the Department of Mechanical Engineering at Colorado State University. He received his PhD from McGill University on processing of polymer nanocomposites and composite materials. Prior to joining CSU, he was a postdoctoral research associate at the Beckman Institute for Advanced Science and Technology at the University of Illinois at UrbanaChampaign. Yourdkhani specializes in advanced polymer composite processing, additive manufacturing of polymer composites, multifunctional materials, and polymer nanocomposites. He is a member of the editorial board of Multifunctional Material journal and a Resident Fellow in the School of Global Environmental Sustainability at CSU.

Preparation and characterization of phenyl modified natural rubber

Nuorn Choothong*[1] and Seiichi Kawahara[2]

[1]Rajamangala University of Technology, Thailand, 2Nagaoka University of Technology, Japan

Abstract:

Chemical modification may have a potential to improve mechanical properties of natural rubber, since glass transition temperature (Tg) of the rubber is varied by chemical modification. For instance, phenyl-modified natural rubber (PhDPNR) may change its Tg as a function of phenyl group content. Thus, the PhDPNR may achieve a good balance between rebound resilience and wet skid resistance, which are necessary to prepare high performance tire. The PhDPNR may be prepared by direct insertion of the phenyl groups into natural rubber. One of the plausible methods is Suzuki-Miyaura cross-coupling reaction, which is known as a homologation reaction of a carbon-carbon formation between phenyl groups and hydrocarbons with allylic bromide groups in the presence of an organometallic catalyst. This reaction is also performed in oil/water emulsion due to stability of the palladium catalyst in water. Therefore, the PhDPNR may be prepared in latex stage by Suzuki-Miyaura cross-coupling reaction in the presence of a suitable catalyst, i.e., di-µ-chloro-bis [5-hydroxy-2-[1-(hydroxyimino)-ethyl] palladium (II) dimer. In the present study, Suzuki-Miyaura cross-coupling reaction was performed to DPNR in solution and latex after bromination. The products, i.e., BrDPNR and PhDPNR were characterized through 1D and 2D-nuclear magnetic resonance (NMR) spectroscopy. The Tg and viscoelastic properties of the PhDPNR were determined by differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA), respectively.

Biography:

Nuorn Choothong graduated from Nagaoka University of Technology, Japan under Prof.Dr.Seiichi Kawahara. After graduated I came back to Thailand and start lecturer position in polymer field. However, I received many scholarships in order to improved rubber latex of Thailand.

Characterization of a chitosan derivative to be used in novel applications

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[1]Forest Products Laboratory, College of Forestry, Wildlife and Environment, Auburn University, Alabama, USA. 2Drug Discovery and Development, Harrison College of Pharmacy, Auburn University, Alabama, USA

Abstract:

Chitosan is a linear multifunctional polysaccharide constituted by D-glucosamine units randomly linked by β-(1→4)-glycosidic bonds to N-acetyl-D-glucosamine units (Figure 1). The polymer is obtained from chitin by partial deacetylation, which strongly affects the resulting polymer's intrinsic characteristics, including the degree of polymerization (DP) and degree of acetylation (DAc). The changes in DP and DAc values will alter, for example, the solubility of the polymer in water, the pKa value, and the net charge. The complete characterization of chitosan and chitosan derivatives is crucial for developing new applications based on these polymers.

In the present work, we have prepared a chitosan derivative (2) by reductive amination of 85% chitosan (1) in the presence of sodium borohydride in methanol at room temperature. The amount of amino functional groups in polymers 1 and 2 have been estimated using the acid orange 7 (AO7) method, the differences in chemical composition were studied using nuclear magnetic resonance and Fourier-transform infrared spectroscopy, and the zeta-potential and hydrodynamic volume (i.e., size) was measured in a zeta-sizer nano. The pKa value of the polymers was determined by pH titration.

According to the results, polymers 1 and 2 showed a similar intensity of AO7-absorption; however, the AO7-absorption capacity of the derivative was lower. The pKa value increased after derivatization from 7.5 to 9.9, whereas the hydrodynamic volume at acidic pH values increased. The results gathered in the present study will be fundamental in our search for new applications using the polymers mentioned above.

Biography:

Iris Beatriz Vega Erramuspe currently work as a Graduate Research Associate and an Instructor at the Forest Products Laboratory in the College of Forestry, Wildlife and Environment at Auburn University in AL, US. I earned my Ph.D. at the Fiber and Cellulose Technology Laboratory in the Chemical Engineering Department in Åbo Akademi in Finland and my M.Sc. degree at the Biocatalysis & Biotransformations Laboratory in the Organic Chemistry Department at the University of the Republic in Uruguay. Iris Beatriz Vega Erramuspe is eager to develop sustainable solutions and contribute to the health and wellness of humans, wildlife, and the environment and pursue (multidisciplinary) collaboration.

Additive approach to flame retard PBT vitrimer

Fabienne Samyn*, Louis Meunier, David Fournier, Valérie Gaucher, Sophie Duquesne

Unité Matériaux et Transformations, University of Lille, CNRS, INRAE, Centrale Lille, UMR UMET, Lille, France

Abstract:

Addition of fillers in a vitrimer matrix to functionalize it is not necessarily a trivial thing. These covalent adaptative networks presents interesting properties that are conditioned by the possibility to make exchange reactions in their networks. The occurrence of such reactions in presence of

additive has barely been investigated. Mainly nanoparticles have been added and it has been proven that their presence can be either detrimental or beneficial to the dynamic of the network. The present work investigates the effect of the addition of classical flame-retardant additives in a PBT vitrimer matrix during their synthesis by reactive extrusion. Different types of additives (phosphinate salts, polymeric phosphorous flame retardant and magnesium hydroxide) have been tested. Depending the type of flame-retardant, the dynamic is either prevented, disturbed or enhanced as observed for nanoparticles. The use of an aluminium phosphinate has been proven as advantageous since it acts as a catalyst in the vitrimer formation enabling quicker exchange reactions. The flame-retardant properties are not impacted neither the mechanical performances. Effect of the vitrimer formation on the ageing properties has been investigated.

Biography:

Fabienne Samyn works since 2004 in the field of reaction and resistance to fire of thermoplastic, thermoset and fibres reinforced composites materials using more particularly the concepts of intumescence, nanocomposites and synergism. After her PhD obtained in 2007 at the University of Lille, she worked as postdoctoral fellow for one year at ICL-IP/Institute Polytechnic of New York (NY, USA) and then for two years in the laboratory UMET-ISP in Lille. Since 2011, she joins ENSCL as assistant professor.

Very Effective, Nontoxic, Nonmigrating Biobased Oligomeric Hyperbranched Poly(ester) Plasticizers for Poly)vinyl chloride) from The Biomonomers, Glycerol and Adipic Acid

Bob A. Howell

Science of Advanced Materials Center for Applications in Polymer Science Department of Chemistry and Biochemistry Central Michigan University Mt. Pleasant, MI

Poly(vinyl chloride) [PVC] is the third largest volume polymer used around the world. It has unique properties that make it valuable for both rigid and flexible applications. Because of its polar character and strong interchain interactions, PVC requires strong plasticization for many uses. In fact, it wasn't until the discovery that PVC could be plasticized in the 1930s that it became a commercial product. Traditionally, esters have been the most common and effective plasticizers for PVC. Phthalate esters have been the most prominent. In particular, di-2-ethylhexyl phthalate [DEHP] has been widely used. This material is generated from two byproducts, o-xylene and butyraldehyde, of petroleum processing and, therefore, has been available at modest cost. More importantly, it is an effective plasticizer. However, DEHP and other phthalates leach from polymer matrices into which they have been incorporated and enter the environment (it has been suggested that DEHP is the compound most widely distributed in the environment and may be found the remotest parts of the world). Consequently, phthalates are common environmental contaminants to which the human population has suffered widespread and prolonged exposure. Human exposure to phthalate esters may lead to lead to a number of disease states, many arising from endocrine disruption. As a consequence, the development of new, effective and nontoxic plasticizers for PVC is an area of interest and activity. Plasticizers derived from abundantly-available, nontoxic biosources are particularly attractive. Prominent among these have esters of tartaric acid and the furanics. Esters of hyperbranched poly(ester)s produced from two biomonomers, glycerol and adipic acid, are particularly effective as PVC plasticizers. Using the Martin-Smith model for the selection of appropriate ratios of starting materials, these polymers may be produced in a single step and high momoner conversion without gelation but with defined molecular weight, structure and endgroup functionality. The endgroups may be capped as esters to generate effective plasticizers. Plasticizer efficiency is enhanced by the hyperbranched structure of the materials. These materials display good compatibility with a PVC matrix, very effective plasticization, and low tendency for migration.

Biography:

Bob A. Howell is professor emeritus of organic chemistry/polymer science at Central Michigan University. He has over thirty years of experience in the area of polymers and polymer additives. Research interests include the use of hyperbranched poly(ester)s for the release of active agents, structural stability of styrene polymers, PVC formulation/stabilization, barrier packaging polymers, nitroxyl-mediated radical polymerization, and thermal methods of analysis/kinetics. A current major focus is the development of nontoxic, biodegradable, environmentally-friendly flame retardants and plasticizers based on renewable biomaterials. He is a Fellow of both the American Chemical Society (ACS) and the North American Thermal Analysis Society (NATAS) and a recipient of the NATAS Mettler Award for outstanding achievement.

ORAL

Biomimetic Nanofibrous 3D Polymeric Materials for Craniofacial Bone Tissue Engineering

Hongli Sun*

Department of Oral and Maxillofacial Surgery, Iowa Institute for Oral Health Research, University of Iowa College of Dentistry, Iowa City, Iowa, United States

Abstract:

The repair of large craniofacial bone defects using biomaterials-based strategies has been a significant challenge because of the complex characteristics required for tissue regeneration, especially in the craniofacial region. Tissue engineering strategies aimed at the restoration of function face challenges in material selection, synthesis technique, and choice of bioactive factor release in combination with all facets. Biomimetic nanofibrous (NF) scaffolds are attractive vehicles for tissue engineering because of their ability to promote endogenous bone regeneration by mimicking the shape and chemistry of natural bone extracellular matrix (ECM). To date, several techniques for generation of biomimetic NF scaffolds have been discovered, each possessing several advantages and drawbacks. I will introduce two of the more popular techniques for biomimetic NF scaffold synthesis, electrospinning, and thermally induced phase separation (TIPS), covering development from inception in each technique as well as discussing the most recent innovations in each fabrication method from my group.

Biography:

Hongli Sun is an Associate Professor at Iowa Institute for Oral Health Research and the Department of Oral and Maxillofacial Surgery, University of Iowa College of Dentistry. Before joining Iowa in 2018, Sun was an Assistant Professor in the Department of Biomedical Engineering at the University of South Dakota at Vermillion. Sun earned his Ph.D. degree in Cell Biology from the Chinese Academy of Sciences in 2007. After that, Sun worked as a Postdoctoral Research Fellow in the Department of Biologic and Materials Sciences at the University of Michigan, College of Dentistry

Mucoadhesive and Viscoelastic Properties of Co-Hydrogels formed by Poly(Ethylene Glycol), Fluoroalkyl and Poly(Acrylic Acid)

Yang Sun, Adiel F. Perez, Ivy L. Cardoza, Nina Baluyot-Reyes and Yong Ba*

Department of Chemistry and Biochemistry, California State University, Los Angeles, CA, USA

Abstract:

A self-assembled co-hydrogel system with sol-gel two-phase coexistence and mucoadhesive properties was developed based on the combined properties of fluoroalkyl double-ended

poly(ethylene glycol) (Rf-PEG-Rf) and poly(acrylic acid) (PAA), respectively. We have integrated Rf-PEG-g-PAA (where g denotes grafted) copolymer into the Rf-PEG-Rf physically cross-linked micellar network to form a co-hydrogel system. Tensile strengths between the co-hydrogel surfaces and mucosal surfaces were acquired. One mucosal surface was made of porcine stomach mucin Type II, while the other one is a pig small intestine. The experimental results show that the largest maximum detachment stresses (MDSs) were obtained when the Rf-PEG-g-PAA's weight percent in the dehydrated polymer mixture is ~15%. Tensile experiments also found that MDSs are greater in acidic conditions (pH = 4–5) and basic conditions (pH = 10.6) than in neutral pH condition. Results of the rheological analyses using shear strain amplitude sweep and frequency sweep reveal that the Rf-PEG-g-PAA was physically integrated into the Rf-PEG-Rf micellar network, and the co-hydrogels remain physically cross-linked in three-dimensional micellar networks with long-term physical dispersion stability. Therefore, the co-hydrogel system is promising for drug delivery applications on mucosal surfaces.

Biography:

Yong Ba is a professor in the Department Chemistry and biochemistry at California State University, 51 Los Angeles. He got Ph.D. at the University of Duisburg-Essen in 1995. His does research in the field of Physical/Biophysical Chemistry. He develops and applies magnetic resonance (NMR and EPR) techniques for the studies of important physicochemical properties of biological/biomedical, porous, inclusion and nanostructured materials. His current research projects include molecular mechanism of antifreeze proteins and anti-freeze fluids for medical and industrial applications, and molecular drug carriers, nanoparticles, and hydrogels for drug delivery applications.

Development of Functional Polymers for Nanomedicines of Anticancer Agents

Kyung Taek Oh

Department of Global Innovative Drugs, The Graduate School of Chung-Ang University, and College of Pharmacy, Chung-Ang University

Abstract:

Various polymers were developed and utilized in a wide range of application fields such as textile, energy, architecture, food, tissue engineering and pharmaceutics. Especially, biomedical applications have been further exploited due to their versatile functions. Our group has focused on the polymeric platforms for nanomedicines. Nowadays, many molecules were discovered and developed for therapeutic agents. However, their potential is severely compromised by the unfavorable properties of molecules and significant delivery and targeting obstacles that prevail in vivo. Therefore, effective drug delivery systems to improve the physicochemical properties and to deliver drugs to targeting sites are required for the successful development of new developed drugs. Amongst various drug delivery carriers, polymeric platforms were developed for pharmaceutical applications with various advantages. We have been developing nanomedicines for anticancer chemotherapy based on several block copolymers to escalate therapeutic efficacy of the anticancer agent by enhanced targeting to cancers. The synthesized copolymers were used to deliver the anticancer agents, genes, and imaging agents. Furthermore, the polymeric nanoplatforms showed several favorable properties in terms of particle size, narrow distribution, high drug loading capacity, increased efficacy of drugs, etc. In this conference, we will discuss about incrementally modified drug, rationale of nanomedicine development, synthesis of functional block copolymers, the polymeric based drug vehicles, and preclinic studies using the nanomedicines developed in our

lab, Nanobiopharmaceutics lab.

Biography:

Kyung Taek. Oh received his PhD at Pharmaceutical Science from UNMC in 2006. He joined the group of Prof. You Han Bae at University of Utah as a post-doctoral researcher. Currently, he works at College of Pharmacy, Chung-Ang University (CAU) as a professor since 2008. His main research area has been the development of innovative drug delivery systems using functional polymers and of industrial products. Specifically, he focuses on nanomedicines to delivery of anticancer agents and conventional products available in pharmaceutical market. He published over 160 articles and 11 patents in these areas.

Cellulose, a versatile material for food- and bio- industry

Young Hoon Jung*

School of Food Science and Biotechnology, Kyungpook National University, Daegu 41566, Republic of Korea

Abstract:

Cellulose is one of the most abundant polymers in nature, which are mostly connected with hemicellulose and lignin in lignocellulosic biomass or marine biomass. As food or bio materials, cellulose can be utilized to its polymeric form itself (i.e. cellulose) or monomeric form (i.e. glucose). For example, for fermentation industry, glucose is the very fundamental sugar source to microorganism. As well as for food industry, differently functionlized cellulose including methyl cellulose, cellulose acetate, etc. are additives to enhance viscoelastic properties of food matrix. In this talk, I would like to give a brief introduction of biomass resources, cellulose polymers, cellulose extraction processes from the biomass, and their functional properties. In addition, the cellulose was applied as a material for bioethanol production, cosmetic ingredients, 3D food ink, etc.

Biography:

2002-2009: BS in Food Science and Biotechnology-, Korea University, South Korea 2009-2015: MS and PhD. In Biotechnology, Korea University, South Korea 2015-2016: Post-doctoral researcher, The University of British Columbia, Vancouver, Canada 2016- current: Assistant & Associate professor, School of Food Science and Biotechnology, Kyungpook National University, South Korea 2020-2022: Honary research officer, National Institute of Crop Science, Rural Development Administration, South Korea 2021: Chief Technology Officer, Food and Bio-industry Research Institute, Kyungpook National University 2021: Head, Major in Food Biotechnology, School of Food Science and Biotechnology, Kyungpook National University Editorial Board: Plos One, Energies, Microbiology and Biotechnology Letters, Preventive Nutrition and Food Science, Korean Journal of Food Preservation.

Post-consumer recycled polyethylene in product packaging applications

Greg Curtzwiler

Polymer and Food Protection Consortium, Iowa State University, Ames, IA

Abstract:

The use of post-consumer recycled (PCR) polyolefin polymers is increasing due to regulatory, consumer, and brandowner pressure for more sustainable materials in packaging. However, applications that involve sensitive products such as food and personal care products presents unique challenges with no global regulatory safety standards and performance specifications. Requirements are often determined by the condition of use (microwave, cold storage) and product type (fatty, aqueous, dry, chemical interaction). Several processes have been developed to recycle PE, but current data gaps exist on the impact of molecular changes from secondary recycling on the performance in product packaging applications when blended with virgin polymer. The molecular structure changes in PCR result in unique and predictable physical properties in PCR/virgin blends that can be exploited to increase product shelf life, tailor performance properties, and empirically determine post-consumer recycled content for regulatory compliance. However, these physical and chemical changes lead to unknown diffusion rates of potentially harmful chemicals such as phthalates and bisphenols. Our goal is to understand how molecular changes in post-consumer polyethylene influence critical parameters that determines suitability for product packaging applications.

Biography:

Greg Curtzwiler is an Assistant Professor in the Polymer and Food Protection Consortium at Iowa State University. His research is focused on developing new sustainable materials for adhesives and coatings in the packaging and automotive industries including bio-based, compostable, and recycled polymers. Curtzwiler received a B.S. in Biochemistry and M.S. in Polymers and Coatings Science from Cal Poly State University, San Luis Obispo, CA. He received a Doctorate in Polymer Science and Engineering from The University of Southern Mississippi School of Polymers and HighPerformance Materials.

Conjugated break: a new design strategy for electron acceptor polymers efficient and thermally stable all-polymer solar cells

Qunping Fan[1] Wenyan Su[1,2,3], Shanshan Chen[4,5], Tao Liu[6], Wenliu Zhuang[1,7], Ruijie Ma[6], Xin Wen[1], Zhihong Yin[2], Zhenghui Luo[6], Xia Guo[2], Lintao Hou[3], Kasper Moth-Poulsen[1], Yu Li[7], Zhiguo Zhang[8], Changduk Yang[4], Donghong Yu*[9,10], He Yan[6], Maojie Zhang[2], and Ergang Wang[1,11]

[1]Department of Chemistry and Chemical Engineering, Chalmers University of Technology, Sweden

[2]Laboratory of Advanced Optoelectronic Materials, College of Chemistry, Chemical Engineering and Materials Science, Soochow University, China

[3]Guangdong Provincial Key Laboratory of Optical Fiber Sensing and Communications, Guangzhou Key Laboratory of Vacuum Coating Technologies and New Energy Materials, Siyuan Laboratory, Department of Physics, Jinan University, China

[4]Department of Energy Engineering, School of Energy and Chemical Engineering, Low Dimensional Carbon Materials Center, Ulsan National Institute of Science and Technology (UNIST), South Korea

[5]MOE Key Laboratory of Low-grade Energy Utilization Technologies and Systems, CQU-NUS Renewable Energy Materials & Devices Joint Laboratory, School of Energy & Power Engineering, Chongqing University, China

[6]Department of Chemistry and Hong Kong Branch of Chinese National Engineering Research Center for Tissue Restoration & Reconstruction, Hong Kong University of Science and Technology, Hong Kong

[7]Guangdong Research Center for Special Building Materials and Its Green Preparation Technology, Advanced Research Center for Polymer Processing Engineering of Guangdong Province, Guangdong Industry Polytechnic, PR China

[8]State Key Laboratory of Organic/Inorganic Composites, Beijing Advanced Innovation Center for Soft Matter Science and Engineering, Beijing University of Chemical Technology, China

[9]Department of Chemistry and Bioscience, Aalborg University, Denmark

[10]Sino-Danish Center for Education and Research, Denmark

[11]School of Materials Science and Engineering, Zhengzhou University, China

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 × 105 cm1 , 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 B.Sc. (1991)/M.Sc. (1994) in polymer chemistry and physics in Jilin University, China. In 1997 he was awarded the PhD degree in polymer chemistry and physics Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, China. Then he started working as postdoc in National Institute of Materials and Chemical Research, Japan & Department of Materials and Production, Aalborg University, Denmark, in 1998 and 2000, respectively. Later in 2001 and 2006, he was appointed as a faculty member as tenure-track assistant professor and tenured associate professor in Department of Chemistry and Bioscience at Aalborg University, respectively.

Flexible Stealth Materials for Multispectral Camouflage from Optical Frequencies to Millimeter Waves

Jae W. Hahn*, Hyeon Bo Shim, Kiwook Han and Jookwon Song

Nano Photonics Laboratory, School of Mechanical Engineering, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul, Republic of Korea

Abstract:

Optical stealth technology is being developed to cope with high-sensitivity infrared image detectors and various guided detectors. Current research on multispectral stealth material technology focuses on practical functionalities such as optical transparency, flexibility, and lightweight. We proposed the multispectral electromagnetic (EM) absorber based on the frequency-selective surface (FSS). A thin and flexible multispectral single-layer FSS (MSLF) absorber is presented using a micro-holed, macroscale FSS combined with an infrared (IR) absorbing ground. We also introduced an optically transparent and single-layer frequency-selective surface (OTSF) absorber for dual-band millimeter-wave (MMW) absorption and low infrared (IR) emissivity. The FSSs are simplified to a single layer by changing the absorbing layered microstructure to a transmitting microstructure. Dual band millimeter waves (MMWs) are absorbed by the macroscale resonance cavity, while the target IR waves are absorbed by the IR absorbing ground after penetrating the micro-hole array pattern. Thermal emission is reduced significantly due to its low emissivity at IR bands other than the target wavelength of the micro-hole pattern. It is confirmed analytically and experimentally that patterns of various sizes do not exhibit functional crosstalk. The OTSF absorber exhibits high absorption at the dual-band frequency in the millimeter-wave range (99.7% at 35 GHz and 89.7% at 103 GHz). In the IR band, the average band emissivity of the OTSF absorber for the mid-wave IR (3–8 μm) band and the long-wave infrared band (8–15 μm) are measured to be 0.26 and 0.23, respectively.

Biography:

Jae W. Hahn received a PhD degree in physics at Korea Advanced Institute of Science and Technology (KAIST) in 1986. As a group leader at the Korea Research Institute of Standards and Science (KRISS) for 14 years, he performed research on nonlinear laser spectroscopy for combustion diagnostic. He joined Yonsei University in 2002. He served as the President of Optical Society of Korea (OSK). He is the general manager of the National Research Center for 'Extremely High Temperature Stealth Special Materials', which was designated by Ministry of Science and Technology of Korean government in 2019.

FruitVax™-platforms for mucossally attacking mucosal infections

S. Indu Rupassara* and John W. Kindt

FruitVaccine Inc., USA

Abstract:

FruitVaccine, Inc., (http://www.fruitvaccine.org/) develops plant-based (short-growth-cycle plants, e.g., tomatoes), mucosally (e.g., orally or nasally) administered subunit vaccines against mucosal infections such as respiratory and gastrointestinal diseases. Our vaccine platforms in-development include a chewable/swallowable fruit-pill, oral-drop, nasal-spray, and fruit-puree/paste, as alternatives to traditional needle-based immunizations. Vaccination via mucosal routes has been shown to be more effective than parenterally delivered vaccines for immunization against infections primarily acquired through mucosal surfaces. Our initial vaccine target is the globally problematic respiratory infection caused by the human respiratory syncytial virus (hRSV). hRSV is a flu-like disease that can cause severe illness in infants and young children, adults over 65, and individuals with compromised immune systems. Each year in the US, more than 100,000 infants (under 1yr), approximately 58,000 children under 5 years old, and 177,000 older adults are hospitalized due

to hRSV infection. An estimated 14,000 of these adults succumb to the disease. On a global scale, hRSV annually infects over 64 million individuals, resulting in 160,000 direct deaths and over 1.4 million additional deaths due to secondary infections (Rupassara et al, 2022). Despite the urgent need, there is no prophylactic (preventive) vaccine against hRSV currently available on the market, and we address this dire need with our NSF-funded FruitVax™ Pill.

Biography:

S. Indu Rupassara, PhD, MBA (Co-Founder/President/CEO), manages FruitVaccine Inc., overseeing the Business- and Research-Projects of the company. Indu's multidisciplinary research and managerial expertise includes biotechnology, immunology, and 'omics' technologies, using a wide array of biological systems such as humans, animals, plants, and microorganisms. Indu is the Principal-Investigator of FruitVaccine's NSF-SBIR-grant and has presented talks in conferences in the US, Europe, Australia, and Asia. Indu received her PhD (Metabolomics/Biotechnology), MBA, and MS (Biochemistry) degrees from the University of Illinois at Urbana-Champaign, USA, MSc (Microbiology) from the University of Sydney, Australia, and BSc (Agric. Sc.) from the University of Peradeniya, Sri Lanka.

Sol-Rec2: Novel Methods for Delamination of Pharma Blister Packs and Other Multi-Layer Materials for Recycling Purposes

Berenika Syrek-Gerstenkorn[1]*, Shiladitya Paul[1], Andrew P. Abbott[1]

[1]University of Leicester, UK

Abstract:

Pharmaceutical blister packaging has become one of the most popular means of supplying medicines, and currently approximately 85% of all prescriptions dispensed within the EU are in blister packs. Those type of packages offer many advantages such as: protection against environmental conditions and crashing during transportation, ease of dosage and safety against tamper.

Unfortunately, at present, multi-material packaging waste is still a challenge for recycling due to difficulties with separation from other plastic waste streams. Moreover, blister packs usually consist of multiple materials with two or more kinds of polymers which require suitable separation methods.

It is reasonable to predict that over 50 billion pieces of blister packaging waste will be produced every year. Therefore, the recovery and reuse of polymers and metals from waste is of paramount importance. New methods of separation of multi-material components allowing further recycling must be researched.

A possible candidate for separation of layers in multi-material packs is the application of deep eutectic solvents. Those solvents are considered "green" – due to their low-toxicity. They also offer several beneficial properties such us ease of preparation and handling and low cost.

In this project (Sol-Rec2, funded by the European Union's Horizon 2020 research and innovation programme under grant agreement N° 101003532) several deep eutectic solvents have been tested for separation of multi-layer packaging waste. The solvents were also assessed based on their price, toxicity, flammability and suitability for use in large-scale operations. Sol-Rec2 also

focuses on the development of innovative watermark technologies for separation of multi-layer waste.

Biography:

Berenika Syrek-Gerstenkorn is a research associate at the University of Leicester in the UK working on the Sol-Rec2 project funded by the European Union's Horizon 2020 research and innovation programme. Berenika has a background in Engineering and Materials Science. Before joining the university, Berenika completed a PhD in Innovative metal processing at University of Birmingham (UK).

Isoporous block copolymer membranes with tuned pore size and functionality for ultra- and nanofiltration

Volker Abetz[1,2]*

[1]Institute of Membrane Research, Helmholtz-Zentrum Hereon, Germany; [2]Institute of Physical Chemistry, University of Hamburg, Germany

Abstract:

Different ways to manipulate diameter, length and functionality of pores in block copolymer membranes will be presented. Block copolymer membranes are prepared by self-assembly in combination with nonsolvent induced phase separation and display an integral asymmetric structure with a narrow-disperse pores in the top layer. Depending on preparation conditions of the membrane, the length of pores can be adjusted. Depending on the choice of the pore forming block, it may be reponsive to external stimuli, which leads to an adjustable permeation behavior of the membrane. The membrane can also be postmodified chemically in a variety of ways, which can affect the pore size and pore functionality. The pore forming block can be modified by organic polymer analogous reactions form the gas phase of in a non-solvent for the membrane in order to keep its structure unaffected. Such reactions can also be used to crosslink the pore forming blocks and adjust the degree of swelling, and by this the degree of pore closing in selective solvents for the pore forming block (which are non-solvents to the matrix). The reduction of pore size by inorganic coating in a controlled manner is also possible. The inorganic membrane surface can be further postmodified to become, i.e., electrically charged or fluorophilic. Examples of the performance of the different types of post-modified membranes will be presented.

Biography:

Volker Abetz received his diploma in chemistry (1987) and his PhD (1990) from University of Freiburg. In the following years, he worked at Max Planck Institute for Polymer Research, Institute Charles Sadron, Universities of Mainz and Bayreuth. He received his habilitation in 2000. In 2004, he joined the University of Potsdam as professor in polymer chemistry. Later, he was appointed as a director of the Institute of Chemistry at GKSS (now Institute of Membrane Research at Helmholtz-Zentrum Hereon) combined with a professorship at the University of Kiel. Since 2012, he is a professor of physical chemistry at the University of Hamburg joint with his position at Hereon.

Synthetic assembly of a series of glycopolymers having N-acetyl-D-glucosamine moieties

for evaluations of lectin—carbohydrate interactions

Koji Matsuoka*

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[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:

A series of water-soluble carbohydrate monomers having different methylene numbers of polymerizable aglycons were systematically prepared from N-acetyl-D-glucosamine (GlcNAc). A known oxazoline derivative derived from a GlcNAc peracetate was condensed with various alcohols having the corresponding w-alkenyl function. The acetyl protection on the glycosides was deprotected by means of trans esterification in MeOH with NaOMe as a catalyst to give the desired water-soluble glycomonomers, respectively. Typical radical polymerization in the presence of ammonium persulfate (APS)—tetramethylethylenediamine (TEMED) in water was applied for the monomers with acryl amide as a regulator for adjusting the average distance between carbohydrate residues, a series of glycopolymers having various densities of GlcNAc residues was obtained. Regulation of the polymers showed two pivotal points: one is the effect of lengths between carbohydrate residues and the polymer backbone and the other one is the influence of average densities of carbohydrates in the glycopolymer. Carbohydrate—protein interaction by means of the glycopolymer library for wheat germ agglutinin (WGA) as a model protein was investigated and the highest Ka value was obtained when the glycopolymer having the longest methylene length and the ratio of 1:10 (sugar unit : acrylamide unit) was used as a substrate.

Biography:

Koji Matsuoka is a Professor of Material Science, Graduate School of Science & Engineering, Saitama University (SU), Saitama, Japan. He received a Bachelor 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 100 research articles and book chapters in organic chemistry and polymer chemistry field.

Functional Polymer Association with PFAS Surfactants

Marina Tsianou

University at Buffalo, The State University of New York, Buffalo, NY, USA

Abstract:

Surface active per- and polyfluoroalkyl substances (PFAS) are used in a wide range of consumer products and industrial applications owing to their high chemical and thermal stability, their incompatibility with both water and hydrocarbons, and their unique ability to render surfaces non-stick. However, several PFAS surfactants are extremely resistant to degradation, accumulate in the environment, and can have adverse effects on human health. In the context of developing materials for sequestering PFAS surfactants from aqueous media, we research how such surfactants associate with other molecules or surfaces. To this end, we utilize complementary experiments (small-angle neutron scattering, SANS) and modeling (molecular dynamics, MD), and present examples on how the structure of micelles formed in water by the notorious PFAS surfactant perfluorooctanoate (PFOA) responds to the presence of polymers (poly(ethylene oxide) (PEO), PEO-based amphiphilic block copolymers, and polymer networks) across a wide range of compositions. A detailed description emerges on how PFAS distribute around polymer segments which is used to rationalize the macroscopic properties of the mixtures. Fundamental knowledge on PFAS surfactant–polymer interactions supports the design of new materials to selectively capture and remove PFAS pollutants from aqueous media. The capability established in our studies to predict from first principles micelle formation and structure, confirms that such multiple and often competing interactions have been properly accounted for. Micelles are relevant to environment and health in that PFAS surfactants, while typically found in very low bulk solution concentrations, they tend to accumulate on surfaces in the context of separations and biointerfaces.

Moisture Responsive Textiles with Artificial Leaf Stomata

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[1]Department of Fiber Science & Apparel Design, Cornell University, Ithaca, NY, USA

[2]Sibley School of Mechanical and Aerospace Engineering, Cornell University, Ithaca, NY, USA

[3]Institute of Textiles and Clothing, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

Abstract:

Smart textiles or membranes that can regulate their structures and properties depending on external stimuli, have many applications such as protective clothing, medical care products, food packing, nutrient/drug release and liquid separations. Smart textiles, which can regulate the opening or closure of their “stomata-like” pores depending on surrounding humidity without external energy input would maximize comfort and protection under varying physiological condition (i.e. changing sweating rate) and external environment. Here we report on the design and fabrication of novel artificial leaf stomata on a fabric surface, the pores of which open and close depending on the surrounding moisture condition. Its working mechanism is based on the differential swelling and bending of the “guard cells” as that in the real leaf stomata. The moisture permeability of the fabric with artificial leaf stomata increases by 56% when the pores opened under wet condition in comparison with that when the pores are closed under dry condition. This moisture responsive fabric can have a direct application in smart functional clothing such as sportswear. The concept can be further extended to developing smart materials for controlled nutrient or drug release and other relevant industrial applications.

Absorption, migration and permeation studies using a quartz crystal microbalance

Maria Teresa S. R. Gomes*

CESAM, Department of Chemistry, University of Aveiro, Aveiro, Portugal

Abstract:

Polymeric materials are often used due to their good barrier properties. Much attention has been paid to migration of polymer residues and additives to food. Less attention has been devoted to the absorption of vapors in the polymers, which can decrease the intensity of the aroma or flavor of the packed item. Permeation of oxygen, water vapor, carbon dioxide, food aroma compounds and many other gases and vapors can be an important source of problems. If, as in the case of fresh fruit packages, permeable plastic packages are commonly used, it is disgusting to fell the fishy smell when we open the refrigerator. Consumers cannot tolerate to feel the vapor from a perfume bottle, which was accidentally broken in the supermarket, or the smell of cleaning products inside a food package.

Permeation, migration, and absorption are phenomena that need evaluation. Very sensitive methods need to be used as exchanged quantities are often very small. Sensors based on piezoelectric quartz crystals are known by their sensitivity to mass. Besides, the study of permeation has much to gain if results could be obtained continuously, and in real time. Examples showing specially designed cell for the crystals, and experimental setup will be present, and advantages and difficulties of the methods will be discussed.

Biography:

Maria Teresa S. R. Gomes obtained a degree in Chemical Engineering at the University of Coimbra in 1983. Afterwards, she became a teacher assistant, until 1997, when she obtained a PhD at the University of Aveiro with the thesis “Development of sensors based on piezoelectric quartz crystals for CO2 and SO2”. At the present she is an associate professor at the University of Aveiro, and her current scientific interests are in the areas of analytical chemistry and sensors. She is president of the forum Ibersensor.

Functionalized Insulated Molecular Wires

Jun Terao

The University of Tokyo, Japan

Abstract not available

Size effects in nano-reinforced polymers and the influence of NPs surface chemistry – Case of PVDF and Fe3O4 NPs

Francisco Sebastian Navarro Oliva[1]*, Mehdi Sahihi[1], Luc Lenglet[2], Alejandro Ospina[1] and Fahmi Bedoui[1]

[1]Roberval Laboratory for mechanics, Sorbonne Universités, Université de Technologie de Compiègne, Rue du docteur Schweitzer, Compiègne, France;, France. Presenter

Abstract:

Polyvinylidene fluoride (PVDF) has attracted the attention of scientists essentially because of the piezoelectric properties of its β-phase polymorph. We electrospun films of PVDF with Fe3O4 NP with different sizes and grafted with oleic acid. By examining the size effect on the scaffold morphology (fiber size), mechanical properties and β-phase percentage, we found that while nanoparticle size acts as an enhancer for mechanical properties, it appeared as an inhibitor for β-phase crystallization. This result seemed in discordance with many previous results. A focus on local interaction between NP surface and PVDF chains revealed the influence of the surface chemistry of nanoparticles on the crystallization of the piezoelectric phase of PVDF. Molecular dynamics simulation results for systems of PVDF chains with slabs of -OH and oleic acid-grafted Fe3O4, showed that the probability of beta phase configuration decreases when the nanoparticles are functionalized with oleic acid and becomes more probable for -OH terminated Fe3O4. These computational results are in accord with our experimental results. We prepared films with purified nanoparticles (without the excess of oleic acid that acts as a β- polymorph inhibitor). As a result, the amount of β-phase obtained for purified NPs increases and the difference in the amount of β-phase between the different samples decreases. Moreover, when heated, the films of nanocomposite with purified NP develop more β-phase for smaller sizes of nanoparticles as changes in the molecular structure of grafted molecules enhances the α- to β-phase transition.

Biography:

Francisco Sebastian NAVARRO OLIVA is a third-year PhD student at the Université de technologie de Compiègne in France. He received a degree in Chemical Engineering at the Universidad Nacional del Comahue in Argentina in 2017. After 2 years studying at the UTC, he started his PhD in Materials Science in the Roberval Laboratory for Mechanics, whose title is Size Effects in NAno-Reinforced pOlymers (SENAREO): magneto-mechanical coupling.

Gene therapy for brain diseases including stroke and Alzheimer’s disease

Jang-Yen Wu, Jigar Modi, Subash Bhandari, Janet Menzie Suderam, Howard Prentice, Rui Tao, and Wen Shen

Department of Biomedical Science, Charles E. Schmidt College of Medicine, Florida Atlantic University, Boca Raton, FL, U.S.A.

Jang-Yen (John) Wu, Ph.D.

Schmidt Senior Fellow and Distinguished Professor Florida Atlantic University

Charles E. Schmidt

College of Medicine 777 Glades Road, P.O. Box 3091 Boca Raton, FL

Abstract:

Granulocyte colony-stimulating factor (GCSF) is a FDA-approved drug for enhancing blood cell formation. We as well as others have shown that GCSF has neuroprotective properties in animal models of stroke, Parkinson diseases (PD), Alzheimer’s disease (AD) and other neurodegenerative diseases. Protein therapy using GCSF is attractive because GCSF is well tolerated after systemic delivery. However, its plasma half - life is about 4 hours; moreover, there is potential for chronically elevating white blood cells during repeated delivery. To circumvent the limitation associated with protein therapy, we have developed a GCSF gene therapy for stroke and AD using adenovirus vectors, (AAV-GCSF), that would provide a sustainable level of GCSF over a long period of time under regulated condition such as in specified cells or under a specified physiological condition such as hypoxic condition. We have also developed a simple and non-invasive delivery system for AAV-gene vectors through eye-drop application and shown that the delivered gene does reach the brain

and express the gene products, both the GCSF mRNA and GCSF protein. We have demonstrated the efficacy of AAV-GCSF gene therapy for stroke and AD in animal models as indicated in marked improvement in brain functions at molecular/cellular and behavioral levels including reduction in infarct volume, decreased level of markers for apoptosis, endoplasmic reticulum (ER) stress, mitochondrial stress, increased level of anti-apoptotic markers and anti-inflammatory markers and improved cognitive function and locomotor activity.

Biography:

Wu received his Ph.D. from University of California, San Francisco, and his postdoctoral training at UCLA. Since then he has taught and conducted research at City of Hope Medical Center, Duarte, Calif., Baylor College of Medicine, Houston, TX, Pennsylvania State University, Milton Hershey College of Medicine and University of Kansas and Florida Atlantic University. He has more than 270 peer-reviewed papers and was recognized in the top 0.5% of the world's most cited authors by Current Contents/ISI in 2002. In addition, he has also received patents for his inventions in treating stroke, Parkinson's disease and other brain disorders.

Size effects in nano-reinforced polymers: hybrid modeling and experimental approach

Fahmi Bedoui[1,2,] Mehdi Sahihi[1], Sebastian Francisco Navaro-Oliva[1], Andres Jaramillo-Botero[2], Willaim A. Goddard[2]

[1]Roberval Laboratory for mechanics, Alliance Sorbonne Université, Université de technologie de Compiègne, Rue du docteur Schweitzer, 60200 Compiègne, France

[2]Materials and Process simulation Center, California Institute of Technology, 1200 East CaliforniaBoulevard, Pasadena 91106, CA, USA

Abstract:

The emphasis in the realm of reinforced polymers has been on increasing ultimate properties, such as maximum stiffness and the maximum load. Nano-reinforced materials were the answer to almost all of those questions. At the same time, the emergence of nanostructured systems raises new scientific questions ranging from materials processing to characterization of their physical behavior and appropriate modeling of their effective properties. The nano-structural-driven nature of nano-reinforced polymeric materials and which make them versatile also represents a challenge to deeply understand the nano-induced behavior. This behavior depends on a complex sequence of elementary phenomena that cross the length scales, ranging from atomic scales (Ångström) governed by QM and atomistic MD, transition through scales dominated by microstructures, and ending with the macroscale (cm and beyond) of the end-user's system. The consequence is that it is not yet possible to completely optimize technological systems based solely on engineering approaches. We must start to integrate modeling and optimization of the salient interactions into the design at each scale, to understand what impact they have on larger scales. The current experimentally-based engineering approach to developing new systems must be enriched and led by modeling, coupled with an experimental approach along with engineering system development. The general idea is to combine the best of computing, with the best expectations from the world of material science to shorten development time for new engineering systems resulting in more competitive manufacturing processes in the most high-demand emerging technology markets.

In this talk the focus will be put on two set of nano-reinforced polymers (PMMA + SiO2 and PVDF

+ Fe3O4 Nanospheres). The reinforcement size effects along with the interfacial interactions will be investigated toward the understanding of how these two aspects could tune the macroscopic mechanical and physical properties.

Biography:

Fahmi Bedoui is a mechanical engineering Scientist with an ongoing interest in polymers materials processing, characterization, and modeling. Well-versed in x-ray and neutron scattering techniques, polymer processing along with micromechanics and atomistic to elucidate structure-properties relationships in polymers and nano-reinforced polymers. His now extended to a more global and integrative approach for nanostructured design. In-silico design approach, combined with length scale characterization and processing, is used to help optimize nano-structured engineering systems with versatile functions. He holds a research faculty position at UTC along with research associate at the Materials and Process Simulation Cenetr at CalTec h. He is also the holder of the research Chain LEEGO jointly funded by UTC, the alliance Sorbonne University and CalTech

Exploring the Folding Mechanism of Small Proteins GB1 and LB

Jooyoung Lee*[1] and Qianyi Cheng[2], InSuk Joung1, Juyong Lee[3], Kunihiro Kuwajima[4]

[1]Korea Institute for Advanced Study, Korea; [2]University of Memphis, USA; [3]Kangwon National University, Korea; [4]University of Tokyo, Japan

Abstract:

The computational atomistic description of the folding reactions of the B1 domains, GB1 and LB1, of protein G and protein L, respectively, is an important challenge in current protein folding studies. Although the two proteins have overall very similar backbone structures (β-hairpin−α-helix−β-hairpin), their apparent folding behaviors observed experimentally were remarkably different. LB1 folds in a two-state manner with the single-exponential kinetics, whereas GB1 folds in a more complex manner with an early-stage intermediate that may exist on the folding pathway. Here, we used a new method of all-atom molecular dynamics simulations to investigate the folding mechanisms of GB1 and LB1. With the Lorentzian energy term derived from the native structure, we successfully observed frequent folding and unfolding events in the simulations at a high temperature (414 K for GB1 or 393 K for LB1) for both the proteins. Three and two transition-state structures were predicted for the GB1 and LB1 folding, respectively, at the high temperature. Two of the three transition-state structures of GB1 have a better formed second β-hairpin. One of the LB1 transition states has a better formed first hairpin, and the other has both hairpins equally formed. The structural features of these transition states are in good agreement with experimental transition-state analysis.

Biography:

Jooyoung Lee received his PhD in statistical physics from Brown Univ., USA in 1990. Since 2000, he has served as a professor in the school of computational sciences, Korea Institute for Advanced Study, Republic of Korea. His main research areas include development of computational methods. Recently, he has been applying his method of global optimization, Conformational Space Annealing to hard combinatorial optimization problems such as 3D modeling of macromolecules under various restraints, network module detection, material design, and chip design.

Parallel Session-1

ORAL

Bioinspired Mechanically Robust and Functional Ternary Nanocomposites

Paramita Das[1],* , Roop Singh Lodhi[1] , Hongwei Duan[2]

[1]Department of Chemical Engineering, Indian Institute of Science Education and Research (IISER) Bhopal, Bhopal 462066, Madhya Pradesh, India

[2]School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore

Abstract:

Nature provides the prime examples of lightweight, stiff, strong, and yet tough materials. Their unique properties are realized via the hierarchical self-organization of hard (inorganic, protein crystals, crystalline polysaccharides) and soft (organic, biopolymeric) building blocks. Nacre sets a gold standard for nacre-mimetic materials showing structural order, high mechanical, and functional properties. Inspired by the ternary nanocomposite structure of biological materials such as nacre made of layered aragonite platelet/chitin nanofibrils/protein, we developed ternary bioinspired nanocomposites based on: (1) carboxymethyl cellulose (CMC) acting as a soft phase and nanoclay platelets (clay) as well as graphene oxide (GO) nanosheets as hard building blocks and (2) CMC as a soft phase and cellulose nanocrystals (CNC) as hard phase surface functionalized with mussel-inspired polydopamine biopolymer, via evaporation-induced solution-based self-assembly technique. We mimic the structure of nacre and crustacean via selfassembly of polymer-coated nanofillers with intrinsic hard/soft character and fabricate films or foils with highly defined and tunable meso-structure. The polymer/nanofiller-based binary nanocomposites show either high stiffness and strength at the expense of toughness, or good strength and toughness compromising their stiffness. However, the ternary nanocomposites demonstrate synergistic improvement in mechanical properties through synergistic toughening of the reinforcing agents, good interfacial adhesion, and efficient interfacial stress transfer. We obtained bioinspired ternary nanocomposites exhibiting higher strength, stiffness, and toughness as compared to their binary counterparts. In terms of functionality, these nanocomposites show good thermal and mechanical stability, fire-retardancy, higher gas barrier, optical transparency and hence opens avenues for various engineering applications.

Biography:

Paramita Das is as an Assistant Professor in the Department of Chemical Engineering, IISER Bhopal, India. She received her doctoral degree with Magna Cum Laude from RWTH Aachen University, Germany in 2016. She did her postdoc from NTU, Singapore. She completed her M.Tech. from IIT Delhi and received DAAD scholarship in 2010 to pursue her master thesis in Germany. She received two bachelor degrees; B.Sc in chemistry in 2006 and B.Tech. in polymer science and technology in 2009 from University of Calcutta. She has 10 years of research experience in the field of colloidal self-assembly and functional polymer nanocomposites and published 21 peer-reviewed articles in high-impact international journals.

Bioinspired Polydopamine Modified Cellulose Nanocrystals/Sodium Carboxymethylcellulose Nanocomposites with Enhanced Mechanical Properties

Roop Singh Lodhi* and Paramita Das

Department of Chemical Engineering, Indian Institute of Science Education and Research (IISER) Bhopal, Madhya Pradesh, India

Abstract:

Bioinspired nanocomposites have attracted considerable attention as a novel, highperformance, lightweight, and eco-friendly composite materials for various applications. Natural high-performance materials inspire the pursuit of ordered hard/soft nanocomposite structures at high fractions of reinforcements and with balanced molecular interactions. Herein, we fabricate the bio-inspired nanocomposite films using naturally derived cellulose nanocrystals (CNCs) and sodium carboxymethylcellulose biopolymer as the nanofillers and the soft energy-dissipating phase, respectively, via water born evaporation-induced self-assembly (EISA) method. The surfaces of CNCs were further functionalized with a thin layer of polydopamine (PDA) biopolymer to improve the interfacial adhesion of the nanocomposite. Further the coating thickness was varied by changing the coating time. We have studied the effect of surface modification on the structure formation, moisture stability, mechanical, optical, thermal, and barrier properties of the nanocomposites. The CMC-PDA@CNC-24 nanocomposites have shown better-ordered structure, excellent mechanical properties enhancement, thermal stability, UV-blocking, and water stability as compared to pristine CMC films and CMC-CNC nanocomposites. At 50% RH, the nanocomposites with 80 % loading of PDA@CNC-24 exhibits enhancement in stiffness up to 5.7 times and strength up to 2.3 times at 60 % loading when compared to pure CMC. Moreover, the CMC-PDA@CNC-24 nanocomposites exhibit higher mechanical stability even at much higher relative humidity due to efficient interfacial adhesion. These mechanically robust eco-friendly nanocomposite films can be viewed as potential candidate for various environmental applications such as packaging, functional coatings, structural and barrier materials.

Biography:

Roop Singh Lodhi is currently a 4th year Ph.D. student in the Department of Chemical Engineering at Indian Institute of Science Education and Research Bhopal and is working under the supervision of Prof. Dr. Paramita Das. His doctoral research work is based on polymer nanocomposites for environmental applications. He works on cellulose nanocrystals-based bionanocomposites and hybrid hydrogels. He completed his M. Tech. with specialisation in environmental management and B.Tech. in Chemical Engineering from Ujjain Engineering College, India. He has published one review paper, two research articles, and two book chapters.

Electromagnetic Interference ShieldingPerformance of 2D-Layered Ti3C2Tx (MXene) Incorporated EMA/EOCTernary Blends Nanocomposites in the S-Band (2-4 GHz)

Nimai C. Nayak[1]*, Rajasmita Malik[1]

[1]Micro and Nano Materials Laboratory, Department of Chemistry, Faculty of Engg.& Technology (ITER), Siksha'O'Anusandhan (Deemed to be University), Khandagiri Square, Bhubaneswar, Odisha, India.

Abstract:

Newly establishedTi3C2Tx (MXenes) based polymer blend composites have attracted extensive attention in the field of EMI shieldingbecause of their excellent electrical conductivity (σ), hydrophilicity, and chemical activity. A set of Poly (ethylene-co-methyl acrylate) (EMA) and Ethylene-octene co-polymer (EOC) (50:50) blend composites were prepared with varying wt% of Ti3C2Tx loading by the solution casting followed by compression moulding method. The formation of blend composites is studied by FESEM, XRD,and thermal behaviour by DSC and TGA. SEM and EDX analysis allowed the determination of etching of Al layers from the 2D-exfoliated Ti3C2Tx flakes/ elemental composition of the blend composites. DSC analysis showed the crystallinity values decrease with the addition of Ti3C2Tx content and the thermogravimetry analysis revealed a constant enhancement of thermal stability and decomposition temperature with an increase ofTi3C2Tx loading.The EMI shielding effectiveness was studied by a network analyzer.It is found that with the addition of 15 wt% of Ti3C2Tx, the total EMI shielding value of -60.85 dB was achieved. The dielectric permittivity and magnetic permeability of the blend composites showed increasing behaviour with an increase in the concentration of Ti3C2Tx and also observed that quite low fluctuations at higher frequency range. the AC conductivity values increase with an increase in the concentration of Ti3C2Tx loading and obtaining the highest value of 19.63 S/m for 15 wt%; combined with good thermal and electrical properties.This EMA/EOC/Ti3C2Tx ternary composite perceives great potential application as high effective EMI shielding material.

Keywords

Ti3C2Tx (MXene), polymer composites, thermal behavior, electrical conductivity, EMI shielding.

Polymer composites incorporated with deep eutectic solvents and complex fillers with ionic liquids for enhancing of membrane separation performance

A. Pulyalina[1]*, V. Rostovtseva[1], I. Faykov[1], G. Polotskaya[1,2]

[1]Saint Petersburg State University, Russia; [2]Institute of Macromolecular Compounds, Russian Academy of Science, Saint Petersburg, Russia

Abstract:

Currently, one of the main industry tasks is to reduce resource and energy consumption. Membrane methods have great advantages in the field of separation of components from liquid and gas mixtures compared to standard separation methods. The advanced development of membrane technologies requires the design of novel polymer materials with characteristics that meet industrial requirements. A promising research direction is the use of ionic liquids (ILs) and deep eutectic solvents (DESs) for the modification of polymer matrix. ILs have already shown their positive effect on the permeability and selectivity of the membrane process. DES compounds are analogues of ionic liquids and, along with them, have properties that meet the principles of "green" chemistry, including ease of preparation, availability of constituent components, and no need for purification.

The aim of this work is to develop novel membranes based on polymers with involving firstly used complex modifiers (star macromolecules+IL) and polymer/DES composites, study their characteristics and separation parameters in purification of liquid and gas mixtures. The membrane morphology was studied by scanning electron microscopy. The membranes were also characterized

by contact angles measurement, Fourier trans- formed infrared spectroscopy, X-Ray diffraction, TG, DSC, quantum chemical calculations. The transport characteristics were studied by carrying out pervaporation experiments with organic media. The developed membranes demonstrates increase the flux with high separation effectivity, which indicates that DES and complex modifiers with IL can be considered as excellent candidates of novel fillers for polymer membranes.

Acknowledgments: This work was supported by the Russian Science Foundation (project 18-79-10116).

Biography:

Place of employment: Saint Petersburg State University, Russia; Position: Associate Professor, Deputy Director of the Institute of Chemistry, Saint Petersburg State University. The mail topics: polymer membranes, polymer composites, pervaporation, gas separation, ultrafiltration 2017-2022 – 35 article (more 60% of the article - Q1 journals). Grant of Russian Science Foundation "New membrane materials for the concentration of bioalcohols, as well as purification and regeneration of industrially significant solvents", grants of Russian Foundation for Basic Research, grants of the Government of Saint Petersburg in the scientific and scientific-technical and pedagogical spheres.

The use of products derived from waste tires (polymer rubber) via pyrolysis as additives for road pavements

Paolino Caputo[1*], Abraham A. Abe[1], Michele Porto[1], Valeria Loise[1], Valentina Gargiulo[2], Giovanna Ruoppolo[2], Michela Alfè[2], Pietro Calandra [3] and Cesare Oliviero Rossi[1]

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[3]CNR-ISMN, National Research Council, Institute of Nanostructured Materials

Abstract:

Waste tires pose significant environmental and health concerns if not recycled or discarded properly. In recent years, the interest of researchers in recycling waste tires for civil engineering applications has increased. Car tires are composed of approximately 50% of polymer (rubber). In this study, we evaluate the effectiveness of the polymeric parts (rubber) treated after pyrolysis process as additive for road pavement application.

The pyrolysis process of rubber tires yields both solid (char) and liquid (boil) products. In particular, the liquid part is used as a fluxing agent to lower the viscosity of bitumen while the solid part is used as a rheological modifier of binder. Fluxed bitumens are bitumen samples in which the viscosity of the binder has been reduced by the addition of relatively non-volatile oils. Typical fluxants include mineral and vegetable-based oils. Flux oils are generally used for two main applications: cold mix asphalt and bituminous emulsions. Conventionally, in cold mix asphalt technology, the most used fluxing agents contain solvents of petrochemical origin rich in hazardous aromatic compounds. Once the asphalt concrete is laid, the evaporation of these solvents allows the bitumen binder to recover its thick consistency. On the contrary, in bituminous emulsions, the fluxing agents are petroleum-derived high-boiling (initial boiling points above 350°C) compounds such as heavy distillates. In this case, they simply act by softening the bitumen and to increase the penetration grade of the bitumen. Nowadays, the research of environmentally and safety friendly substitutes of traditional fluxing agents has become one of the main topics in the bitumen industry. High-value liquid products derived from the reuse of waste tires through pyrolysis were explored as fluxing agents. It was found that the pyrolysis oil from tires acts as a fluxing agent with better properties than traditional vegetable oils and derivatives. The initiative of reusing materials at the end of their life cycle represents a feasible approach to mitigate waste tire disposal and a viable alternative to the use of edible vegetable oils (rapeseed oil).

KEYWORDS: bitumen, additives, fluxing agents, rapeseed oil, pyrolysis, tires, pyrolysis

Biography:

Caputo Paolino obtained his PhD in Life Science and Technology from the University of Calabria, Italy. He is currently a Temporary Research Associate (**RTDa**) in the department of Chemistry and Chemical Technologies at the University of Calabria. He is also an afferent of the National Inter-University Consortium of Materials Science and Technology (INSTM) which is the largest consortium of its kind in Italy, drawing on the expertise of not less than 50 universities – and all those that are active in Italy in researching advanced materials and technologies. Paolino Caputo's research focuses on physical chemistry with a main focus on bitumen characterization and food based industrial materials and compounds. He has over 50 publications with over 600 citations. He is also one of the inventors of the Anti-smoke Patent (release date: October 31, 2018; number 102016000041219).

Thermomechanical properties of semicrystalline thermoplastics: Experimental characterisation, constitutive modelling and numerical implementation

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[2]Aerospace Structures Centre for Aeronautics, Cranfield University, Cranfield, UK

Abstract:

Thermoplastics and thermoplastic-based composites have been a major trend in the vehicle industries and advanced processing technologies are highly demanded, of which the solid-state stamp forming attracts many researchers' interest thanks to its short cycle time and flexibility. To understand and optimise the solid-state stamp forming process, it is essential to study the thermomechanical behaviour of thermoplastics under the solid-state stamp forming conditions. In this research, two semicrystalline thermoplastics, Polyamide 6 (PA6, or Nylon 6) and Poly-Ether-Ether-Ketone (PEEK) are studied via uniaxial tensile tests at temperatures between their glass transition temperatures (Tg) and melting temperatures (Tm), and at different strain rates (0.001 – 50 /s). The temperature and strain rate effects are analysed quantitatively. The results show that temperature has significant effects on the thermomechanical behaviour of thermoplastics, while the strain rate effects are relatively marginal in the investigated strain rate range. Based on the experimental results and analysis, a new physically-based viscoelastic-viscoplastic constitutive model is proposed to simulate the thermomechanical behaviour of both materials. The model shows good prediction accuracy on tensile stress responses and provides an insight into the microstructural evolution of the semicrystalline thermoplastics. Furthermore, a VUMAT subroutine based on the constitutive model has been implemented in ABAQUS and validated by experimental results on these thermoplastics. The results and outcome of this research can be used to analyse

and simulate solid-state stamp forming of pure semicrystalline thermoplastics and thermoplastic matrix composites (TPMCs).

Biography:

Nan Li is a Senior Lecturer and Research Leader of the Advanced Manufacturing Group, at Imperial College London. Her team on Lightweight Design for Manufacturing addresses a major challenge facing the transport industry world-wide: developing technological breakthroughs in manufacturing and design of high-performance lightweight vehicles for a more environmentally friendly footprint. She has 60+ publications and 10 patents and is PI/Co-I of research projects funded by multiple research councils and companies. She was the 'Rowbotham Medal' winner by the Institute of Materials, Minerals and Mining (IOM3) for her outstanding contribution to the innovative use of materials for automotive applications.

Glycolysis of Polyurethanes Composites containing PCMs

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[1]*Department of Chemical Engineering, University of Castilla-La Mancha, Ciudad Real, Spain*

Abstract:

Polyurethane (PU) is one of the most relevant families of polymers with a huge number of specialties for a wide variety of applications, finding the building isolation between the main ones. PU foams composites containing phase change materials (PCMs) are being developed for the improvement of buildings energy efficiency, combining the foams isolation and the PCMs thermoregulating capacity.

Up to now, PUs wastes are mainly deposited in landfills, causing a high environmental impact. Glycolysis stands out as one of the most promising research fields for PUs recycling but there still much work to do such as the case of studying the recovery of all the components of PU composites. In this work, rigid PU foams containing microencapsulated PCMs constituted by a paraffin core (Rubitherm®RT27) and a polymer shell material (LDPE and EVA) have been glycolyzed by a single-phase glycolysis process employing crude glycerol as transesterification agent. A pure recovered polyol (71% of purity) was obtained using a mass ratio of PU scraps to crude glycerol of 1 to 1, a reaction temperature of 190°C and stannous octoate as catalyst in a 1.3wt% concentration. Besides, the developed process allowed to recover the microcapsules components and the polyol separately. This way, both components of the composite are recovered and can be reused in the manufacturing of new products. Finally, the recovered polyols were successfully employed to replace a raw rigid polyether polyol in the synthesis of new rigid PU foams.

Biography:

Associate Professor of the UCLM (Spain) from November 2020. From the same university she received her Ph.D. with honors (cum laude) in May 2011 and her degree in Chemical Engineering also with honors. Her research activities have been focused on the microencapsulation of PCMs, polyurethane foams composites and their recycling and polymer functionalization. She co-authored 3 research patents, 46 research papers, 64 participations in congresses and 2 book chapters. She has taken part in 16 research projects with European, National and Regional institutions and companies and has been awarded with the best "spin-off" in the CLM region Innovared Award.

Remarkable Enhancement of thermal and electrical properties for PEEK composite through a conducting network

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[3]Nanoscale and Microscale Research Centre (nmRC), University of Nottingham, University Park, Nottingham, NG7 2RD, UK

Abstract:

A nanostructure of graphene oxide (GO) and carbon nanotubes (CNTs) decorated with silver nanoparticles (AgGNT) has been prepared via a molecular-level-mixing (MLM) method followed by a subsequent freeze-drying and reduction process. The obtained well-dispersed AgGNT nanostructures were then applied as fillers to reinforce the poly(ether ether ketone) (PEEK) matrix. Owing to the unique morphology of AgGNT nanostructures, which made them uniformly dispersed in the PEEK matrix and formed a 3D network structure, the AgGNT-PEEK composites displayed much higher thermal conductivity and around 109 times better electrical conduction performance than pure PEEK, and superior thermal durability even above the melting temperature of pure PEEK. Thus, the AgGNT-PEEK composites have shown great potential for applications such as semiconductors, high-temperature electrical applications, aerospace, and automobile materials.

Biography:

Fang Xu is currently an assistant professor in Materials science, University of Nottingham, UK. She has obtained her Bachelor and Master degree in Materials Science and Engineering from Northwestern Polytechnical University, China in 2005 and 2008 respectively. She then graduated with her PhD in Materials Engineering from University of Exeter, UK. Her research has focused on two themes: 1. Creation and characterisation of novel nanostructures, 2. Functional nanocomposites towards advanced applications. She has so far co-authored over 40 peer-reviewed journal publications and established substantial expertise on the fabrication and characterisation of a wide range of nanocomposites and nanostructured materials.

Innovative closed-loop recyclable bio-based composites from epoxidated waste flour and recycled carbon fibers

Gloria Anna Carallo[1]*, Antonio Greco[1], Francesca Ferrari[1]

[1]University of Salento, Italy

Abstract:

Epoxy-based composites are designed for long-lasting applications, though their wide use is in contrast with their poor recyclability, which poses serious end-of-life issues. The use of precursors derived from fossil raw materials should be replaced with eco-friendly sources, thus allowing a further decrease of their environmental impact. In this paper, both strategies were analyzed, by replacing traditional monomers with epoxidated waste flour (EWF), an innovative bio-precursor derived from organic waste stream, and a cleavable hardener, which allows for the recyclability of the matrix. Finally, the recyclable matrix was reinforced with recycled carbon fibers, deriving from pyrolysis. DSC measurements were carried out in order to optimize the curing steps of the matrix, then flexural tests were performed to evaluate the mechanical response of the composite. A green recycling procedure was then investigated, which involves the use of non-toxic solvents and mild working conditions, which allows to recover the matrix still preserving the properties of the carbon fibers. The components obtained after recycling were analyzed by FTIR analysis, which revealed the presence of epoxy ring on the recycled waste flour. Hence, recycled waste flour was again used as a precursor and mixed with the cleavable hardener, thus obtaining a closed loop recycling.

Biography:

Gloria Anna Carallo is a second-year Ph.D. student in “Material, Structure and Nanotechnology Engineering” at University of Salento, Italy. She received a BSc. in “Industrial Engineering” and a MSc. in “Materials Engineering and Nanotechnology”, both at University of Salento, Italy. She is actually involved in research and development activities on composite materials, with a special focus on renewable raw materials analysis and processing. In particular, her research line is focused on bio-based epoxy systems design and characterization, with re-use and recyclable purposes in a life cycle approach.

Modeling hyper elastic behavior of 3D printed Kirigami-flex

Séverine A.E. Boyer[1]*, Alain Burr[1]

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Abstract:

Kirigami geometries have great potential for making highly stretchable devices [Lamoureux et al. 2015, DOI: 1038/ncomms9092]. These applications are demanding a material with a hyper elastic behavior. Thermoplastic PolyUrethane (TPU) offers these features. To determine the stiffness related to a 3D design of stretchable systems, a realistic modeling approach is needed. In our approach, two 3D geometries, i.e. a model tensile-bone specimen and a Kirigami specimen [Nakajima et al. 2020, DOI: 10.1016/j.addma.2020.101100], were printed with a SnapMaker 2.0 Fused Deposit Material (FDM) printer. The way of printing is fixed. A homogenous isotropic behavior was presumed for hyper elastic structures. Uniaxial tension tests with the use of Digital Image Correlation (DIC) are performed [Janeliukstis et al. 2021, DOI: 10.1016/j.compstruct.2021.114143] to identify specifically the Young’s modulus, the Poisson’s ratio, and the stress versus strain behavior of the material. Nevertheless, the tensile data are too poor to able a good representation of more complex loading conditions. This is due to premature rupture on tensile specimens. To overcome this limitation, an inverse analysis is leading to an optimal extension of the data from the tensile tests. From the gained data, a Constitutive Eq. (CEq.) was derived and optimized under the control of the criteria of stability of Drucker [Romanov 2001, DOI: S0021-8928(01)00017-X]. Finally, Finite Element Modeling (FEM) with the CEq. are then compared with experimental Kirigami findings. Acknowledgments: IMT with ALaRM (”Automatization of Laboratory Equipment through Rapid Manufacturing of Biopolymeric Multi-Material Parts”) and Roaming (“A Roadmap for Industrializing Additive Manufacturing”) projects.

Biography:

Séverine A.E. Boyer activities conduct fundamental and finalized studies on the mechanisms of the poly-morphogenesis/deformation of structural synthetic and natural organic systems to develop or to recycle functional and hybrid materials. Are developed chains of original experimental and numerical models linking the multi-scale structure, from chemical-molecular size to macroscopic size, in complex and extreme environments. International recognitions: Thesis - 'William F. Giauque Student Award, CALCON 2003 (USA)'; Young Researcher - "ICTAC Young Scientific Award, ICTAC 2012 (Japan)" (1st time awarded to a French researcher); 'First Place Best Poster, PPS 2019 (South Africa)'; and Awards deserved to her collaborative colleagues.

Conducting Polymer Based Composite Gel Electrolyte for Concurrent Solar Energy Harvesting and Storage

Arash Takshi[1]*

[1]University of South Florida (USF), USA

Abstract:

In most applications, an energy storage device is required when solar cells are applied for energy harvesting. The research at Bio-Organic Electronics Lab at USF is focused on novel composite materials for developing electrochemical devices with dual properties of energy harvesting and storage. We have studied the application of composite materials of a conducting polymer and dye materials for making electrodes of "photoactive supercapacitors". Devices with open circuit voltage of 430 mV and storage time longer than 2 hours have been demonstrated. Also, composite gel electrolytes with ability of conducting both ionic and electronic charges have been studied as a redox-photoactive electrolyte for concurrent energy harvesting and storage. In this work, it is found that the bulk electrolyte of a polyaniline (PANI) composite material can be used for storing charges generated via a photoredox reaction in the polymer. The results of the study are encouraging to further customize the composite gel for enhancing the energy conversion efficiency and storage capacitance.

Biography:

Arash Takshi is an Associate Professor of Electrical Engineering and a faculty affiliate in the Clean Energy Research Center (CERC) at the University of South Florida. Takshi's research group at USF was established in fall 2010. His group is active in the field of advanced energy materials, using conducting polymers, perovskite, and nanomaterials (Ag NW, ZnO NW, TiO2 nanoparticle, graphene, MoS2) for energy conversion and storage in electrical devices such as solar cells and supercapacitors. His research activities cover from materials synthesis/process to device fabrication/characterization/optimization.

Optimization of a Polymer-Surfactant Self-Assembling Network System for the Remediation of Sands Contaminated with Heavy Crude Oil

Laura Romero-Zeron[1]*, Salman Alribi[1]

[1]Chemical Engineering Department, University of New Brunswick, New Brunswick, Canada

Abstract:

The efficient removal of hydrocarbon pollutants from contaminated soils continues to be current environmental Issue. The pump and treat remediation process is commonly applied worldwide using an array of flushing solutions.

In this study, a self-assemble polymer-surfactant system (SAP) was optimized as a flushing solution to detach, mobilize, and displace hydrocarbon contaminants, in this case heavy crude oil. We hypothesized that the application of a polymer-surfactant self-assembly network would be more efficient as a flushing solution to dissolve and displace hydrocarbon pollutants. The SAP system formulated was based on a partially hydrolyzed polyacrylamide of medium molecular weight, an anionic surfactant, and b-Cyclodextrin. The optimization process evaluated the effect of different polymer, surfactant, and b-Cyclodextrin concentrations on the rheological performance of the SAP system. The performance of the optimum SAP was evaluated for salinity tolerance, thermal stability, mechanical stability, flow performance in porous media, and hydrocarbon removal efficiency.

The experimental results demonstrate that the optimum SAP network shows superior structural strength, salinity tolerance, mechanical stability, and thermal stability than the baseline polymer. The flow behavior of the optimum SAP system demonstrates a higher apparent viscosity and lower adsorption onto the porous media than the baseline polymer. In terms of hydrocarbon pollutant removal, the SAP system was more effective in removing heavy crude oil (> 85% removal) compared with the baseline polymer. Therefore, the optimum SAP network developed in this study seems to be effective as a flushing solution for the pump and treat soil remediation process.

Biography:

Laura Romero-Zerón, Ph.D., P. Eng. is a Chemical Engineer and professor in the Dept. of Chemical Engineering at the University of New Brunswick. Fredericton, Canada, since 2004. Her research interests include remediation of hydrocarbon contaminated soils, selective adsorption of pharmaceutical drugs and toxins using natural fibers, recycling and upcycling of plastic waste, recovery, and identification of biosurfactants, polymer-surfactant self-assembling systems, evaluation of synthetic and biopolymers functionality, rheological evaluation of polymer-surfactant systems, and pyrolysis of biomass waste to produce value-added bio-additives. Romero-Zerón has published more than 64 scientific papers including two book chapters and has edited two technical books.

Conjugated polymers pixelated devices for artificial retina

M. Shkunov*, L. Askew

Electrical and Electronic Engineering, Advanced Technology Institute, University of Surrey, Guildford GU2 7XH, United Kingdom

Abstract:

Photo-stimulation of semiconductor - biointerfaces provides efficient pathways towards eliciting neural activity in future bio-medical devices without wires. In applications to visual prosthesis, multi-colour excitation capability is key to restoring full-colour vision.

Organic semiconductor materials, such as conjugated polymers, bear intrinsic affinity to biological systems as they demonstrate excellent photoresponse characteristics, can conduct both electrons

and holes, and allow intimate interface with liquid bioenvironment. Importantly, different band-gap conjugated polymers demonstrate highly selective colour-response that can be tuned via chemical synthesis.

We demonstrate tri-colour optoelectronic devices based on solution-processable conjugated molecules with absorption in red, green and blue spectral regions, mimicking absorption of human retinal cones responsible for full colour vision. The devices do not require wiring or external bias to operate and are stable in aqueous physiological conditions. Specifically, photo-response of these devices is studied via interfacing with biological electrolyte solution. Upon long-pulsed excitation from monochromator-filtered light source, both photo-voltage and photo-current responses show some signatures of capacitive charging at the electrolyte/device interface and spectral response is also shown to deviate from optical absorption of dry films.

We further explore ink-jet printing to produce pixelated devices with red, green and blue absorption characteristics, to demonstrate capabilities of additive manufacturing for future bio-medical devices.

We discuss the suitability of conjugated polymers for potential medical applications as artificial retina devices for the restoration of human vision, and evaluate prospects of wider, colour-selective excitations of bio-interfaces

Biography:

Maxim Shkunov holds academic position at the University of Surrey (UK) and leads printed electronics at the Advanced Technology Institute, Electrical and Electronic Engineering Department. Maxim Shkunov current research interests include: flexible organic opto-electronics for bio-interfaces, charge transport phenomena in organic semiconductors, conjugated polymers photo-capacitors, plastic field-effect transistors, self-assembly, solution processable nanowire electronics, pi-conjugated liquid crystals, organic-inorganic hybrid devices and ink-jet printed electronics. Maxim Shkunov holds PhD from the University of Utah (USA), and has worked at the University of Cambridge (UK) and Merck Chemicals (UK). Maxim (co)-authored more than 130 publications, including articles in peer reviewed journals, book chapters and patents.

Advanced Polymer Ferroelectrics and Their Applications

Q. M. Zhang[1]*, Xin Chen[1], Wenyi Zhu[1], and Shihai Zhang[2]

[1]The Pennsylvania State University, USA; [2]PolyK Technologies

Abstract:

Owing to their high pliability, easy fabrication into complicated shapes, and light weight, polymer ferroelectrics have been widely used in sensors, transducers, and actuators. However, the low electromechanical (EM) coupling and low piezoelectric effect, compared with their inorganic counterparts, severely limit their performance and usefulness in these applications. This talk will present recent advances in ferroelectric polymers that exhibit the EM coupling and piezo-coefficient higher than the most widely used piezo-PZT ceramics. Such a high EM performance, in addition to improve the performance of the current devices in haptics, soft robotics, wearable sensors, and acoustic imaging, has the promise of realizing high efficiency energy harvesting.

An emerging area in which the polymer ferroelectrics have the most promise is the electrocaloric

(EC) cooling, as an alternative to the present vapor compression cycle cooling technology which is a major cause of greenhouse gas emissions. Polymer ferroelectrics are intrinsically possessing much higher polar-entropy change compared with their inorganic counterpart. Indeed, investigates in the past decade reveal giant ECE in polymer relaxor ferroelectrics (PRF), and EC cooling devices employing the PRFs show the potential of compact and high efficiency EC coolers. This talk will present recent advances in EC polymer cooling devices and breakthroughs of EC polymers in generating large EC temperature change at very low electric fields.

Biography:

Qiming Zhang is a Distinguished Professor of Engineering at the Pennsylvania State University. His research covers a broad range of electronic materials and their applications. Zhang developed the relaxor ferroelectric polymers which possess record high dielectric permittivity at room temperature and polymer thin film actuators with giant electroactuation. The relaxor polymers have been commercialized by Arkema. He founded Novasentis, Inc. (was acquired by KEMET in 2019) in commercializing the polymer thin film actuators and sensors, as well their haptics, wearable devices. In 2008, he developed ferroelectric polymers with giant electrocaloric effect, creating unique opportunity for solid state cooling with high efficiency and zero green greenhouse gas emission.

Value-added Functional Biomaterials from Renewable Resources

Zhaohui Tong*

Chemical and Biomolecular Engineering, Georgia Institute of Technology, U.S.A

Abstract:

Our society is facing long-term environmental challenges such as extreme climate change, resource and energy depletion, air pollution, food scarcity, water and soil contamination. To tackle these environmental and sustainable concerns and challenges, our team has been dedicated to synthesizing value-added functional biomaterials from renewable resources, especially bio-based waste from biorefinery, agriculture, and other resources. The adaption of chemical functionalization and self-assembling methodologies to renewable starting materials for functional materials is very challenging due to bio-based feestocks' macromolecular structures, heterogeneous properties, poor solubility, and the disturbance of impurities. In this talk, we will focus on how we explore new synthesis and functionalization methods/ reaction systems to attack these technical barriers. We will use some examples to describe a series of recently fabricated functional biomaterials for applications in the areas of environmental mitigation and human health. For example, a glycerol-based intelligent and sensoring food packaging film for a universal, accurate, easy-to-use, and real-time food spoilage monitoring system. Besides, smart materials with controllable release functions have been synthesized from low-cost agricultural residues to improve nutrient (N, P, and micronutrients) utilization efficiency in agriculture and reduce environmental pollution to soil and water. The biocompatible and tunable biocomposites derived from lignin and cellulose can achieve prolonged, stimuli-driven, and slow drug release function. Ultimately, we would like to utilize a waste-treat-waste approach to fabricate value-added functional materials to achieve a high-efficiency circular bioeconomy.

Biography:

Tong is an associate professor in the School of Chemical and Biomolecular Engineering at the Georgia Institute of Technology (GT). She obtained her Ph.D. degree in chemical engineering at GT in 2007. After the two-year industrial experience, she worked as an assistant and associate professor in the Agricultural and Biological Engineering Department at the University of Florida from 2010-2021. Tong's research focuses on the development of innovative technologies for producing chemicals, materials, energy, and fuels from renewable resources. She has led many multidisciplinary Federal-funded projects and published over 50 peer-reviewed journal articles.

Functional and Responsive Polymer Brushes via Surface-Initiated Atom Transfer Radical Polymerization

Jian Wang*[1,2] and Harm-Anton Klok[2]

[1.]Department of Chemistry, University of Illinois Urbana–Champaign, Urbana, Illinois, United States

[2.]Institut des Matériaux and Institut des Sciences et Ingénierie Chimiques, Laboratoire des Polymères, École Polytechnique Fédérale de Lausanne (EPFL), Bâtiment MXD, Station 12, CH-1015 Lausanne, Switzerland

Abstract:

The preparation of polymer brushes by surface-initiated atom transfer radical polymerization (SI-ATRP) techniques has become a powerful approach to tailor the chemical and physical properties of interfaces.1, 2 Taking advantage of the assets of SI-ATRP, we study the fundamental research questions with regard to the sensitivity of chemical bonds towards mechanical forces in polymer brush system in the first part.3 In the second part of this research, we focus on the development of thin polymer films that allow to control adhesion between synthetic materials and tissue. PHEMA brushes have been prepared that can be transformed, on-demand using UV light from a non-fouling surface coating into a bioadhesive interface.4 The third part of the research attempts to understand the pyroelectric behavior of thin PE brushes prepared via SI-ATRP. This part builds upon the serendipitous discovery that was made when a substrate modified with a PE brush was connected to an open circuit and subjected to an alternating sequence of temperature changes. Surprisingly, a clear current change was detected in the circuit upon the temperature change. We hypothesize that the pyroelectric current which is generated upon applying an alternating sequence of temperature changes because of a permanent dipole moment in the materials. This permanent dipole moment is believed to be the consequence of a non-neutral net charge within the polymer brush film.

Biography:

Jian Wang was born in 1989 in Jilin Province, China. He received his B.Sc. from the College of Chemistry, Jilin University, in 2012. After that, he became a master student under the guidance of Professor Yapei Wang at the Department of Chemistry, Renmin University of China. In 2015, he joined Professor H.-A. Klok's group in École Polytechnique Fédérale de Lausanne (EPFL), Switzerland as a Ph.D. student. In 2021, he became a SNSF postdoc in Professor Jeffrey Moore group in UIUC. His research mainly focuses on responsive and functional polymers at interfaces and plasma electrochemistry.

Influence of Montmorillonite's d-Spacings on Heat Release Rate of an Intumescent Formulation in Fire Spread: A theoretical Study

Ana Lucia Ventapane[1]*, Simone Pereira da Silva Ribeiro

[1]Chemistry Institute, Federal University of Rio de Janeiro, Brazil

Abstract:

Polymer materials are easily flammable. As a result, it can cause several risks to human and the environment. The ignition is a very important step in chemical process of burning because the radiative heat flux is a relevant parameter for evaluating flashover. To reduce the effects of fire development, the heat release in these reactions must be reduced. The flame retardant additives have increasingly become a preventive protection in polymers against fire. The use of intumescent formulations has been presented as an eco-friendly flame retardant compared to others, such as halogen flame retardants. A strategy to increase the flame retardancy properties in intumescent formulations is the use of synergistic agents such as montmorillonite. In a previous work the influence of presence and d-spacing of the commercial montmorillonite Cloisite Na, Cloisite 30B and Cloisite 15A on ammonium polyphosphate (APP) and pentaerythritol (PER) formulations in polyethylene-co-butylacrylate) (EBA-30) composites was investigated. The montmorillonites with d-spacing up to 18.2 A demonstrated a positive effect on char formation generating a large reduction in heat release rate (HRR). However, montmorillonite with d-spacing greater than 30 A did not lead to a significant reduction of HRR measured by the Cone Calorimeter. To evaluate the results in a flame behavior analysis in domestic environment, computational modeling was developed, such as the Fire Dynamics Simulator (FDS). The present work aims to evaluate, throughout theoretical studies, the effect of montmorillonite's d-spacing s in an intumescent formulation containing APP and PER using the HRR of these composites by computational fluid dynamics.

Biography:

Currently completing a master's degree in chemistry on the post-graduation program in chemistry from Federal University of Rio de Janeiro (PGQu/UFRJ) and obtained a bachelor's in chemistry from the Federal University of Rio de Janeiro (2021). Making part of a research group in Studies Laboratory for the Environment and Energy (LEMAE) developing theoretical studies in intumescent formulation as a flame retardant.

Disappearance of polyelectrolyte peak in salt-free solutions

Alexandros Chremos[1*], Ferenc Horkay[1]

[1]Section on Quantitative Imaging and Tissue Sciences, Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, Maryland, USA

Abstract:

A characteristic feature of polyelectrolyte solutions is a broad peak in the scattering profiles, suggesting a liquid-like ordering on a length scale of the size of the polymers and it is often referred to as the "polyelectrolyte peak" due to its ubiquitous nature its absence in neutral polymer solutions. We found with molecular dynamics simulations that the polyelectrolyte peak progressively disappears as the strength of solvation for the charged species is increased and the scattering profiles start to resemble those of neutral polymer solutions. These findings are

further supported of two polyelectrolytes having similar monomer structures (hyaluronic acid and chondroitin sulfate), but one exhibits a well-defined scattering peak while the other does not. We propose that the disappearance of the polyelectrolyte peak coincides with the emergence of attractive interchain interactions over a wide range of length scales. Our findings provide insights into the microscopic origin of the polyelectrolyte peak.

Biography:

Chremos received his Ph.D. in Chemistry from Edinburgh University under Prof. Philip Camp. Since then he has worked at Princeton University and Imperial College, and National Institute of Standards and Technology and has published over 60 papers in high impact journals and book chapters. He develop methods and technology aimed at creation of stronger, lightweight, and cost-effective materials suitable for the development of advanced materials and materials for infrastructure and every life that also do not have a negative impact on the environment. Currently he works as a consultant for National Institutes of Health for the design gel materials as replacements of articular cartilage.

Simultaneous improvement of stability and durability of composite membrane containing polyhedral oligomeric for PEM fuel cell and water electrolysis

Anima B. Bose

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

Abstract:

The PEM Fuel Cell (PEMFC) and Water Electrolysis (PEMWE) received strong attention recently because of the rapid increase of electrical devices and green-hydrogen consumption demand. One of them is the fabrication of a simultaneously applied membrane with high chemical, mechanical stabilities, and low dimensional swelling ratio. In this study, a series of NafionTM-plus membranes were successfully fabricated via NafionTM and polyhedral oligomeric POSS in flexible solvent options. The hydration, mechanical and electrochemical properties of NafionTM -plus membrane were evaluated and compared to the NafionTM membrane with various operating conditions. The NafionTM -plus showed a new benchmark compared to the state-of-art NafionTM membrane with higher mechanical stability and lower hydration property. In PEMFC study, the peak power density of NafionTM is 350 mW cm-2 while that of the NafionTM-plus is over 600 mW cm-2. In addition, the NafionTM-plus membrane showed very comparable PEM water electrolysis, PEMWE performance to the state-of-art NafionTM membrane, with the current density of 0.625 A cm-2 in the range potential 2.25 V at room temperature.

Biography:

Anima (Ani) Bose received her M.S. degree in solid state physics from Georgetown University in Washington, D.C., Ph.D. in Materials Chemistry from Kent State University, and completed her postdoctoral fellowship in polymer engineering at the University of Akron. Before joining the University of Houston, she worked as a Research Assistant Professor at Ohio University, and served as an Assistant Director of Fuel Cell Initiatives at Northern Illinois University. Her research interests are in the areas of integrated fuel cell technology, energy storage materials, and ion conducting membranes. She has extensively published her materials science and fuel cell technology in many high impact journals such as Journal of Power Sources and Journal of the American Chemical Society, and presented talks as invited symposium speaker at many national and international conferences. She is an author of four issued and three pending patents. Her patents deal with developing efficient oxygen reduction catalyst for fuel cell, remediating water flooding in Proton Exchange Membrane Fuel Cell, boron-carbon meso-sphere materials for batteries, and non-gasoline hybrid vehicle power sources.

Advanced Mechanical Recycle Process based on Physical Degradation / Physical Regeneration Theory

Shigeru Yao*

Institute for Creation of Functional and Structural Materials, Fukuoka University, Japan

Abstract:

Mechanical recycling is an indispensable technology to solve the problem of the environmental load of waste plastics and to establish a resource circular economy. However, conventionally, waste plastics have been irreversibly deteriorated in mechanical properties due to chemical degradation accompanied by molecular chain breakage, and it has been said that they can be applied to almost one-time downgrade recycling.

On the other hand, from the basic investigation, we have found that the main cause of this deterioration of mechanical properties is physical degradation due to structural deformation inside of the plastic, and it is possible to improve the mechanical properties by optimizing the molding method. According to this investigation, we proposed the Physical Degradation / Physical Regeneration Theory. Furthermore, it has been clarified that the mechanical properties can be improved efficiently by using a new designed extruder with molten resin reservoir used when repelling waste plastic.

Biography:

Shigeru Yao, Doctor of Engineering, now is a Professor of Department of Chemical Engineering, Fukuoka University. He got his B Eng., M Eng., and Engineering Doctor’s degree at Kyoto University. He worked at Ube Industries, Ltd. and Mitsubishi Research Institute, Inc.. From 2011, he is working at Fukuoka University. Currently Shigeru Yao researches focus on mechanical recycle process of waste plastics based on “Physical degradation and Physical regeneration theory”. He also focus on self-organization mechanism of polymer and especially the crystalline supramolecular interaction between side chain crystalline block co-polymer and crystalline polymer.

Mechanically Tough Composite Gels Reinforced by Inorganic Particles and Nanofibers

Hiroyuki Takeno*

Gunma University, Japan

Abstract:

Gels prepared in conventional methods are mechanically weak and brittle. The incorporation of fillers such as inorganic nanoparticles and nanofibers into polymer gels is one of the ways of

circumventing such drawbacks. For the production of composite gels with excellent mechanical performance, various preparation methods have been developed to date. It is important to produce composite gels with excellent mechanical performance in simple and affordable ways in terms of efficiency and sustainability. This presentation will provide the strategy. In the previous works {Colloid Polym. Sci. (2013), Polymer (2016), Appl. Clay Sci. (2016), Gels (2017) Colloid Polym. Sci. (2019)}, we suggested three key factors indispensable for the preparation of mechanically tough clay/polymer nanocomposite; (i) dispersibility of clay nanoparticles, (ii) connection between clay and polymers, and (iii) the use of ultra-high molecular weight polymers higher than a few million. In recent works, we demonstrated that the combined use of a nanofiller and a conventional cross-linker {Cellulose (2020), Colloids Surf. A (2021), Gels (2022)} and the use of two kinds of nanofillers {Mater. Today Commun. (2021), Gels (2022)} have been effective for the preparation of mechanically excellent composite gels, and these composite gels are constructed by multiple cross-linking.

Biography:

Hiroyuki Takeno is currently an associate professor in the Division of Molecular Science, Graduate School of Science and Technology, Gunma University, and in the Gunma University Center for Food Science and Wellness, Japan. He earned his bachelor's degree in 1992 and his doctoral degree from Kyoto university in 2000 under the supervision of Takeji Hashimoto Hiroyuki Takeno research interests lie in soft material physics and material science. In particular, his current interests are studies on the mechanical and structural properties of composite gels and food gels using synchrotron SAXS, WAXS, SANS, and FT-IR techniques.

Carbonic Acid Capture-Induced Self-Assembly into Polymer Materials

Eri Yoshida*

Department of Applied Chemistry and Life Science, Toyohashi University of Technology, Japan

Abstract:

Global warming by greenhouse gas emissions is a pressing issue worldwide. However, satisfactory methods have not been found yet to solve this problem. With the aim of reducing CO2 emission, this study utilized CO2 as a component of polymer materials. This paper describes the synthesis of polymers by their self-assembly induced by capturing carbonic acid in aqueous media.

Poly(2,2,6,6-tetramethyl-4-piperidyl methacrylate) supporting the hindered amine of 2,2,6,6-tetramethylpiperidine (TP), captured carbonic acid in an aqueous dispersion. The polymer dispersion turned into a clear solution due to the protonation of the TP into its quaternary ammonium bicarbonate. The tetramethylpiperidinium bicarbonate-containing polymer underwent electrostatic ion exchange with poly(sodium 4-styrenesulfonate) (PSS), producing water-insoluble polymer complexes. The complexes were dissociated by introducing N2, which depended on the PSS molecular weight. The PSS with Mn = 1,100 reversibly repeated dissociation-association of the complexes by alternative N2/CO2 introductions. On the other hand, the PSS having Mn = 14,900 stored the carbonic acid in the tight aggregates. The aggregates had specific morphologies depending on the PSS chain length. The short PSS produced a ribbon-like morphology of the aggregates due to the linear complexes, while the long PSS provided planar morphology based on the network complexation. These findings indicate that the capture and storage of carbonic acid by the hindered amine-supporting polymer create new plastics composed of carbonic acid, which helps preserve the marine ecosystem from ocean acidification.

Biography:

Eri Yoshida has completed her Ph.D. in polymer engineering at the Tokyo Institute of Technology, Japan. After her Ph.D. completion, she joined the Kyoto Institute of Technology as an Assistant Professor. She was also a visiting scientist at the University of North Carolina at Chapel Hill. She is an Associate Professor at the Toyohashi University of Technology. She has published more than 120 papers in reputed international journals and has 24 patents. She is an editorial board member of 8 international journals.

Plasma-treated Carbon Nanotubes Reinforced Polyimide Nanocomposites

Seira Morimune-Moriya* and Keiya Obara

Department of Applied Chemistry, College of Engineering, Chubu University, Matsumoto, Kasugai, Japan

Abstract:

In this study, polymer nanocomposites based on polyimide (PI) and nanodiamond (ND) were prepared by in-situ polymerization. ND is a hydrophilic nanocarbon with the size of less than 10 nm with excellent properties derive from diamond such as high modulus, high hardness, high thermal conductivity and so on. Due to several oxygen containing functional groups on the surface, ND can be readily dispersed in water at nanoscale. In the present study, polyamic acid (PAA), a precursor of PI, was polymerized in the presence of ND. As a result, ND was homogeneously dispersed in PI at nanoscale. The FT-IR spectra indicate that amide bond was formed at the interface between PI and ND, showing that the strong interfacial interaction was produced. The nanocomposites showed excellent enhancement in the mechanical and thermal properties at very low content of ND. The Young's modulus increased approximately by 70% at ND content of 0.1 wt%. The strong enhancements in the thermal decomposition temperature (544 °C à 572 °C) and the melting point (593 °C à 610 °C) were achieved by the addition of only 0.01 wt% ND loading. It was suggested that the molecular motion of PA66 was effectively suppressed by well dispersed ND with the strong interactions. Moreover, the PI/ND nanocomposites exhibited the high thermal conductivity comparable to that of commercially available thermal interface materials.

Biography:

Seira Morimune-Moriya is a senior assistant professor in College of Engineering at Chubu University. She received her B.Eng., M. Eng. and Ph.D. degrees from Kobe University. During her Ph.D. course, she worked as a JSPS research fellow (DC2). After obtaining her Ph.D. degree, she worked as a JSPS research fellow (PD) followed as a postdoctoral fellow at Nagoya University. In 2015, she started her academic career as an assistant professor at Chubu University. Since 2018, she has been in the current position. Her research interests include the design of polymer composites/nanocomposites, characterization of polymer structures/properties and functionalization of nanofillers.

Entropy Driven Ultratough Blends from Brittle Polymers: Mechanisms and Applications

Hou Xunan[1] and He Chaobin[1,2] *

[1]Department of Materials Science and Engineering, National University of Singapore

[2]Institute of Materials Research and Engineering, A-star

Abstract:

Polymer blends with synergetic performance play an integral part in modern society and the compatible polymer systems often relies on strong chemical interactions. By contrast, the role of entropy in polymers is often neglected. In this presentation, I will discuss our new findings that entropy effect could control the phase structure and mechanical behaviors of polymer blends, which could transform the intrinsic brittle polymers into ultratough polymer blends.

We found that, for weakly interacting polymer pairs such as polylactic acid (PLA) and polymethylmethacrylate (PMMA), the seemingly small mixing entropy favours the formation of nanoscale co-continuous structures. The abundant nanointerfaces combined with the high entanglement due to entropy effect could initiate large plastic deformations by crazing or shear, thus, transforming brittle polymers (elongation < 9%) into super-ductile materials (elongation ~ 146%). The resultant polymer blends display high transparency, strength (~70 MPa), and toughness (~60 MJ/m3) beyond most engineering plastics.[1]

The principle of entropy-driven blends have also be applied in other polymer systems, offering a strategy to develop mechanically robust bulk polymeric materials. For example, this concept has been successfully applied to select polymers as compatibilizer for non-miscible polymers of polyhydroxybutyrate (PHB) and PLA to derive ultra-tough polymer blends,[2] to use entanglement to tailoring the crystalline morphology of PHB so as to overcome its inherent brittle behaviour which is effected strongly by crystalline morphology,[3] and to design ultratough, malleable and foldable biocomposites for robust green electronic devices. [4]

Biography:

Chaobin He is an Associate Professor at Department of Materials Science and Engineering, National University of Singapore and hold a joint appointment as a Principal Scientist at the Institute of Materials Research and Engineering, A-star, Singapore. He obtained his Ph.D. degree from Dept of Materials Science and Engineering, Cambridge University. Before moved to Singapore, he worked as a postdoc fellow at Cavendish Laboratory, Cambridge University and USM in USA. His research interests are in areas of polymer composite and nanocomposites, green plastics and functional polymers and self-assembly. He is an author of over 300 journal papers with an h-index of 64 (ISI) and a co-inventor of over 30 patents.

4D Printed Smart Scaffolds Programming Neural Stem Cell Differentiation

Ying Zhong*, Yi Yang, Omar Khater, Nathan Gallant

University of South Florida, USA

Abstract:

The limited regeneration capability of “permanent” cells is the major reason for the continuous suffer and limited treatment options for patients who are suffering from serious health conditions including spinal cord injury (SCI) and myocardial infarction (MI). Stem cells, which can be derived from adult tissues can generate almost all types of cells under the right condition, including neurons and other nervous system cells. Differentiation of the patient's own stem cells can be an effective solution with advantages of providing personalized therapy, preventing immunoreaction, and reducing recovery time. However, for high-quality SCI recovery, the newly generated cells need to be well aligned with each other to form a neural buddle, similar as their original alignment in the undamaged spinal cord. Unfortunately, current stems cell differentiation procedures are lack of direction or control, the newly generated axons are distributed randomly with limited length of neurites, severely impact its effectiveness in SCI repairing. Finding efficient solutions to program and guide the differentiation of stem cells to functional nerves and eventually aligned bundles is the most important step to benefit SCI patients with enhanced reconnection and recovery capability. We designed and 4D printed multilayer smart scaffolds to guide and program the differentiation of neural stem cells. In this talk, I will share the working mechanism and functionality of our 4D printed smart scaffolds in this application.

Biography:

Ying Zhong is a tenure-track assistant professor at Department of Mechanical Engineering at University of South Florida (USF). She received her Ph.D. from University of California at San Diego (UCSD) in 2017. She continued her work as a postdoctoral researcher in UCSD for two years before starting her career at USF. Within her first three years at USF, she has secured three NSF awards ($1.24 Million), including the NSF CAREER Award. The GREEN lab at USF directed by Zhong is conducting Green Research for Energy-Efficient iNnovations in advanced manufacturing field to address energy and healthcare problems. She is the recipient of the 2022 USF Excellence in Innovation Award.

Functionalized Nanomagnetic Cellulose-Polyethyleneimine for Removal of RB5 Dye

Norzita Ngadi* and Abu Hassan Nordin

Scool of Chemical and Energy Engineering, Faculty of Engineering, Universiti Terknologi Malaysia, Skudai Johor MALAYSIA

Abstract:

In this study, cellulose from oil palm empty fruit bunch was modified with polyethyleneimine (PEI) and magnetic nanoparticles via crosslinking method to remove reactive black 5 (RB5) dye. The best conditions to prepare the magnetic-PEI-cellulose adsorbent were investigated and the results obtained for cellulose to PEI ratio is 2:1, impregnation time is 6 hours, crosslinking contact time is 60 mins, volume of glutaraldehyde is 1 ml and cellulose-PEI to magnetic nanoparticles ratio is 2:1:0.25. Then, the synthesised magnetic-PEI-cellulose was characterised using Fourier transform infrared spectroscopy, Brunauer Emmett Teller surface area, vibrating sample magnetometer and point of zero charge. A batch adsorption experiment was conducted and the results obtained were excellent, with almost 100% RB5 removal under the following conditions: 180 min of contact time, 0.1 g of adsorbent, 0.1 g/L of initial RB5 concentration, pH 7 and at 27°C. Kinetics, isotherm and thermodynamics evaluation were also performed for the adsorption data. The adsorption data fitted well to the pseudo second order model with the influence of intraparticle diffusion. For isotherm study, the data best fitted to the Langmuir model ($\chi 2$ = 3.478E-09) with the maximum

adsorption capacity of 330 mg/g. A thermodynamics analysis shows that the adsorption was endothermic, random and spontaneous. The magnetic-PEI-cellulose is able to be regenerated and reused for 4 times with RB5 percentage removal above 70%. In conclusion, magnetic-PEI-cellulose was successfully demonstrated and can be used as a new promising adsorbent for the removal of dye from textile wastewater

Biography:

Norzita Ngadi is an Associate Professor in School of Chemical and Energy Engineering, Faculty of Engineering, Universti Teknologi Malaysia (UTM), where she has been a faculty member since 2002. She received her Ph.D. degree from University of Canterbury, New Zealand in 2010. Norzita Ngadi obtained her M.Eng in Chemical Engineering from UTM in 2002, after completion of her undergraduate study in Universiti Sains Malaysia. Her research interest includes wastewater treatment, catalytic reaction, renewable fuel and surface coating. She has published over 200 articles in journals and conference papers.

Polymeric membranes for H2 separation

(Neal) Tai-Shung Chung

Graduate Institute of Applied Science and Technology, National Taiwan University of Science and Technology, Taipei, Taiwan

Abstract:

Clean water, clean energy, global warming and affordable healthcare are four major concerns globally resulting from clean water shortages, high fluctuations of oil prices, climate changes and high costs of healthcare. Clean water and public health are highly related, while clean energy is essential for sustainable prosperity. Among many potential solutions, advances in membrane materials and technology are one of the most direct, effective and feasible approaches to solve these sophisticated issues. Membrane technology is a fully integrated science and engineering which consists of materials science and engineering, chemistry and chemical engineering, separation and purification phenomena, environmental science and sustainability, molecular simulation, process and product design. In this presentation, we will introduce and summarize our efforts on polymeric nanomaterials for membrane development in the fields of H2 purification and separation. Various material and fabrication strategies to enhance membrane performance will be discussed.

Biography:

Chung is a Jade Mountain Chair professor at National Taiwan University of Science and Technology (NTUST). Before joining NTUST, he was a Provost's Chair Professor at National University of Singapore in 2011-2021. His research focuses on polymeric membranes for clean water and clear energy. He became a Fellow in Academy of Engineering Singapore in 2012 and received IChemE (UK) Underwood Medal and Singapore President's Technology Award in 2015. His H-index = 115 (Scopus) or 135 (Google Scholar). He is an editorial board member of > 20 journals including J. Membrane Science, Env. Sci. & Tech., AIChE J, I&EC Research.

Mechanical Property of Epoxy-Modified Cyanate Ester Resin Containing Liquid Crystal Domains

Satoshi Yanaura1*, Miyuki Harada[1]

[1]Kansai University, Japan

Abstract:

The maximum junction temperature (Tjmax) of inverter module is on the rise. Currently, modules operating at 200 °C are being developed. High glass transition temperature (Tg) is also required for the resin used as the insulating material of the inverter module. In this high temperature range, the application of cyanate ester resin is considered as well as the conventionally used epoxy resin. Cyanate ester resin is known for its high heat resistance, but it is not widely used due to its brittleness. We have investigated the improvement of toughness of cyanate ester by epoxy modification. The cured product containing liquid crystal domains was obtained by modifying bisphenol A dicyanate ester (BADCY) with diglycidyl ester terephthalylidene mesogenic epoxy, which has low solubility in BADCY and with organophosphine catalyst. The mixture of BADCY and the mesogenic epoxy showed clear before the curing reaction, but reaction-induced phase separation occurred as the curing reaction progressed. This phase-separated structure provided high toughness because fine cracks were generated inside the liquid crystal particles and absorbed the fracture energy. The toughness of this system was about twice that of the unmodified BADCY cured product.

Biography:

Satoshi Yanaura done Bachelor of Engineering, Tokyo University of Agriculture and Technology 1983 Mitsubishi Electric corp. Japan 1983 – 2018 Kansai university Japan doctor's course 2018.

Parallel Session-2

ORAL

Chitosan Functionalized Isatin Thiosemicarbazones: Synthesis, Characterization, and Anticancer Activity

Hari Sharan Adhikari[1], Aditya Garai[2], Krishna Das Manandhar[3], Paras Nath Yadav[4]*

[1]Institute of Engineering, Pashchimanchal Campus, Department of Applied Sciences, Tribhuvan University, Pokhara, Nepal

[2]Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore, India

[3]Central Department of Biotechnology, Tribhuvan University, Kathmandu, Nepal

[4]Central Department of Chemistry, Tribhuvan University, Kathmandu, Nepal

Abstract:

The incorporation of thiosemicarbazide moiety on to amino group at C2 position of chitosan ring, and the condensation with isatin was employed to get chitosan functionalized as chitosan isatin thiosemicarbazones, and the corresponding copper(II) complexes were synthesized. Functionalization was confirmed by FT-IR, 13C NMR spectroscopic studies and CHNS elemental analysis. The NNS tridentate coordination behavior of thiosemicarbazones with copper(II) ion to form the complexes of square planar geometry were shown by FT-IR and EPR spectral data, elemental analysis and magnetic moment values. The changes in original crystallinity phases of chitosan accompanying these processes were indicated by powder X ray diffraction curves. An intact thermal endurance and minimal loss in weight up to 250°C, and then a steady progression of chitosan backbone degradation was shown by thermal studies. The MTT assay against the tumorigenic MDCK and MCF-7 cancer cell lines in vitro showed higher activity of low molecular weight commercial chitosan thiosemicarbazone (IC50 351 µgmL-1 in MDCK and 370 µgmL-1 in MCF-7 cell line) than its high molecular weight crab shell chitosan analogue (IC50 358 µgmL-1 in MDCK and 384 µgmL-1 in MCF-7 cell line), and higher activity of complexes (low molecular weight chitosan complexes: IC50 220 µgmL-1 in both MDCK and MCF-7 cell line, and high molecular weight chitosan complexes: IC50 205 µgmL-1 in MDCK and 356 µgmL-1 in MCF-7 cell line) than their corresponding ligands. The results revealed an enhancement in anticancer activity with decrease in molecular weight and increase in DDA of constituent chitosan, and upon the complex formation.

Biography:

Yadav obtained his M. Sc. from Tribhuvan University (TU), Nepal and his Ph.D. from University of Ioannina, Greece in 2002. In 1992, he was appointed as an assistant lecturer of Chemistry at TU where he subsequently became professor in 2015. Yadav is Executive Director of Curriculum Development Centre, TU, Nepal and an academician and senator at Nepal Academy of Science & Technology (NAST). He was postdoc fellow at Acadia University, Canada (2003-2005), Academia

Sinica, Taiwan (2008) and Research Professor at Ewha Women's University, South Korea (2012-2013). Yadav has (co)authored 65+ research papers in peer reviewed journals. He is a recipient of several scientific awards and his research interests are centered on the coordination chemistry, bioinorganic chemistry, synthetic chemistry and the design of novel therapeutic agents.

New Click Chemistry Reaction Toward Enhanced Interfacial Bonding Between Functionalized bio-filler and Polymer in Bio-composites

Khalid I. Alzebdeh[1]*, Mahmoud M.M Nassar[2]

[1]Sultan Qaboos University, Oman; [2]Palestine Polytechnic University, Palestine

Abstract:

Surface modification of bio-filler and hosting polymer in natural fiber reinforced composites is essential to promote compatibility between the two components. A limited number of studies on functionalization of bio-filler to improve its reactivity with the polymer matrix have been reported in the literature. This research work is about developing a new scheme i.e., Azide-Alkyne Huisgen Cycloaddition to introduce chemical crosslinking between modified Date Palm Particles (DPP) and Polypropylene (PP). First, the chemical modifications of PP and DPP yielding PP-g-Azyde and DPP-g-Alkyne, respectively, are presented in this experiment by means of efficient and novel synthesis routes. Upon mixing the two ingredients, through copper-catalyzed azide-alkyne, cycloaddition click chemistry reaction takes place. Fourier Transform Infrared Spectroscopy (FTIR), solid state Nuclear Magnetic Resonance (ssNMR) Spectroscopy, X-ray Photoelectron Spectroscopy (XPS) and Scanning Electron Microscopy (SEM) were used to validate the reaction. Subsequently, bio-composite sheets were fabricated, and specimens were cut out and tested for chemical composition, thermal stability, and physical and mechanical properties to confirm the effectiveness of the proposed techniques. The results have shown that the developed crosslinking enhanced the interfacial adhesion of the filler/polymer as was observed by SEM. Also, the mechanical properties of the new bio-composite with functionalized ingredients were improved over the unmodified composite counterpart. In particular, this research provides a ground-breaking attempt towards improving the strength, ductility and reliability of polymeric composites reinforced with biomass-based particles.

Biography:

Khalid Alzebdeh has completed his PhD from Michigan State University, USA and postdoctoral studies from Michigan State University and Georgia Institute of Technology, USA. He is currently an Associate Professor at the Department of Mechanical and Industrial Engineering, Sultan Qaboos University, Sultanate of Oman. He has published more than 35 papers in reputed journals and has been serving as an editorial board member of several journals. Alzebdeh is a registered Professional Engineer in the state of Minnesota, USA. His current research interests include technology innovation, processing of advanced materials, which include bio-composites, nano-structured and cellular materials.

Physicochemical properties of polyethylene glycol, a green solvent

Markus M. Hoffmann

SUNY Brockport, Department of Chemistry and Biochemistry, USA

Abstract:

Interest of using polyethylene glycol (PEG) as a green chemical solvent is growing because of its low toxicity, biodegradability and interesting solvent characteristics that allowed is successful use in one-pot, multi-component synthesis reactions. Thus, there is an increased need of physicochemical data to characterize PEG as a solvent to further its use in chemical synthesis. New physicochemical data on density, viscosity, and self-diffusion coefficient are presented for some PEGs as well as ethylene glycol oligomers up to nonaethylene glycol covering a temperature range from 298.15 K – 358.15 K. The effects of the exact compositions of polydisperse PEG200 as well as the presence of water as the most comment impurity on these physicochemical properties was tested and found to be negligibly small. Several trends of these physicochemical properties with respect to the ethylene glycol homologous series were observed that combined with a mole fraction weighted approach allow for reasonable estimates of these physical properties for polydisperse PEG.

Biography:

Hoffmann studied chemistry as an undergraduate at the Technical University Darmstadt in Germany. In 1992, he moved to the US to pursue a graduate degree in physical chemistry and completed his Ph.D. at Washington University in St. Louis, MO, in 1997. After a post-doc with the Pacific Northwest National laboratory, he has since 2000 been a Professor in Physical Chemistry at State University of New York, College at Brockport.

Synthesis and Recycles of Bioplastics and Celluloses

Lucia D'Accolti

Chemistry Department -University of Bari "Aldo Moro"

Abstract:

Bio-plastic synthesized from vegetable fatty acids are an alternative to fossil materials and from agri-food waste and represent a useful method to achieve carbon neutral without modifying industrial processes. Applying non-critical raw materials catalysts and a cradle to cradle approach it is possible to obtain some kinds of the materials and chemicals. This speech will offer a survey our recent findings in this field with special attention to linear polymerization of glycerol (1) as well as the synthesis of biobased polyurethane for digital doming (2,3). With the same approach and using the principles of the circular economy it is possible to synthesize biobased polycarbonates by replacing bis phenol A. (4)

Lastly, we showed to opportunity to use the cellulose waste for obtain the various building blocks for industrial chemicals using the catalytic acid process, with high selectivity and mild conditions. (5)

Density Functional Theory Studies of Polypyrrole and Polypyrrole Derivatives; Substituent Effect on the Optical and Electronic Properties

Andrzej Łapiński[1]*, Adam Mizera[1], Alina T. Dubis[2]

[1]Institute of Molecular Physics, Polish Academy of Sciences, Poland

[2]Department of Chemistry, University of Białystok, Poland

Abstract:

Polypyrrole PPy and its derivatives are widely studied organic polymers due to their relatively high conductivity. In the last years, quantum chemistry has developed toward modeling systems of high complexity – most of the research on polymers using the first-principles methods concerns oligomers. It provides a good insight into polypyrrole-oligomeric systems' electronic and optical properties.

We report a theoretical study of pyrrole-based oligomers' vibrational and electronic properties. Seven model oligomers differing in chain length and charge were investigated. Quantum mechanical calculations at Density Functional Theory (DFT) and Time-dependent DFT (TD–DFT) methods are performed to establish the electronic and vibrational structure of an oligomer of pyrrole and its derivatives. The influence of substituent groups on optical and electronic properties was investigated for polypyrrole and polypyrrole derivatives. Molecular structure and frontier molecular orbitals of neutral and ionized oligomers were analyzed. The energy gap, ionization potential, electron affinity, electronegativity, hardness were calculated and discussed.

Based on the theoretical calculations, the physical properties of the investigated polymers can be deduced. This approach can provide the convergence behavior of the structural and electronic properties of the investigated oligomers. The calculated data provide insight into molecular properties for electronic ground and excited states allowing prediction of optical bandgap and analyzing the effect of side groups introduced into pyrrole backbone on the optical properties.

Structure-Properties Relations for Polystyrene/Polyglycidol Containing Copolymers and MicroparticlesAssemblies - Role of Copolymer and Microparticle Architecture

Stanislaw Slomkowski[1]*, Damian Mickiewicz[1], Mariusz Gadzinowski[1], Maciej Kasprów[2], Łukasz Otulakowski[2], Teresa Basinska[1], Barbara Trzebicka[2]

[1]Polymer Division, Centre of Molecular and Macromolecular Studies, Polish Academy of Sciences, Poland; [2]Centre of Polymer and Carbon Materials, Polish Academy of Sciences, Poland

Abstract:

Amphiphilic block copolymers, micelles, nano- and microparticles produced from them and colloidal structures (e.g. colloidal crystals) found numerous applications in pharmacy, meducal diagnostics and medical treatment. In all aforementioned fields are needed materials with purposefully tailored properties. Tailoring of copolymers, nano- and microparticles and their assemblies was usually accomplished by chosing proper chemical structure of copolymer blocks. The lecture shows that this goal could be achieved simply by changing copolymer chain architecture and shape of particles. Investigated system consisted of copolymers with hydrophobic polystyrene and hydrophilic polyglycidol blocks. Particles were produced by synthesis of block copolymers and subsequently their self-assembly into polymeric micelles and micellar aggregates (among them colloidal crystals)

or by polymerization induced self-assembly (PISA) in dispersion copolymerization of styrene and α-tert-butoxy-ω-vinylbenzyl-polyglycidol. PISA yielded particles with diameters ranging from 60 to 830 nm. Their cores were composed of polystyrene and shells were enriched with polyglycidol. Copolymers had linear and "bottle-brush" architecture. Significant differences were noticed between linear and "bottle-brush" copolymer. The critical micelle concentration for the latter was about ten times larger than for the linear ones having the same proportion of polystyrene and polyglycidol constitutional unitd. Films made from linear copolymers were moderately hydrophilic, whereas films from "bottle-brush" copolymers were superhydrophilic. The microspheres formed hexagonal-like packed colloidal crystals, whereas microspheroids produced from them self-assembled into nematic liquid-crystalline domains. Mechanical and optical properties (angle-resolved reflection spectra) of these assemblies were investigated.

Acknowledgment: This work was financially supported by the National Science Centre

Biography:

Stanislaw Slomkowski received master degree (physic) from Lomonosov Moscow State University (SU), PhD and DSc degrees (chemistry) from Technical University in Lodz (Poland). He was the post-doctoral fellow at New York State University (Syracuse, USA), research associate at the University of Toronto, visiting Professor at the University Paris 7 and collaborating researcher at National Institute of Standards and Technolgies (Gaithersburg, USA). Since 1972 he is permanently employed in Centre of olecular and (Macromolecular Studies, Polish Academy of Sciences (Lodz, Poland). His research interests are concentrated in polymers and polymer disperse systems for applications in pharmacy, medical diagnostics and medical treatment.

Sulfenamides offer a new approach to flame retardancy of wood products, films and insulation materials for construction and building industries

Carl-Eric Wilen*

Laboratory of Molecular Science and Engineering, Åbo Akademi University, Aurum Building, (Room 412), Henriksgatan 2, FIN Åbo, Finland

Abstract:

Today the construction industry uses a staggering half of the global raw materials, and it is responsible for a third of greenhouse gas emissions.1 Furthermore, according to United Nations report by 2050 more than 65 % of world´s population will be living in cities, whereby new housing and built environment for over 1.5 billion people is required.2 Consequently, there is an urgent need to start implementing the concept of circular economy in construction to tackle the challenge of climate change, usage of material resources and the mega trend of urbanization. Work to change the design, use of resources and enhancement of recyclability of building materials is ongoing.

Polymeric materials account for the highest growth area in construction materials. Well-established applications of polymers in construction include products used for insulation, flooring, windows, cladding (wood), pipes, insulation of electrical cables, membranes, seals, etc.

The energy consumption, acoustic properties, reaction to fire and water vapor resistance and overall environmental issues of a building are strongly dependent on the choice of polymeric materials. Moreover, the overall impact on the environment and on human health need to be carefully assessed.

The goal of this presentation is to introduce a new approach to flame retardancy based on sulfenamides for wood coatings, barrier films and polystyrene-based insulation materials which are used in construction and building sectors. 3-4

1. Green Building Council Finland (https://figbc.fi/en/)

2. 2018 Revision of World Urbanization Prospects by United Nations

3. Risku, A.; Wilen, C-E.; Flame retardant composition, WO2021/151493 A1.

4. Mountassir, A., Tirri, T., Sund, P. Wilén, C-E. Sulfenamides as Standalone Flame Retardants for Polystyrene, Polymer Degradation and Stabilization, 188 (2021), 109588

Biography:

Carl-Eric Wilen is a Professor of Polymer Technology at Åbo Akademi University. His research fields include environmentally friendly flame retardants, printable electronics, controlled radical polymerizations, electron beam induced polymer modifications and paper chemicals. He has written numerous articles in international scientific journals, and he is a holder of several patents. Carl-Eric Wilen has participated in several EU projects, established successful international collaborations, and been involved in technology transfers. In addition, he has been a Research Manager at Borealis Polymers during 2002-2004.

Reinforcement of woven steel mesh insert in the lap shear joint

Yiling Lu[1]*, Marzena Pawlik[1], Paul Wood[2]

[1]College of Science and Engineering, University of Derby, UK; [2]Institute for Innovation in Sustainable Engineering, University of Derby, Derby, UK

Abstract:

Adhesive bonding is a desirable method of joining carbon fibre-reinforced polymer (CFRP) material because of light-weighting and easy operation. CFRP laminate usually requires effective surface treatments in order to achieve strong bonding strength. A woven steel mesh was co-cured on the CFRP laminate during the manufacturing stage, and resultant lap shear joint was then subjected to static tests. This new surface modification was compared with other traditional methods such as acetone cleaning, sanding, grit blasting and peel ply. All adherends were bonded with the same low viscosity epoxy adhesive. The lap shear joint test was conducted following ASTMD5868 standard and topography of CFRP adherends was analysed through microscopic imaging. The woven steel mesh insert has yielded the highest bonding strength of CFRP joint (average value 24.2 ± 6.4 MPa), which is two times that of acetone-cleaned samples (12.0 ± 2.0 MPa). The reinforcement of lap shear joint by woven mesh insert is mainly attributed to two aspects: the adherend show increased surface roughness and enhanced surface free energy; the anchoring between metal meshes has resulted in stress redistribution and increased stiffness of the whole lap shear joint. The metal mesh modification method greatly improves the lap shear strength and shows huge potential to achieve high bonding performance for CFRP bonded joints.

Biography:

Yiling Lu obtained BSc in Mechanical Engineering from University of Science and Technology of China and later earned PhD degree in Medical Engineering at Queen Mary, University of London.

After working in University of Derby in 2014, Yiling has developed himself into the field of composite materials. In the Advanced Composite Materials lab, he has led the research work in multiple directions: a) mechanical characterisation and multiscale modeling for fibre reinforced composite polymer, b) development of composite material featuring natural fibres, hybridsation and nanoengineering, and c) development of adhesive joining solution for flat sample and corner joint.

Enzybiotic-loaded hydrogel dressings for the treatment of infected wounds: a comprehensive study

Lucy Vojtová[1*], Katarína Kacvinská[1], Jana Dorazilová[1], Šárka Kobzová[2], Lukáš Vacek[2], Břetislav Lipový[1,3], Filip Raška[3], Edita Jeklová[2] and Lubomír Janda[2]

[1]CEITEC -Central European Institute of Technology, Brno University of Technology, Czech Republic, Europe.

[2]Veterinary Research Institute, Brno, Czech Republic, Europe.

[3]Department of Burns and Plastic Surgery, Institution shared with University Hospital Brno, Faculty of Medicine, Masaryk University, Brno, Czech Republic, Europe.

Abstract:

Wound dressings containing collagen are biologically active, which, in addition to the absorption effect, stimulate the natural activity of cells and angiogenesis. Like collagen, the dressings made of cellulose affect the biochemistry of the wound. E.g., the oxidized cellulose fibers themselves form a cohesive gel in contact with the wound bed, absorbing exudates into the fiber structure and creating a moist environment. The combination of cellulose fibers with collagen thus enables the preparation of materials with improved properties and favorable production costs. Antimicrobial dressings mainly use silver ions and nanoparticles, iodine compounds, chlorhexidine, or antibiotics, the excess of which leads to the resistance of many strains. Thanks to this, recently bacteriophages, isolated antibacterial proteins, enzymes, or peptides have come to the fore.

In our project, we prepared both porous lyophilized dressings as well as fully resorbable and easily injectable hydrogels based on the collagen/cellulose biopolymers with incorporated enzybiotics, such as recombinant lysostaphin and endolysin. These hydrogels were subjected to the in vitro method to determine their antibacterial activity on different bacterial strains. The hydrogels themselves are not antibacterial, however, the addition of a low concentration of enzybiotics was sufficient for the high effectiveness of all test hydrogels against specific bacterial strains. The selected hydrogels were then successfully applied to a pig model in skin defects infected with different bacterial strains. Hydrogels can be easily applied even to a complicated and irregular defect. It is also possible to precisely dose enzybiotics to achieve targeted efficacy in complicated infected wounds.

Acknowledgment: The study was supported by the Ministry of Health of the Czech Republic, grant No. NV19-05-00214. All rights reserved.

Biography:

Lucy Vojtová, is currently a Group leader of the Advanced biomaterials group at the Central European Institute of Technology, Brno University of Technology, Czech Republic. She has participated in projects supported by the US NSF and NIH within three years of her post-doctoral position at Columbia University in the City of New York (2000–2002). She is a specialist in the advanced synthesis, characterization, and 3D/4D printing of novel polymers (biopolymers, hydrogels) and polymeric multifunctional composites with a controlled lifetime, structure-property relationship evaluation, preparation of cell or drug carriers and composites for regenerative medicine and tissue engineering.

Towards Scalable Manufacturing of Color-Changing E-Textiles

Joshua J. Kaufman,[1] Felix A. Tan,[1] Morgan C. Monroe,[1] and Ayman F. Abouraddy[1]

[1]CREOL, The College of Optics and Photonics, University of Central Florida, USA

Abstract:

Textiles and clothing have been a staple of human existence for millennia, yet the basic structure and functionality of textile fibers and yarns has remained unchanged. While color and appearance are essential characteristics of a textile, an advancement in the fabrication of yarns that allows for user-controlled dynamic changes to the color or appearance of a garment has been lacking. Touch-activated and photosensitive pigments have been used in textiles, but these technologies are passive and cannot be controlled by the user. The technology to be presented in this talk allows the owner to control both when and in what pattern the fabric color-change takes place. In addition, the manufacturing process is compatible with mass-producing both the user-controlled, color-changing yarns, the woven e-textiles, and the constructed end-use products.

The yarn fabrication utilizes a fiber extrusion system and a thread-coating attachment to encapsulate a metal wire inside a polymer sheath impregnated with thermochromic pigment. The color change is distinct from garments containing LEDs that emit light in various colors. The pigment itself changes its optical absorption to appear a different color. The thermochromic color-change is induced by a temperature change in the inner metal wire of each filament when current is applied. The temperature required to induce color change is near body temperature and not noticeable by touch. The prototypes already developed either use a simple push button to activate the battery pack or are wirelessly activated via a smart-phone app over Wi-Fi. The app allows the user to choose from different activation patterns of stripes that appear in the fabric continuously. The power requirements are mitigated by a large hysteresis in the activation temperature of the pigment and the temperature at which there is full color return.

The fiber fabrication process is readily scalable, and the fibers can be woven on industrial looms at commercial speeds. Furthermore, we have developed a method for quickly making the hundreds, if not thousands, of electrical connections that are necessary to produce a working product that can change between different colors and multiple patterns. This method utilizes ultrasonic welding and a multi-layer, multi-material bus that also accomplishes insulation of the electrical connections and ruggedization of the connected edge all in a single step. Rapid connectorization of the electrical components in an E-Textile has been a long-standing problem in the field, and this method aims to solve the last major hurdle in bringing this E-Textile technology to the market.

The developments to be discussed in this presentation represent a never-before seen capability: user-controlled, dynamic color and pattern change in large-area woven and sewn textiles and fabrics with wide-ranging applications from clothing and accessories to furniture and fixed-installation housing and business décor. The ability to activate through Wi-Fi opens up possibilities for the textiles to be part of the 'Internet of Things.' Furthermore, this technology is scalable to mass-production levels for wide-scale market adoption.

Conventional & Creative Ways to Study Interfacial Chemistry in Polymer Materials

Michelle Gaines[1]*, Nefatiti Anderson[1], Ekua Beneman[1], Taylor Beverly[1], Gabrielle Brim[1], Alfred Crosby[2], Martha Grover[3], Diane Ingabire[1], Jessica Kamuche[1], Princess Kamuche[1], Imanii Kolailat1, Andrea Mancia[4], Nolan Miller[2], Lauryn Norris[1], Sara Oliveros Gomez[3], Orlasha PhillipsPickens[1], Leah Oliver[1], Imani Page[1], Mitchell (Kameron) Smith[5], Taylor Talley[1], Regan Thomas[1], Kaitlyn Vaughn[1], Jade Weatherington[1]

[1]Spelman College, USA; [2]University of Massachusetts, USA; [3]Georgia Institute of Technology, USA; [4]Emory University, USA; [5]Furman University, USA

Abstract:

Microgels and hydrogels have expanded the field of soft matter. They have been built into materials for cosmetic products, biomaterials, food packaging and additives, and oil refinement. In our lab, we synthesize microgels and hydrogels to develop biomaterials from polymers that are highly sensitive to external stimuli, such as pH, temperature, or ionic solvent content. These external factors induce drastic changes to their phase behavior and cause them to reversibly change volume by absorbing and releasing the aqueous solvent that they are swollen in. Hair is a natural polymeric composite material and is one of the key characteristics that classify us as mammals. Much like our bodies, our hair tresses need water and nutrients to maintain hair health and appearance. The inner cortex of each of our hair fibers is composed of tight bundles of keratin protein. Very much like synthetic microgels and hydrogels, these natural protein keratin bundles and highly responsive to external stimuli, and they also absorb and expel water according to changes in the pH, temperature, and ionic solvent content. This research illustrates how our lab uses stimuli responsive microgels and hydrogels to create tunable 3D-biocomposite cell scaffolds to study malignant cell behavior. Several of these principles which dictate the material properties of hydrogels are also applied to analyze the surface chemistry of textured hair. Our work involves applying chemical and biochemical concepts to answer material science related research questions that a relevant to society and culture.

Biography:

Michelle Gaines is an assistant professor of Chemistry at Spelman College. Her research is themed around examining the interfacial properties of soft materials. The Gaines lab creates stimuli-responsive composites from hydrogels and polymer colloidal microgel particles, which are used to develop a synergistic synthetic 3D culture microenvironment to control cell behavior. The aim is to understand on how cells respond to specific controlled variances in the material properties of the extracellular matrix, to predict strategies to control cell behavior in physiological systems. The Gaines lab also explores the impact phenotypic differences in hair has on its resulting material properties.

Study of the Mechanical Strength of Jackfruit using 3D Printed Models

Benjamin Lazarus [1], Jaqueline Vieira[2], Willams Barbosa[2], Josiane Barbosa[2]* Marc Meyers[1]

[1]Materials Science and Engineering Program, University of Califórnia San Diego, San Diego, CA, USA;

[2]Department of Materials, University Center SENAI CIMATEC, Salvador, BA, Brazil;

Abstract:

Jackfruit can grow up to 35 kgs and fall from branches 25m high, generating impact energies of up to 8.5 kJ. To protect the large seeds on their interior, the jackfruit has developed a progressive failure structure consisting of three layers: collapsible exterior thorns, a soft transition layer, and a highly aligned tubular region. The underlying tubular zone is the first region to experience deformation during loading, absorbing large amounts of strain before the other layers begin to collapse. The next line of defense is the exterior thorns with a unique microstructure consisting of a fiber-reinforced foam composite covered by a tough exterior skin that exhibits patterned preferential collapsibility. The transition region helps control crack propagation and holds the two other parts of the fruit's defense together. In this novel study, the different layers were characterized using microscopy, and mechanical tests were performed on each layer independently and in tandem at different strain-rates to highlight the synergistic effects of the fruit's layers. The jackfruit structure was explored using models produced using 3D printed to show that engineered materials can harness the lessons in impact-resistant design from nature's largest fruit.

Biography:

Josiane is a Ph.D. in materials science engineering. She has experience in research using tissue engineering and cells bioprint, nanocomposites; blends with biodegradable polymers; the processing of polymers, biomaterials. Currently, Josiane is an Associate Professor and Coordinator of the Professional Master's and Doctorate Programs in Management and Industrial Technologies – PPGGETEC; at SENAI CIMATEC, Bahia, Brazil. In 2020, she was a Visiting Scholar at UCSD (University California San Diego). She integrated a Prof Marc Meyers team to explore bioinspired materials, and she kept connected with this collaboration. SENAI CIMATEC has good facilities and labs under your supervision, including polymer processing, tissue engineering lab, and materials characterization.

Machine Learning Aided Polymeric Membrane Design and Optimization

Yongsheng Chen*

Professor and Director Nutrients Energy Water Center for Agriculture Technology School of Civil & Environmental Engineering, Georgia Institute of Technology

Abstract:

Membrane technology is essential to treat water/wastewater and recover valuable resources for fit-for-purpose reuses. It addresses one of the 21st century grand challenges "Sustainably Supply Food, Energy, and Water." Development of novel materials relies exclusively on experience- and experiment-driven, time-consuming, trial-and-error selection and optimization processes. As polymeric nanofiltration membrane design is a multidimensional process involving selection of membrane materials and optimization of fabrication conditions from an infinite candidate space. It is impossible to explore the entire space by such trial-and-error experimentation. Here, we present a polymeric membrane design strategy utilizing machine learning-based Bayesian optimization to precisely identify the optimal combinations of unexplored monomers and their fabrication conditions from an infinite space. Our findings demonstrate that ML-based Bayesian optimization demonstrates a paradigm shift for next-generation separation membrane design. Moreover, the quantitative relationship between fabrication conditions and polymeric membrane performance determining properties has not been established. To analyze input features associated with

both fabrication and operational conditions and output variables for the polymeric membrane performance to determine the quantitative relationship among them, thereby proving useful guidance for future membrane design. Our approach would provide fasttrack the design of fit-for-purpose separation membranes through virtual experiments.

Biography:

Yongsheng Chen is a Bonnie W. and Charles W. Moorman IV Professor and Director of the N.E.W. Center for AgTech in School of Civil and Environmental Engineering at Georgia Institute of Technology. Chen's expertise is in the area of environmental nanotechnology and sustainability. Chen has led more than $ 18 M federal research projects and published 200 journal papers. His work has been widely reported by National and International Medias, including Forbes, C&EN, and AJC. He has received many awards, including ES&T editor's choice paper award, CAPEES/Nanova Lifetime Achievement Award, and AEESP Outstanding PhD Student advisor Award.

Flexible Polymer Electrolytes for Solid-State Supercapacitors

Irune Villaluenga[1,2]*, Anto Puthussery Varghese[1,4], Nicolas Goujon[1] , Andrew Rider[3] , Patrick Howlett[4]

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[2]Ikerbasque, Basque Foundation for Science, Bilbao, Spain

[3]Aerospace Composite Technologies Group, Defence Science and Technology Group, Australia

[4]Institute for Frontier Materials (IFM) - Deakin University, Geelong Waurn Ponds Campus Locked Bag Geelong, Victoria , Australia

Abstract:

The demand for high power energy storage applications where fast energy transfer is required, has been booming in the recent years.1 With this respect, supercapacitors have attracted a lot of attention because of their inherent energy storage properties (i.e. electrical double layer and faradaic processes), enabling high power and moderate energy densities. However, traditional supercapacitors still suffer from challenges associated with their liquid electrolytes, such as toxicity, corrosiveness and leakage.2 Herein we propose the use of solid state polymer electrolyte for supercapacitor applications. The polymer electrolytes exhibit high ionic conductivity with sufficient mechanical strength, enabling room temperature supercapacitor operation. Electrochemical studies in a symmetrical configuration with carbon nanotubes (CNT) mat electrodes revealed very similar performance to its liquid electrolyte counterpart.

Biography:

Irune Villaluenga is a staff scientist at Polymat-Basque Center for Macromolecular Design and Engineering. She obtained her PhD degree in chemistry in 2010, both from the University of the Basque Country (Spain). This was followed by two postdoctoral appointments at CIC Energigune (Spain) and Lawrence Berkeley National Laboratory/University of California, Berkeley (USA). In 2018, she joined as battery materials scientist at Blue Current, Inc. (USA). In 2020, she moved to Spain to join Polymat-Basque Center for Macromolecular Design and Engineering. Her current research interests include smart battery materials, nanostructured block copolymers, hybrid electrolytes, and electrochemistry for energy storage applications.

Material Extrusion 3D Printing of Highly-Filled Copper Powder-Polymer Composites for Fabrication of Metallic Parts

Kunal H. Kate*[1], Kameswara Pavan Kumar Ajjarapu[1],Carrie Barber[2], Matteo Zannon[3], Sundar Atre[1]

[1]Materials Innovation Guild, University of Louisville

[2]Kymera International, Durham NC

[3]Kymera International, ECKA Granules Germany, Velden, Germany

Abstract:

Material extrusion (MX) additive manufacturing (AM) process utilizes powder-filled polymer filaments with a combined Fused filament fabrication (FFF) and sintering processes to fabricate complex metallic or ceramic structures. In the current work, copper powder-filled polymeric feedstocks and filaments with 58 vol.% solids loading were prepared and characterized for physical, thermal, and rheological properties. Subsequently, the filaments were 3D printed into tensile and tablet geometries via a benchtop MX-AM machine. An L9 Taguchi design of experiments was performed by varying print temperature, print speed, and layer height for three levels to identify optimal process conditions to obtain the highest green density and minimum surface roughness perpendicular and parallel to the build direction. Copper green parts were further sintered and characterized to understand the physical and mechanical properties of the final part.

Additionally, heat sinks that are typically made with copper were designed, fabricated, and sintered using the filaments developed within this work. It was identified that thick and thin features in heat sinks tend to debound at different rates due to the differeces in surface area and amount of binder material that needs to be removed. This behavior has challenges with retaining part integrity post debinding and sintering. Therefore, this study looks at understanding the strucutre-material property relationships behind 3D printing copper heat sinks by MX-AM process by implementing new designs that can withstand polymer removal in debinding and powder compaction in sintering to manufacture copper heat sinks.

Biography:

Kunal Kate is an Associate Professor in Mechanical Engineering at the University of Louisville. He has expertise in 3D printing, materials characterization, and design of metals, ceramics, and natural fibers composites with the fused filament fabrication (FFF) process in which he has published > 30 journal articles and filed invention disclosures in the past five years. Kate's current research is supported by NASA, NSF, NIST, APLU, USDA, and United Soybean Board agencies. Additionally, Kate strives to train next-generation talent about Additive Manufacturing through the courses he teaches at the University of Louisville and hands-on industrial projects.

A Duel Cellular-Heterogeneous Catalyst Strategy for the Production of Olefins from Glucose

Zhen Q. Wang[1,2]*, Heng Song[1,6], Edward J. Koleski[1], Noritaka Hara[1], Dae Sung Park[3,5], Gaurav Kumar[3], Yejin Min[1], Paul J. Dauenhauer[3] and Michelle C.Y. Chang[1,4,7]

[1]Department of Chemistry, University of California, Berkeley, USA; [2]Department of Biological Sciences, University at Buffalo, USA; [3]Department of Chemical Engineering and Materials Science, University of Minnesota, USA; [4]Department of Chemical & Biomolecular Engineering, University at California, Berkeley, USA; [5]Korea Research Institute of Chemical Technology, South Korea; [6]College of Chemistry & Molecular Science, Wuhan University, China;7Department of Molecular & Cell Biology, University of California, Berkeley, USA.

Abstract:

Living systems provide a promising approach to chemical synthesis, having been optimized by evolution to convert renewable carbon sources such as glucose to an enormous range of small molecules. However, a large number of synthetic structures can still be difficult to obtain solely from cells, such as unsubstituted hydrocarbons. In this work, we demonstrate the use of a dual cellular-heterogeneous catalytic strategy to produce olefins from glucose, using a selective hydrolase to generate an activated intermediate that is readily deoxygenated. Using a new family of iterative thiolase enzymes, we have genetically engineered a microbial strain that produces 4.3 ± 0.4 g L-1 of fatty acid from glucose with 86% captured as 3-hydroxyoctanoic and 3-hydroxydecanoic acids. This 3-hydroxy substituent serves as a leaving group enabling heterogeneous tandem decarboxylation-dehydration routes to olefinic products on Lewis acidic catalysts without the additional redox input required for enzymatic or chemical deoxygenation of simple fatty acids.

Biography:

Zhen Wang joined the faculty of Biologicals Sciences at The State University of New York, Buffalo, in 2017. Her research focuses on plant natural product biosynthesis and the sustainable production of medicines, fuels, and materials through metabolic engineering and synthetic biology. She has made significant contributions in the areas of bioproduction of renewable olefins, microbial engineering for terpenoids, elucidating the biosynthetic pathway of plant natural products, identifying nontoxic plant protectant, and plant lipid biosynthesis.

Chirality-Driven Self-Assembly – Application Toward In Situ Generation of Janus Dendrimers

Shin A. Moteki[1]* and John Zhou

University of Missouri – Kansas City, Kansas City, Missouri, USA

Abstract:

A new strategy to build various structurally distinct Janus dendrimer using chirality-directed self-assembly of heteroleptic Zn(II) BOX complexes is presented. The chirality-driven self-assembly is a highly versatile approach in connecting two macromolecules in situ. Highly selective formation of heterochiral Zn(II) complexes over homochiral Zn(II) complexes enables to connect two structurally distinct dendron subunits in highly selective manner. The assembly is accomplished without a use

of harsh chemical/thermal conditions which often required for covalent assembling approaches. Moreover, unlike non-covalent bonding approach, the complex is highly stable under wide range of thermal/chemical environments. Thus, the approach enables quantitative synthesis of Janus dendrimers in situ without the need for isolation and purifications. The Zn(II) BOX complex can be easily disintegrated into dendritic domains under very mild condition using EDTA. This enables recycling each dendritic domain without negatively affecting functional groups on dendron subunits. Lastly, a library of structurally distinct Janus dendrimers can be built in short period of time by simply mixing various dendron subunits in a presence of Zinc (II) acetate.

Biography:

Shin A. Moteki completed his Ph.D. in Organic Chemistry (supramolecular catalysis) at University of Nebraska under the guidance of Prof. James M. Takacs. He completed postdoctoral research at Kyoto University where he was promoted to a rank of research assistant professor. Currently, Shin serves as an assistant professor in the Division of Energy, Matter, and Systems (Chemistry) at University of Missouri Kansas City, he carries out his research on the orthogonal tandem catalysis using polymer-based artificial enzymes.

Janus Nanoparticles and a Facile Solution to Determine their Amphiphilic Character by Emulsion Stabilization Route

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[2]Escuela de Ingeniería Química, Pontificia Universidad Católica de Valparaíso, Av. Brasil 2162, Valparaíso, Chile.

[3]CEITEC - Central European Institute of Technology, Brno University of Technology, Brno, Czech Republic.

[4]Institute of Microelectronics of Barcelona (IMB-CNM, CSIC), Campus UAB, Cerdanyola del Vallès (Barcelona), Spain.

Abstract:

Janus nanoparticles (JNPs) are characterized by their asymmetrical structure due to different chemical compositions, which confers amphiphilic properties to these nanomaterials. The dual nature of JNPs generates fascinating performances, e.g., distinctive surface properties between both sides and the capacity to develop clusters with engineered size and shape [1]. Consequently, different applications have been proposed in the field of biomedicine [2], as solid surfactants [3], and as orienting materials [4], among many others. In this work, different silicon-based JNPs were synthesized employing sol-gel procedures in a self-assembly method. Moreover, various techniques are used to characterize the developed nanomaterials, i.e., electron microscopy (SEM and TEM), X-ray diffraction, infrared spectroscopy, and X-ray photoelectron spectroscopy, and the inefficiency of such methods in determining the duality of several nanoparticles was confirmed. Therefore, a simple and economical route is described in this work to achieve a clearer and most straightforward determination of the dual nature of JNPs. This experiment proposes two different emulsion stabilization paths: analyzing the dispersion/aggregation behavior of nanoparticles in

different solvents with different polarities (dodecane, toluene, tetrahydrofuran, methanol, and water); and analyzing their behavior at the interface of two immiscible solvents, which allowed the determination of the amphiphilic character of the nanomaterials. In the first trial, JNPs with higher asymmetry degrees stay stable for longer in all solvents due to their dualism in polarity property. In the second trial, these JNPs remain for a longer time at the interface of immiscible solvents. Consequently, a procedure to determine nanoparticle amphiphilicity could be further standardized.

Acknowledgment: Yanio Milian would like to thank the Postdoctoral/FONDECYT N°3200786 projects. This work was also supported by the Czech Science Foundation (GAČR), via Grant No. 20-20123S.

Development of Photocurable Epoxy Nanocomposites using Bacterial Cellulose Nanofibers and a Curing Agent derived from Limonene

Ricardo Acosta Ortiz, Rebeca Sadai Sánchez Huerta

Centro de Investigación en Química Aplicada, México

Abstract:

In this work is reported the development of photocurable epoxy nanocomposites using the epoxy/thiol-ene photopolymerization technique. In this process is combined the anionic ring opening polymerization (AROP) of the epoxy resin with a thiol-ene photopolymerization. Derived from this technique is produced a crosslinked-co-network of polyether-polythioether type. In order to perform this technique a curing agent with two allyl-functionalized tertiary amine groups is required. In this study the limonene was used a renewable starting material to produce the curing agent. The limonene was subjected to amination reactions by means of thiol-ene coupling. In a subsequent stage the intermediate was alkylated with allyl bromide. The obtained curing agent was used as component of the thiol-ene system to photocure a biobased epoxy resin. Bacterial cellulose nanofibers (BCNF) were added to the photocurable formmualtion to produce the epoxy nanocomposites. The reactivity of the photocurable system was determined using the Real-Time FTIR spectroscopy and the thermal and mechanical properties of the composite were determined using differential scanning calorimetry (DSC), dynamic mechanical analysis (DMA) and thermogravimetric analysis (TGA)

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 phopolymerization including the thermal and mechanical analysis of photopolymers

Dispersion States of Cellulose Nanofibers Investigated by a Time-Domain Nuclear Magnetic Resonance (Td-Nmr)

Chika Takai-Yamashita*[1]and Junko Ikeda[2]

[1]Gifu University, Japan; [2] Mageleka Japan Co,. Ltd.,

Abstract:

A short-length cellulose nanofiber (CNF) aqueous sol, prepared by a high-pressure homogenizer, showed a rapid longer relaxation time (T2) in the low-field 1H-nuclear magnetic resonance (NMR) when diluted from 20 wt% to 1 wt%. Magnetic stirring for 30 min disentangled the fiber networks and the fragmented fibers appeared in the 1 wt% CNF sol. A decrease in the specific viscosity of the diluted sols changed the rheological behavior from exponential to linear below 1 wt%, suggesting a significant decrease in the inter-fibril interaction. The small angle x-ray scattering (SAXS) with the generalized indirect Fourier transformation (GIFT) also indicated similar changes in the fiber flocculation structure without a change in the fiber size. The increasing viscosity upon severe fiber fragmentation by a high-pressure homogenizer may be ascribed to tighter holding of the interfibril water molecules. The time-domain (TD)-NMR fully supported the estimation that the transverse relaxation time (T2) showed consistently short for the 2 wt%, became shorter with the stirring time when diluted from 5 wt% to 2 wt%, and showed long upon dilution from 20 wt% to 2 wt%. Understanding the complex behavior of the highly viscous CNF sols during a simple dilution process may pave the way for developing CNF-related technology. [Acknowledgements: Anton Paar Japan K.K. for SAXS and rheological measurements]

Biography:

Chika Takai-Yamashita is an Associate Professor of Materials Chemistry at Gifu University, Japan. Her work focuses specifically on the structural design, dispersibility control, and establishment of evaluation for nanoparticles in a liquid from powder technology point of view. Her recent interest is to take care of reptiles, to improve breeding techniques for crickets and rhinoceros beetles. She applied Mahalanobis-Taguchi System as one of machine learning techniques to classify droppings of beetles' larva into male/female based on their shapes which appeared on Advanced Powder Technology 2022.

Tunable Large-Scale Compressive Strain Sensor Based on Carbon Nanotube/ Polydimethylsiloxane Foam Composites by Additive Manufacturing

Junjun Ding* and Chao Liu

New York State College of Ceramics at Alfred University, USA

Abstract:

The compressive strain sensor is an extensively used flexible electronic device because of its capability to convert mechanical deformation to an electrical signal. However, the difficulty in tuning the performance of the strain sensor limits its further applications. Herein, the approach of fabricating a carbon nanotube (CNT)/polydimethylsiloxane (PDMS) compressive strain sensor, which has both tunable mechanical and electrical performances, is presented. CNT plays the role of reinforcement due to its outstanding mechanical strength and electrical conductivity. PDMS is a widely used matrix because of its softness and nontoxicity. The material extrusion 3D

printing method is used to fabricate the composites, due to its advantages of design flexibility and compatibility with liquid-based materials. The foam microstructure formed by removing sodium chloride provides a large-scale deformation of at least 50% compressive strain and excellent elasticity. The strain sensor works durably over 10000 cycles, with a gauge factor (GF) of 17.4. The compressive strain sensor in detecting both large- and small-scale human motions due to the tunability of CNT/PDMS composites is also tested.

Biography:

Junjun Ding is an assistant professor of Materials Science and Engineering, Inamori School of Engineering, New York State College of Ceramics at Alfred University. His current research focuses on advanced manufacturing and functional composites, including large-scale nanomanufacturing and additive manufacturing of ceramics, polymer, and their composites. He received his PhD in Mechanical Engineering from Stevens Institute of Technology in 2017, and his BS and MS in Mechanical Engineering from University of Science and Technology of China (USTC) in 2007 and 2010, respectively.

Metalla-aromatics, New Building Blocks of Conjugated Polymers

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[1]Department of Chemistry, Southern University of Science and Technology, Shenzhen, China.
[2]Department of Chemistry, Xiamen University, Xiamen , China

Abstract:

Conjugated polymers, whose skeletons are normally composed of aromatic repeating units, continue to attract great attention. But the fundamental building blocks of conjugated polymer skeletons are quite limited to conjugated hydrocarbons and heterocycles (e.g., CH2=CH2, benzene, thiophene, and pyrrole). The inclusion of transition metals with d orbitals into aromatic frameworks results in dπ-pπ conjugated metalla-aromatic systems, but metalla-aromatics have not been used to date to produce conjugated polymers.

In the last decade, we have reported a series of conjugated metal-bridged bicyclic compounds, in which a metal atom is shared by two fused five-membered rings. These novel metalla-aromatic complexes have been named carbolong complexes. Importantly, they have been demonstrated intriguing properties and applications. They are promising building blocks for conjugated polymers. Herein, we report a new polymerization reaction that leads to the first transition metalla-aromatic conjugated polymers, also called polycarbolongs. These metallopolymers could open up significant opportunities for preparation of functional materials.

Biography:

Haiping XIA obtained his B.S. in Chemistry in 1983, M.S. in Polymer Science in 1986, and Ph.D. in Chemistry in 2002, all from Xiamen University, where he was promoted as a Full Professor in 1999. In 2018, he moved to Southern University of Science and Technology as a Chair Professor, and has been appointed as the Executive Dean of Shenzhen Grubbs Institute since 2019. He has won many awards, such as the "Chinese Chemical Society Huang Yao-Zeng Award in Organometallic Chemistry", and the second prize of "the National Natural Science Award" of China in 2020.

Oligosaccharide Analysis of the Backbone Structure of the Characteristic polysaccharide of Dendrobium officinale

Tin-Long Wong[1*], Li-Feng Li[1*], Ji-Xia Zhang2, Quan-Wei Zhang[1], Xue-Ting Zhang[1], Li-Shuang Zhou[1], Hau-Yee Fung[1], Lei Feng[3], Hui-Yuan Cheng[1], Chu-Ying, Huo[1], Man Liu[1], Wan-Rong, Bao[1], Wen-Jie, Wu[1], Cheuk-Hei Lai[1], Su-Ping Bai[2], Shao-Ping Nie[3], Pema-Tenzin Puno[4], Clara Bik-San Lau[5], Ping-Chung Leung[5], Quan-Bin Han[1], Han-Dong Sun[4]

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*These authors contributed equally.

Abstract:

The backbone of Dendrobium officinale polysaccharide (DOP) was reported to be glucomannan. But the dispute continues due to the limitation of conventional analysis methods eg. the overlapped NMR signals. Herein, we describe an oligosaccharide sequencing analysis which successfully correct the backbone to mannan. This analysis involves producing oligosaccharide fragments from mild acid hydrolysis of DOP followed by p-aminobenzoic ethyl ester (ABEE) derivatization. Then, a series of oligosaccharides with varied polymerization degrees (DP =2~10) were isolated and identified by innovative LC-MS profiling and monosaccharide composition, linkage analysis, and NMR spectroscopy. Finally, we conclude that the backbone of DOP is a β-D-1,4-mannan. This oligosaccharide analysis is more straightforward and reliable by transforming the complicated polymers into oligomers which have more accurate and convincing MS and NMR data.

Keywords: Dendrobium officinale polysaccharide; β-1,4-Mannan; Oligosaccharide; Structure analysis;

Study on the Shearing Mechanical Behavior and Damage Model of the Polymer Grouting Material-Concrete Contact Surface

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[2]Jinzhong Longcheng Expressway Co., Ltd., Jinzhong, China;

Abstract:

The polymer grouting material (PU) has been increasingly used in trenchless repair of concrete pipes and roadbeds. Investigating the mechanical behavior of the PU-concrete (P-C) contact surfaces provides a basis for further evaluating the stability of the reinforced concrete structures, which, however, has not been conducted yet. In this study, based on the shear testing results, the mechanical properties and cracking characteristics of the P-C contact surfaces were investigated, followed by establishing the damage model. Results show that the cohesion force of the P-C contact surface increases from 0.42 MPa to 1.44 MPa when the density of the PU materials increases, and there exists residual strength when normal stress is applied. The shear failure of the P-C contact surface is caused by the shearing zone, of which the thickness is about 9-10 mm. The theoretical shear stress-strain curves of the P-C contact surfaces are in good agreement with the experimental ones. The maximum relative difference between the theoretical and experimental shear strength is about 4.2%, implying that the damage model can reflect the stress-strain laws of the P-C contact surfaces under shear.

Biography:

Mingrui Du was born in 1989. He received the Degree in Civil Engineering from China University of Mining and Technology. He is currently working in School of Water Conservancy Engineering, Zhengzhou University. His research interests include the development, application and reinforcing mechanism of polymer grouting materials in civil engineering, multi-scale characterizations and simulations on civil engineering materials

Crystallization effect towards Mechanical Properties for Additive Manufactured Polyamide-12

How Wei Benjamin Teo[1]*, Kaijuan Chen[1], Weidong Li[1], Jun Zeng[2] and Hejun Du[1]

[1]Nanyang Technological University, Singapore; [2]HP Labs, United States of America

Abstract:

Additive manufacturing (AM) is receiving a rising trend in many industries. The mechanical and physical properties of the polymer parts differ when it is fabricated through additive manufacturing process. Polymer parts fabricated through powder bed fusion (PBF) are experiencing different thermal condition within the print bed during the process. Hence, this affects the crystallization behavior of the polymer parts are manufactured.

Polyamide-12 (PA12) is one of the polymer materials adopted for additive manufacturing due to its wide application in the food and medical industries. The PA12 parts fabricated in a single print job have different mechanical properties due to its printed location within the print bed. The crystallinity and the thermal properties of the printed parts are experiencing similar trend to that of the mechanical properties. Due to the low thermal conductivity of polymer powders, the PA12 parts located within the middle of the print bed experience a lower cooling profile as compared those at the boundaries. The difference in cooling profile affects the crystallization temperature, shrinkage during crystallization and crystal morphology, which is believed to have correlation towards the mechanical and physical properties of PA12 parts.

In this work, the crystallization behavior of PA12 is discussed from (i) the different cooling rate experience by the polymer melt; (ii) the heated temperature exposed after the melt process; (iii) the aging effect of the powder and (iv) the addition of binders. The understanding of crystallization behavior from the thermal profile provides an estimation of the properties of the printed parts.

Biography:

How Wei Benjamin Teo is a Research Fellow in HP-NTU Digital Manufacturing Corporate Laboratory, Nanyang Technological University, Singapore. His research interest is to analyze the crystallization behavior of polymers through experimental characterization and phase field model while undergoing additive manufacturing process. He pursued his doctoral degree at the School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore, and he was awarded the Nanyang Presidential Graduate Scholarship for his graduate studies. He developed an expertise in synthesis, modification, characterization and adsorption performance of Metal-Organic Frameworks through experiment and modelling during his graduate studies.

Heterocyclic Polyacenes and Quinodimethanes

Chunyan Chi*

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Abstract:

Acene-based molecular materials have been demonstrated to be useful semiconductors and chromophores. For example, pentacene and rubrene are among the top most studied molecules used in active layer in organic field effect transistors (OFETs) with high hole mobilities. Longer acenes can be also used as model compounds to investigate zig-zag edges of graphene. However, one drawback which hampers their general applications is their intrinsic instability. Typical reactions of acenes related to the diene conjugation include addition with singlet oxygen to form endoperoxide and dimerization under light irradiation. In addition, parent acenes usually have poor solubility in common organic solvents. Therefore, we have developed several strategies to stabilize and solubilize acene based molecules, and a few kinds of acene derivatives have been prepared. Heteroatom-containing quinoidal acene analogues and their charged forms could serve as good model compounds to understand the electronic properties of the all-carbon acenes. Some of them also show open-shell diradical character and exhibit unique optical, electronic, and magnetic activity.

Biography:

Chunyan Chi received her PhD degree from the Max-Planck Institute for Polymer Research in 2004. After that, she conducted her postdoctoral work in the University of California at Santa Barbara. She is now a tenured associate professor in the Department of Chemistry, National University of Singapore. Her research interests are synthesis of extended π-electron systems with novel structures, aromaticity, organic diradicaloids, dyes, liquid crystals and functional materials for organic electronics and sensors.

Recent Progress of Photo-Polymerization for 3D Printings

Jui-Teng Lin*

Medical Photon Inc., Taipei, Taiwan

Abstract:

The synergic features and enhancing strategies for 3D printings using various photopolymerization systems are reviewed by kinetic schemes and the associated measurements. The important topics include: (i) photo crosslinking of corneas for corneal diseases using UVA-light (365 nm) light and riboflavin as the photosensitizer; (ii) synergic effects by a dual-function enhancer in a 3-component

system; (iii) synergic effects in a 3-initiator C/B/A system, having an electron-transfer and oxygen-mediated energy-transfer pathways; (iv) copper-complex (G1) photoredox catalyst in G1/Iod/NVK systems for free radical (FRP) and cationic photopolymerization (CP); (v) thiol-ene and thiol–acrylate Michael (TM) addition reaction; (vii) synthesis of nanogold via copper/iodonium/amine system under a visible light. (viii) dual-wavelength (UV and blue) controlled photopolymerization confinement; (ix) dual-wavelength (UV and red) selectively controlled 3D printing; (x) 3-wavelength (UV, red, blue) selectively controlled in 3D printing and additive manufacturing (AM); and (xi) the key factors for 3D-printing performance. Finally, we will propose some new directions for 3D printings and additive manufacturing (AM), based on the innovative concepts (kinetics/schemes).

Biography:

J.T. Lin, Ph.D in physical chemistry, University of Rochester (NY). Chairman & CEO of Medical Photon, Inc. Editor in Chief of Open Access J of Ophthalmology Research. He is the inventor of flying-spot in PRK-Lasik surgery. Prof. Lin has published 55 book chapters and about 250 peer-review papers. His research areas including photochemistry, phototherapy, vision corrections, corneal surgery, medical lasers design, kinetic modeling.

Additive Manufacturing of Polymeric Scaffolds with Airbrushed Nanofibrous Membranes for Tissue Interface Engineering

Murat Guvendiren*

New Jersey Institute of Technology, Otto H. York Department of Chemical and Materials Engineering, University Heights, Newark, NJ, USA

Abstract:

Additive manufacturing, also known as 3D printing, has become a common manufacturing technique to create tissue engineering scaffolds. Material extrusion-based 3D printing is the most commonly utilized technology yet the printed scaffolds have low resolution leading to macroporous constructs. The lack of nano and submicron features provides a low surface-to-volume ratio, which often leads to poor cell attachment and slow cell growth in vitro or reduced cell infiltration in vivo. Moreover, large open pore structure often results in low cell retention. To address these issues, we incorporated airbrushed nanofibrous members directly into 3D printed scaffolds. By using polycaprolactone (PCL) as a model biodegradable polymer, we fabricated hybrid scaffolds composed of alternating layers of 3D printed struts with airbrushed membranes. We adjusted the fiber density within airbrushed membranes to to control seeded stem cell penetration and infiltration in vitro. We demonstrated our ability to create 3D printed scaffolds with user-defined mixed cell distribution throughout the scaffolds or with distinct cell distributions within the selected regions of the scaffolds. We believe that our approach has a strong potential for developing highly tunable 3D printed solid scaffolds with user-defined and spatially controlled cellular heterogeneity.

Biography:

Murat Guvendiren is an Assistant Professor in the Chemical and Materials Engineering Department at NJIT. His research focuses on 3D printing of tissues and organs, and advanced functional materials. He received his PhD degree in Materials Science and Engineering from Northwestern University. He did postdoctoral research in Bioengineering Department at the University of Pennsylvania. Guvendiren is the recipient of NSF CAREER award (2021), NJIT Excellence in Innovative Teaching award (2021), NJIT Innovation in Engineering Education Award (2020), and MTF Biologics Junior Investigator award (2019). He is an elected Senior Member of the National Academy of Inventors (NAI) since 2022.

Development of Textile-based Electric Heater for Portable Warmth

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Abstract:

Wearable electric heaters for portable warmth have attracted much attention due to their potential application for personal heating system and thermal therapy management. For the development of textile-based electric heaters, a high durable conductive yarn is a vital role for constant warmth. In this work, a low-voltage and light-weight textile heater was prepared in wearable form using a low-cost dip-coating process. The conductive yarn was transformed from traditional cotton yarn by coating silver nanowires (Ag NWs), and dyeing of poly(3,4-ethylenedioxythiophene):poly(4-styrenesulfonate) (PEDOT:PSS) mixing ethylene glycol (EG). The conductive yarn exhibited high electrical conductivity and good stability after washing. The AgNWs/PEDOT:PSS/EG heater showed a heating temperature higher than 110 °C at a driving voltage as low as 4 V. The yarns showed a stable Joule heating performance under repeated bending stress and stretching/releasing. To demonstrate on-body heating systems, the heating yarns were sewed on a fabric with an additional fabric backing. When the heater was connected to a power supply and attached to a person's wrist, the heat distribution in the thermal wristband was steady as it was bent back and forth. These results demonstrated a great potential using AgNWs/PEDOT:PSS/EG yarns as heat generator in wearable electronic heater.

Biography:

Rawat Jaisutti obtained his Ph.D. in Physics in 2012 from Mahidol University, Thailand. After graduated, he joined Thammasat University as a lecturer at Department of Physics, Faculty of Science and Technology. His research focuses on the development of wearable electronic devices, sensors and actuators based on organic and inorganic semiconducting materials, and integration technologies for wearable electronic systems.

ORAL

Radiosensitizing Biopolymeric Hydrogel and Nanoparticles for Cancer Chemoradiotherapy

Prateek Bhardwaj[1*], Vikram Gota[2], Komal Vishwakarma[2], Venkatesh Pai[2], Pradip Chaudhari[2], Bhabani Mohanty[2], Rahul Thorat[2], Subhash Yadav[2], Murari Gurjar[2], Jayant Sastri Goda[2*], Rinti Banerjee[1*]

[1]Indian Institute of Technology Bombay, India; 2Tata Memorial Centre (ACTREC), India

Abstract:

Limited therapeutic gain with neoadjuvant chemotherapy of locally advanced inoperable cancers can be improved with concomitant use of chemoradiotherapy (CRT) owing to their spatial cooperation and synergistic cytotoxicity. However, poor circulation half-life, limited passive bioavailability, and dose-limiting systemic toxicities of clinically approved radiosensitizers significantly affect the treatment efficacy and patient's quality of life. Incorporation of clinical radiosensitizers into smart biopolymer-based nanomedicines can overcome these limitations, however, location of the malignant niche and the choice of polymer in terms of biodegradability, mucoadhesiveness, and rheological properties are imperative to their rational designing. To target malignant oral mucosa involving lips, tongue, the floor of the mouth, and buccal mucosa, we designed a biodegradable and mucoadhesive high acyl gellan based hydrogel impregnated with gellan- and lipid-based dual nanocarriers for controlled and prolonged site-specific delivery of clinically relevant radiosensitizers i.e. cisplatin and paclitaxel. Interestingly, the nanoparticle-in-gel prolonged the tumor bioaccumulation of both the drugs with reduced systemic absorption in subcutaneous oral cancer xenograft bearing NOD-SCID mice, thereby improving in vivo efficacy and safety as compared to systemic commercial formulations approved for oral cancer chemoradiotherapy. Porous hydrogel facilitated the release of both the radiosensitizer-loaded nanoparticles at the tumor vicinity for enhanced intracellular uptake and cell arrest at the radiosensitive G2/M phase. Concomitant focal irradiation predominantly deposited lethal double-stranded DNA nicks in these pre-sensitized cells and thus, synergistically enhanced the tumor apoptosis. Our findings suggest the clinical potential of this platform in the loco-regional management of oral cancer requiring curative CRT over the current systemic regime.

Biography:

Prateek Bhardwaj is a Postdoctoral Associate at the Yale University. His research primarily focuses on finding therapeutic radiosensitizing targets by understanding and exploiting the synthetic lethal interactions between the genes involved in DNA damage response. Pertaining to his doctoral research on using smart biomaterial-based theranostic nano-platforms and gels for cancer chemoradiotherapy at the Indian Institute of Technology Bombay, India, he has been granted a patent and published several peer-reviewed research and review articles in esteemed international journals like Nanoscale, Journal of Controlled Release, Biomaterials, Acta Biomaterialia, and Biomacromolecules. He has shared his research leads through multiple invited talks at different international conferences including a 'keynote' talk.

A Rational Approach towards Bioproduction of Bacterial Cellulose

Anindya Basu

Rajiv Gandhi Technological University, India

Abstract:

Bacterial cellulose (BC) has been gaining importance over the past decades as a versatile material that finds applications in diverse industries. However, a secured supply of the polymer is hindered by its slow production rates and batch-to-batch yield variability. Such hindrances are largely due to the limited knowledge about the physiological and environmental conditions facilitating the biopolymer production. For example, bacterial growth is not always associated with cellulose production. Moreover, the difficulty in simultaneous monitoring of the bacterial growth rates under cellulose producing conditions, adds to the complexity in testing the associated cellulose productivities under varied environmental conditions. Hence a novel analytical platform was developed that could be used simultaneously for studying the biology and optimizing growth conditions of cellulose producing bacteria. The analytical platform, based on the organisms' surface growth patterns, helped in efficient determination of the environmental impacts on BC production. The findings obtained from the developed analytical platform paved the way for establishing a rational BC bioprocessing strategy. Interestingly, process characterization studies revealed that the achievable BC yields is a function of the media carbon source and the corresponding reactor design and / or the operating conditions. The systematic study helped establishing a high yielding Bioprocessing strategy for BC production.

Antibacterial Performance of Bio-Hybrid Chitosan-Grafted-Polybenzoxazine Films

Richa Priyadarshini[1*], Nisha Yadav[2], Monisha Monisha[2], Rashmi Niranjan[2], Amrita Dubey[1], Sachin Patil[2] and Bimlesh Lochab[2]

[1]Department of Life Sciences, School of Natural Sciences, Shiv Nadar University, Gautam Buddha Nagar, Uttar Pradesh, India.

[2]Materials Chemistry Laboratory, Department of Chemistry, School of Natural Sciences, Shiv Nadar University, Gautam Buddha Nagar, Uttar Pradesh, India.

Abstract:

Emergence of drug resistant gram positive Staphylococcus aureus strain have increased mortality rate and imposed a significant economic burden on the healthcare systems. S. aureus causes a variety of diseases including, skin infections, abscesses, pneumonia, osteomyelitis, endocarditis, toxic shock syndrome and septicemia. Due to the formation of S. aureus biofilms on medical implants, treatment often involves the removal of these implants and devices. Moreover, with the emergence of antibiotic resistant S. aureus strains, such as Methicillin resistant S. aureus (MRSA), these infections have increased in morbidity and mortality. Thus, development of new antibacterial agents and polymers is an urgent requirement are of significant medical importance. One such functional biopolymer is chitosan (CS), and modified chitosan polymers. Limited efficacy and stability of CS demands exploration of reactive chemical modifications with improved antimicrobial property. In current work, fully biobased benzoxazine (V-fa, vanillin-furfuryl amine) is grafted on CS and tested for antimicrobial properties. Nature and type of chemicalinteractions were probed

by FTIR, P-XRD, DSC and XPS studies. Antimicrobial action was probed by Disc diffusion and live dead assays. Enhance antimicrobial action of CS-graftpoly(V-fa) films is attributed to increased oxidative stress in the bacterial cells. Current work illustrates that biobased CS-graft-poly(V-fa) films are an attractive alternative for antibacterial applications in future. Reference: Nisha Yadav, Monisha Monisha, Rashmi Niranjan, Amrita Dubey, Sachin Patil, Richa Priyadarshini, Bimlesh Lochab. 2021. Antibacterial performance of fully biobased chitosangrafted-polybenzoxazine films: Elaboration and properties of released material. Carbohydrate Polymers, Volume 254, 117296. https://doi.org/10.1016/j.carbpol.2020.117296.

Biography:

Richa Priyadarshini is an Associate Professor at Dept. of Life Sciences at Shiv Nadar University, India. I have received my Ph.D. in Microbiology from University of North Dakota and completed postdoctoral training at Yale University and Forsyth Institute. Main focus of my research is on cell wall modifying enzymes and their role in cell morphogenesis, antibiotic resistance and biofilm establishment. Other areas of research are antimicrobial and antifouling agents, nanoparticles and microbial degradation of xenobiotics.

Preparation of Ultrahydrophobic Coatings using Polymer-Based composite materials for Various Industrial Applications.

Sangeetha Sriram*

National Institute of Technology Rourkela, India

Abstract: Not available

Polysaccharide Production by Lactic Acid bacteria [Screening for Polysaccharides Improving Functional Properties of Fermented Products]

Vera Kuzina Poulsen[1*], Paula Gaspar[1], Kristian Jensen[1], Elahe Ghanei Moghadam[1], Gunnar Oregaard[1] and Anders Krarup[1]

[1]Chr. Hansen A/S, Denmark

Abstract:

In the food industry, the ability of lactic acid bacteria (LAB) to produce exo-cellular polysaccharides is associated with improvement of the texturing properties and increased health benefits of fermented products. Polysaccharides from food-grade LAB are non-toxic, biodegradable, environment friendly and are commercially used for a broad range of applications like natural viscosifiers, emulsifiers, stabilisers, binders, gelling agents, coagulants and suspending agents. Thus, texture generation in fermented food is a value adding feature for LAB. For this reason, screening and selection of texturing LAB is of importance to both academia and industry.

High-throughput screening assays have been developed in our laboratories to identify LAB strains that produce homo- and hetero-polysaccharides. Applying these, we identified several strains producing functional polysaccharides that improved the texture in fermented milk and plant-based matrices. Mining for polysaccharide genes clusters was performed and polysaccharide structures

elucidated. The data generated is being used to establish gene-structure relationship for exocellular polysaccharides in LAB.

Grafting of Polyaniline by a Dynamic Inverse Emulsion Polymerization Technique onto Membranes as an Anti-Biofouling Agent: An Innovative Approach

Ran Y. Suckeveriene[1*]

[1]Department of Water Industry Engineering, Kinneret Academic College on the Sea of Galilee, Zemach

Abstract:

The demand for clean water is on the rise but since water sources are limited, the need for purification processes, such as membranes and filters, has become increasingly crucial. One of the main hurdles facing these processes is fouling and biofouling. In general, fouling is related to the deposition of macromolecules, colloids, particles and inorganic materials on the membrane surface and pores. Biofouling consists of the deposition of large bacterial colonies and biofilm on the membrane surface and inside the pores. Both are difficult to clean effectively. Anti-biofouling additives are typically insufficient, since they need to be stable to the water current and located at the surface of the membranes or filters. One of the suggested methods for effective biofouling prevention is the use of electrically conductive polymers (ICP).

This work describes an innovative approach for the anti-biofouling protection of membranes. This approach consists of a novel in-situ interfacial dynamic inverse emulsion polymerization process under sonication of aniline in the presence of carbon nanotubes (CNT) and graphene nanoparticles in organic solvent. The resulting hybrids were filtered, and the remaining filtration cake was used and analyzed as a nanocomposite membrane.

The resulting polyaniline (PANI) chains were grafted to the membrane surface, creating an anti-biofouling coating. High-resolution scanning electron microscopy (HRSEM) indicated that the nanocomposite membranes were coated with PANI. The grafted PANI exhibited a remarkably improved anti-biofouling effect. The membranes' salt rejection and flow properties were analyzed and showed that the flow properties were only slightly different compared to the reference membrane.

Biography:

Suckeveriene is Head of the Water Industry Engineering Department and group leader, of the Laboratory of Polymers, Composites, and Nanocomposites at Kinneret Academic College on the Sea of Galilee. He is also the CTO of Kinneret Innovation Center (KIC), and the CTO of CaleeTech (formerly known as Obvislim) start-up. Suckeveriene received his Ph.D. in Polymer Engineering (2012), M.Sc. (2008) and B.Sc. (2005) degrees in Chemical Engineering, all from the Technion – Israeli Institute of Technology. Ran has published more than 30 academic articles and three patents. Also, ran is an editor and reviewer for several journals.

Processing of Bacterial Nanocellulose and Resulting Properties of the Biomaterial

Hanna Staroszczyk[1*], **Paulina Dederko-Kantowicz**[1,2], **Agata Sommer**[1], **Edyta Malinowska-Pańczyk**[1], **Piotr Siondalski**[3], **Magdalena Kołaczkowska**[3]

[1]Faculty of Chemistry, Gdańsk University of Technology, Poland; [2]Centre for Modern Interdisciplinary Technologies, Nicolaus Copernicus University in Toruń, Poland; Department of Cardiac and Vascular Surgery, Medical University of Gdańsk, Poland

Abstract:

Bacterial nanocellulose (BC) is a natural biomaterial with a wide range of biomedical applications. The usefulness of BC in healing various types of wounds was confirmed as early as the 1990s [1]. As a non-toxic, non-irritating, hypoallergenic, non-pyrogenic and biocompatible biomaterial, BC also shows great potential as a bioimplant material in cardiac and vascular surgery [2]. Mammals do not have enzymes that degrade BC, so once implanted, a BC should not biodegrade [3]. However, BC contains 99% water, which makes it too thick to be used for this purpose. Thus, to reduce the thickness of the biomaterial, the BC was dehydrated and then rehydrated, and the in-vitro biodegradability of such modified BC was investigated under conditions simulating human plasma with and without Aspergillus fumigatus. Finally, mechanical and physicochemical properties of BC were assessed in the context of its use as bio-prostheses in the cardiovascular system.

Nitrocellulose Membranes Entrapped with Gold Nanoparticles for Highly Sensitive Protein Detection

Huiyan Li[1*] and Nikan Momenbeitollahi[1]

[1]University of Guelph, Canada

Abstract:

Proteins are functional molecules in life, providing physiological and pathological information at functional levels. Measuring proteins in body fluids such as blood plasma can advance our knowledge in disease biology, and help in disease management such as diagnostics, prognosis, and treatment monitoring. However, conventional protein quantification techniques have limitations in assay sensitivity, unsuitable for disease detection at an early stage. In this work, I will present our recent efforts on developing a 3D platform entrapping gold nanoparticles in nitrocellulose membranes for highly sensitive protein detection based on metal enhanced fluorescence phenomena. Gold nanoparticles with different sizes from 5 nm to 10 nm were tested with different concentrations. Two cellulose membranes with different surface chemistry and pore sizes were compared to achieve optimal fluorescence signal intensities for quantifying proteins in blood plasma samples. After optimization of the assay steps, we used the platform to measure protein levels in blood plasma and extracellular vesicles. Compared to conventional protein assays, an improved assay sensitivity up to four orders of magnitude was achieved using our method. This new 3D nitrocellulose-based platform with gold nanoparticle enhanced fluorescence provides a powerful tool for highly sensitive protein detection from complex biofluids. The simplicity of the method facilitates technology dissemination and enables broad applications beyond protein measurement.

Biography:

Huiyan Li obtained her PhD in Biomedical Engineering from McGill University. After postdoctoral training from Massachusetts General Hospital, Harvard Medical School, she joined the Biomedical Engineering program in the School of Engineering at the University of Guelph. Her research focuses on developing novel micro- and nano-technologies and lab-on-a-chip systems for the study of health and diseases. Her work has been published in top peerreviewed journals in the research field and has been highlighted in major scientific magazines.

Magnetic Molecularly Imprinted Polymer for Cancer Therapy

Nébéwia Griffete[1*], Aude Michel[1], Christine Ménager [1], Michèle Sabbah[2], Claire Wilhelm[3]

[1]Sorbonne Université, CNRS, Physico-chimie des Électrolytes et Nanosystèmes Interfaciaux, France. 2 Sorbonne Université, Centre de Recherche Saint-Antoine, France. 3Laboratoire Matière et Systèmes Complexes, France.

Abstract:

Research in nanotechnology prospered during the last decade and yielded several prerequisites for drug delivery systems. Among the broad spectrum of nanoscale materials being investigated for biomedical applications, magnetic nanoparticles have attracted significant attention due to their intrinsic magnetic properties. The last 20 years have witnessed an important increase in the number of reports dedicated to magnetic hyperthermia. Magnetic hyperthermia is a type of thermal cancer treatment that takes advantage of the heat generated by magnetic nanoparticles when applying alternative magnetic field (AMF). An interesting field of research concerns the use of localized temperature around the magnetic nanoparticles (hot spot effect). Molecularly imprinted polymers (MIPs) have been widely utilized as molecular-recognition and separation materials in different fields. The imprinting process involves the polymerization of a functional monomer in the presence of a molecule with a cross-linking agent. After the extraction of the molecule, the polymer matrix contains tailor-made binding sites, perfectly complementary to the molecule. In recent years, their use in nanomedicine has emerged. In this context, we recently developed innovative molecularly imprinted polymers magnetic delivery nanomaterial for triggered cancer therapy showing active control over drug release using AMF. Upon AMF, the magnetic nanoparticle locally heats and the drug, sequestered in the MIP, is released by disrupting hydrogen bonds existing with the polymer. As many anticancer drugs possess side effects, this novel material could be helpful to release the drug, with control, at the desired place.

Biography:

Nébéwia Griffete graduated in Chemistry in 2008 at Sorbonne Université. She received her PhD in Physical Chemistry in September 2011 from Paris-Cité University where she worked for the first time on molecularly imprinted polymers that she combined to photonic crystals to develop optical sensors for the detection of Bisphenol A in water. After her post docs in Adolphe Merkle Institute and ESPCI, Paris she joined in 2013 Sorbonne Université as associate professor to develop a novel research thematic that concerns molecularly imprinted magnetic nanomaterials for health and environmental applications.

Mixed Chitosan-Bioglass Coating on Plasma Activated Peek Polymer

Agnieszka Ewa Wiącek[1*], Kacper Przykaza[2], Małgorzata Jurak[1]

[1]Faculty of Chemistry, Maria Curie-Skłodowska University, Lublin, Poland; 2 Biomedical Faculty, Medical University of Lublin, Poland.

Abstract:

Polyether ether ketone (PEEK) is biocompatible, chemically and physically stable polymer that exhibits a similar elastic modulus to human bone, making it an attractive orthopedic implant material. However, PEEK is also biologically inert, preventing enough strong bonding with surrounding bone tissue during implantation. Surface modification and composite preparation are two main strategies to improve the bioactivity of PEEK.

Air plasma activated PEEK surfaces with embedded bioglass, chitosan and chitosan-bioglass mixed layers applying dip coating/from solution hybrid coating technique were investigated. The obtained surfaces were studied in terms of wettability/surface free energy changes. Moreover, FTIR (Fourier Transformation Infrared Spectrometry) and SIMS (Secondary Ion Mass Spectrometry) has been applied to establish and control coatings composition. Simultaneously the structure of films were visualised with SEM (Scanning Electron Microscopy). Finally, the obtained systems were incubated in SBF (Simulated Body Fluid) to verify the modifications influence on the bioactivity/ biocompatibility of PEEK surface. For the preparation of bioactive PEEK surfaces, the main challenge is to keep its excellent mechanical properties when impregnating bioactive materials, thus all conducted modifications affected only polymer upper surface. The development of PEEK surface covered with nano/micro-sized bioactive materials/films may provide an effective way to obtain both mechanical and biological benefits.

Biography:

Agnieszka Ewa Wiącek studied chemistry at Maria Curie-Skłodowska University and was employed in the Department of Physical Chemistry. She received D. Sc. degree in chemistry in 2000 and habilitation degree in physical chemistry in 2013 writing dissertation titled “Effect of the selected biologically-active substances, mainly phospholipids and (phospho)lipases on the interfacial properties of dispersed systems”. She has published more than 80 research articles which were cited according to Google Scholar more than 1350 times. Additionally she is author/co-author of 100 conference' articles. She is promoter of master of science and licentiate thesis (more than 50) and 2 doctoral thesis. She participated in 6 scientific projects. In 2018 she obtained the position of an Associate Professor at MCSU.

Application of Synthetic Polymers in the Construction of Oil & Gas Wells

Ashok Santra

Aramco Research Center - Houston, 16300 Park Row, Houston, TX, United States

Abstract:

Applications of polymers in hydrocarbon extraction has been growing with increase in global energy demand. Due to the lower cost and environmental factors biopolymers are highly favored in the oil and gas industry operations. However, synthetic polymers have been playing major roles for many decades to deal with harsh thermal and chemical environments especially when the biopolymers are not capable of handling the situations. Designing efficient cementing or drilling fluids for high temperatures (250-450F) requires inclusion of many synthetic polymers to optimize important properties like rheology, emulsion stability, delay of cement setting, filtrate loss control and fluid migration control to achieve trouble free drilling and zonal isolation, are two main aspects of constructing an oil & gas well. In addition, synthetic polymers have been used to improve the ductility of cement sheath for improving longer-term integrity of the well. This presentation will include a brief review of various applications of synthetic polymers especially in drilling and cementing fluids, with focus on structure property relationship. Development of some of the latest state of the art synthetic polymers from our laboratory and their applications will also be presented herewith. Reversible Addition Fragmentation chain Transfer (RAFT) polymerization has been used to synthesis these

Biography:

Ashok Santra is a Research Science Consultant, conducting innovative research for Aramco Americas Drilling Technology group at their Houston facility. He has graduated from IIT, IISc and worked as a researcher at Cambridge (UK), Cardiff (UK) and Texas A&M Universities. He has 25+ years of research experiences including 15 years with O&G industry in new product/processes development for Oilwell Drilling, Cementing and Production Enhancement. Ashok has co-authored 90+ scientific publications and 90+ US/international patents.

Porous Organic Polymers for the Selective Capture of Molecular Targets

Peter A. G. Cormack*

WestCHEM, Department of Pure and Applied Chemistry, University of Strathclyde, Thomas Graham Building, 295 Cathedral Street, Glasgow, G1 1XL, Scotland, UK

Abstract:

Porous organic polymers are exploited in a broad range of specialist and everyday applications, e.g., as polymer supports in solid-phase synthesis work and heterogeneous catalysis, as ion-exchange resins for water-softening, as tissue engineering scaffolds and as functional materials in biological assays. Furthermore, they are highly attractive for use in a number of important chemical separation scenarios, including as high-performance sorbents and stationary phases in solid-phase extraction (SPE) and chromatographic separation technologies, respectively, spanning large-scale chemical separations and analytical-scale work (e.g., the monitoring of environmental pollutants and drug molecules).

At the University of Strathclyde in Glasgow, we specialize in the design, synthesis and application of porous organic polymers, optimised to solve an array of real-world scientific challenges, including analytical chemistry problems (environmental analysis, bioanalysis, forensic toxicology and omics). In this lecture, I will outline how we control the physical format, porosity and chemical functionality of porous polymers tailored for high-performance chemical separation work, and show how the polymers can be used as advanced sorbents in solid-phase extraction (SPE) protocols. Typically, the polymers are synthesized by methods such as precipitation polymerization and suspension polymerization, and porosity is installed into the polymers though either the use of porogenic agents and/or hypercrosslinking methodologies. Affinity and selectivity for molecular targets by the polymers is ensured through the incorporation of chemical motifs such as ion-exchange groups or molecular receptors installed through template-directed synthetic strategies. The latter approaches deliver antibody binding mimics which we apply to disease diagnosis, prognosis and management.

Biography:

Peter Cormack is Professor of Polymer Chemistry and Head of Materials & Computational Chemistry at the University of Strathclyde in Glasgow, Scotland, UK. Peter has a built a global reputation as international leader in polymer science, and he is motivated by a desire to pursue useful polymer chemistry research which promises tangible, societal benefits. Peter’s research interests lie predominantly in the areas of synthetic polymer chemistry and materials science, with special emphasis on the design, synthesis and applications of functional organic polymers, including porous organic solids, polymeric synthetic receptors, polymer microspheres, chemical sensors and ion-exchange resins.

Computational Design of Zwitterions-based Protein Delivery Capsules

Sousa Javan Nikkhah[a] and Matthias Vandichel[a]

[a]Department of Chemical Sciences, Bernal Institute, University of Limerick, Limerick, Republic of Ireland

Abstract:

Protein-based therapy has become a central research topic in the field of biomacromolecular medicine. During the last decades, numerous proteins have become available as medicines for various diseases and chronic illnesses. However, these medicines are mostly available as injectables, and strategies need to be developed to make these proteins orally deliverable. In particular, the stability of proteins following oral administration is poor because of the highly acidic environment in the stomach and the short protein half-life time. Therefore, designing a protein delivery system which can protect and improve the protein's pharmaceutical effects is crucial. Zwitterions or polyzwitterions ((poly)zwitterion) are potentially ideal materials for protein delivery due to their ability to form the dense shell of cations/anions to protect proteins. The main aim is to identify effective protein delivery solutions based on zwitterions, which require encapsulation into particles with controllable sizes that are able to move in the body and deliver the protein easily. The (poly)zwitterions may contain cations, anions, and also neutral parts, which are able to form different self-assembled structures, and when properly designed, they can be transport platforms for hydrophobic as well as hydrophilic proteins.

The resulting aggregate structure of this mixing depends on the structural, binding properties, concentration of the (poly)zwitterion, and the neutral part's chemistry. In this research, we design (poly)zwitterion-based delivery systems for glucagon with high stability and load efficiency. To achieve this goal, this project proposes the development and implementation of integrated, multiscale modeling techniques especially suited to screen different (poly)zwitterionic carriers for this specific protein under experimentally relevant conditions. Our study shows how the system's parameters, i.e. the polymer chains length and the block length ratio, etc. affect the final aggregate structure, morphology, and the protein release kinetics. We believe the multiscale modeling-led outcome of our research can be a road map for future experimental and clinical studies on protein therapy.

Biography:

Sousa Javan Nikkhah is currently a Marie-Curie fellow at the University of Limerick who is developing intelligent drug/hormone/protein delivery platforms based on (poly)zwitterion copolymers using multiscale molecular modeling. During her previous Marie-Curie fellowship, she designed a polyelectrolyte-based drug delivery with the purpose of monoclonal antibody (Mab) therapy. She received her Ph.D. degree in chemical engineering focused on polymer science and engineering and multiscale modeling of macromolecules. Her primary research experience and interests include multiscale modeling of macromolecules; unraveling of polymer based materials self-assembly pathway; multiscale material engineering of polymeric drug delivery systems; explaining the effect of polymers architecture on the dynamical processes and properties of self-assembling; designing polymer-based cascade multi-drug delivery systems; and developing the coarse-graining modeling techniques to increase their accuracy and efficacy.

Genetic Algorithms for Scaffold Design

Maraolina Domínguez-Díaz[1*], Marco Cruz-Chávez[1] and Angelica Meneses-Acosta[2]

[1]Centro de Investigación en Ingeniería y Ciencias Aplicadas, Universidad Autónoma del Estado de Morelos, Av. Universidad 1001, Cuernavaca, Morelos, , México; 2Facultad de Farmacia, Universidad Autónoma del Estado de Morelos, Cuernavaca, Morelos, México

Abstract:

The scaffolds designed for cell growth imply considering different combinations of properties of a fiber mesh, for which a process of trial and error is usually carried out. In this work, a Genetic Algorithm (GA) was used to obtain scaffolds for osteoblast culture. The input parameters of the Algorithm were electrospinning processing parameters, and as output, scaffolds with favorable characteristics for the growth of osteoblasts were obtained. The computational results that indicated best, intermediate and worst aptitude for osteoblast growth were processed by electrospinning and characterized. The Normal Human Osteoblast cell line (NHOst) was used for testing the scaffolds. The number of cells at 148 hours was 2.8 x 105 cells/ml for best, 2.3 x 105 cells/ml for intermediate, and 1.8 x 105 cells/ml for worst case.

Biography:

Maraolina Domínguez-Díaz has Physics degree from the Universidad Autónoma del Estado de Tabasco; Master's and Doctorate degrees in Engineering and Applied Sciences, with specialties in Materials and Electrical Technology, by the Centro de Investigacion en Ingeniería y Ciencias Aplicadas, Universidad Autónoma del Estado de Morelos. She did a postdoc on plasma treatment of polymers at the Universidad Nacional Autónoma de México and a second postdoc on polymer/ceramic composites at the Centro de Investigación y de Estudios Avanzados del IPN. She has worked with polymers, ceramics, cold plasma and genetic algorithms, for antibacterial, cell culture and in dye degradation applications.

Use of Biopolymers in Food Packaging

Sridevi Narayan-sarathy

Environmental sustainability is one of the pillars of the PepsiCo Positive agenda and packaging is a significant component of our Carbon footprint as well as single use plastics use. Use of biopolymers in Flexible packaging could help reduce the green-house gas emissions associated with food packaging. In addition to that, flexible packaging has also a challenge from an end of life point of view as the current multi-material structures are not recycle friendly in existing infrastructure. We have developed a multi-pronged approach to address this problem globally by developing materials which are bio-based and can be recycled or easily composted. This is based on a deep materials science understanding of novel materials development with the right partners, solving

engineering challenges of conversion and building supply chain that is committed to leaving a more sustainable world for our future generations.

The Origin of Life on Earth History was Recorded in Trna Sequences

Zachary Frome Burton*

*Department of Biochemistry and Molecular Biology, Michigan State University, E. Lansing, MI

Abstract:

The primordial transfer RNA (tRNA) sequence is known (almost) to the last nucleotide. The sequence was comprised entirely of RNA repeats and inverted repeats that persist in living organisms. TRNA is the polymer around which mRNA, aminoacyl-tRNA synthetases (enzymes that charge cognate tRNAs with their amino acid), ribosomes, proteins, translation factors and the genetic code coevolved. In evolution of pre-life, polymer world evolved to 31-nt minihelix world, which evolved to tRNA world, tRNAomes, the genetic code and life. The model reliably describes both type I and type II tRNA evolution. Type II tRNAs have a longer variable loop (initially 14-nt). So, surprisingly, the most important innovation in the pre-life to life transition (tRNA) evolved from ordered RNA repeats and inverted repeats that survived the transition to living systems. Evolution of tRNA and the genetic code is an issue of artificial intelligence, because emerging living systems "taught" themselves through evolution to code. So, tRNA sequences relate a history of the pre-life to life transition covering perhaps ~200 million years of pre-life about 4 billion years ago. Also, tRNA is the central function in evolution of translation systems and the genetic code, which, with cells and DNA replication, are the major hallmarks of living systems. The 3-31-nt minihelix model for tRNA evolution can largely be confirmed by inspection of the tRNAomes of ancient Archaea, essentially by puzzle solution. Statistical analyses support the model. Previous to this work, tRNA evolution was characterized as a chaotic evolutionary process.

Biography:

Burton was a Professor of Biochemistry and Molecular Biology at Michigan State University from 1987-2017 (now retired). Burton has published 2 books and many peer-reviewed scientific papers (https://scholar.google.com/citations?user=ZgAJpnUAAAAJ&hl=en&oi=ao). Burton's research was on transcriptional mechanisms, early evolution of transcription systems and early evolution of translation systems. Recently, Burton solved early evolution of transfer RNA to the last nucleotide. There is no comparable model (essentially a theorem) for primordial evolution of a core biological function. Burton has contributed major progress in evolution of tRNA, tRNA modifications, aminoacyl-tRNA synthetases and the genetic code.

A Modular Polymer Platform that Delivers Recombinant Cytokines and chemotherapeutics. Allows for de-escalation of Radiation Therapy in an Animal Model of Head and Neck Squamous Cell Carcinoma

Yazeed Alhiyari Ph.D.1, Jundong Shao Ph.D.2**, Albert Y. Han M.D, Ph.D.1,3,4 , Amanda Miller B.S.4 , Jeffrey F Krane M.D, Ph.D.†, Marie Luff B.S.4, Milica Momcilovic5 Ph.D., David Shackelford3,5 Ph.D., Zhen Gu Ph.D.2*, Maie A. St. John M.D. Ph.D.1,3,5**

[1]Department of Head and Neck Surgery, David Geffen School of Medicine at University of California, Los Angeles, CA

[2]University of California Los Angeles Department of Bioengineering

[3]Jonsson Comprehensive Cancer Center, at University of Los Angeles Medical Center, Los Angeles, CA

[4]David Geffen School of Medicine at University of Los Angeles, CA

[5]DGSOM Division of Pulmonary and Critical Care Medicine Head and Neck Cancer Program at University of Los Angeles, CA

[†]Department of Pathology & Laboratory Medicine, UCLA Medical Center, Los Angeles, CA

Abstract:

Purpose: Head and neck cancer is the sixth most common cancer in the world, with more than 300,000 deaths attributed to the disease annually. Aggressive surgical resection often with adjuvant chemoradiation is the cornerstone of treatment. However, the necessary chemoradiation treatment can result in collateral damage to adjacent vital structures causing a profound impact on quality of life. We had previously shown the antitumor efficiency of a novel polymer in delivering chemokines, cisplatin and non-traditional chemotherapeutics

(thymoquinone) in an animal model of SCCHN, and have further improved upon the initial single polymer platform to a multiple layer layout allowing for cross-sectional imaging and different elusion rates of each layer for multiple drug delivery schemes. In all iterations of the polymer platform we evaluate the safety and efficacy of this polymer in combination with radiation therapy (RT) in an effort to see if this combination allows for a de-escalation of RT.

Materials/Methods: Using a tumor mouse model SCCVII/SF tumors where established in C3H/HeJ mice. Tumors were 50% resected when they reached 1cm in volume and treated with either 1) no polymer; (2) plain polymer; (3) drug layered-polymer (cisplatin, CCL21, or TQ); (4) combinational polymer. (CCL21+cisplatin or TQ+CaCO3). Tumor size was measured every day until the mice were euthanized.

Results: In all cases where polymer secreting chemotherapeutics, cisplatin, CCL21, combination cisplatin+CCL21, and TQ, the polymer effectively reduced SCCVII/SF tumors in C3H/HeJ mice ($p<0.01$) as compared to control and plain polymer groups. Histopathology revealed no adverse tissue effects when the cisplatin polymer was inserted in direct contact with surrounding tissues.

Biography:

Alhiyari received his dual B.S. degrees in Cellular Molecular biology and Mathematics from Texas Tech University, his M.S. from the Texas Tech Health Science Center in Molecular Pathology and his Ph.D. in Medical Physics with an emphasis in radiobiology from UCLA. His current research focus is in biomedical translational science with the development of new treatment strategies and imaging modalities for cancer therapy.

Patterned Liquid Crystal Elastomer Coatings with Dynamic Topography

Oleg D. Lavrentovich*

Advanced Materials and Liquid Crystal Institute, Department of Physics, Kent State University, Kent, OH

Abstract:

Liquid crystal elastomers (LCEs) are currently explored as promising materials to create programmable and adaptive soft mechanical elements and systems. The orientational order of the networks is used to preprogram their mechanical response to stimuli such as temperature and electromagnetic fields. In this work, we demonstrate that the predesigned director patterns with topological defects can be used to control a dynamic surface topography of LCE coatings. In these coatings, one surface is rigidly bound to a solid (glass) substrate, while the other is free. The director pattern is created by the recently developed photoalignment method based on plasmonic photomasks. A highly ordered polymeric coating is prepared by photoinitiated free-radical polymerization of a mixture of liquid crystal mono- and di- acrylate monomers in the nematic phase. The coating responds by changing the topography of the free surface to stimuli such as temperature, photoirradiation and the electric field. The topography change is uniquely determined by the type of topological defects and director gradients preprogrammed during the alignment and polymerization of LCNs. Topological defects of strength one with a pure bend of the director produce hills upon heating, while the defects of the same topological charge with pure splay produce valleys. We relate the underlying mechanism to the local expansion-contraction stresses triggered by the changes of the scalar order parameter. The work was supported by the Office of Sciences, DOE, grant DE-SC0019105.

Biography:

Oleg D. Lavrentovich received his Ph.D. (1984) and Doctor of Science (1990) degrees in Physics and Mathematics from the Ukrainian Academy of Sciences. In 1992 he joined the Liquid Crystal Institute at Kent State. He served as the director of institute in 2003-2011 and is currently a Trustees research professor. His research focuses on electro-optics of liquid crystals, topological defects, liquid crystal elastomers, active matter, colloidal liquid crystals, ferroelectric liquid crystals, and nonlinear electrokinetics. He is the editor of Liquid Crystals Reviews (Taylor & Francis), fellow of SPIE and American Physical Society.

Multi-Shape-Changing Interpenetrating Networks with Shape Memory Effect and Adaptive Plastic Deformations

Zi Chen[1,2*], Lin Wang[1], Shanshan Wu[3], Xing Guo[1,3], Jing Fan[4] and Shaobing Zhou[3]

[1]Thayer School of Engineering, Dartmouth College, Hanover, New Hampshire, USA.

[2]Division of Thoracic Surgery, Brigham and Women's Hospital, Harvard Medical School, , Boston, MA, USA.

[3]Key Laboratory of Advanced Technologies of Materials Ministry of Education, School of Materials Science and Engineering, Southwest Jiaotong University, Chengdu, China.

[4]Department of Mechanical Engineering, City College of New York, New York, NY, USA.

Abstract:

Shape-changing materials with precisely programmable configurations, each having its own functional regime, provide a wide range of applications in engineering and biomedical fields. Polymers with dynamic reversible covalent/non-covalent bonding feature the potential of having

remarkable plasticity, which endows them with the capability of undergoing significant and sophisticated shape changes. Here we report a facile method to build an interpenetrating network (IPN) structure with plastic deformation and shape memory properties. The IPN is consisting of Poly(vinyl Alcohol) (PVA) with slight chemical covalent crosslinking and poly(UPyMA-AAc) with two potential dynamic reversible non-covalent bonding (quadruple hydrogen-bonding and ferric coordination bonding). This IPN structure not only has the capability of thermal plasticity and metal-coordinated plasticity, but also possesses shape memory properties similar to typical shape memory polymers. Hence, the polymers with this structure can undergo programmable shape changes through sequential adaptive plastic deformations triggered by a variety of stimuli.

Biography:

Zi Chen is an Assistant Professor at Harvard Medical School and Brigham and Women's Hospital (BWH). Chen received his PhD in Mechanical and Aerospace Engineering from Princeton University. Chen worked as an Assistant Professor at Dartmouth (2015-2020). Prior to Dartmouth, he did postdoctoral research at Washington University in St. Louis and Harvard University. Chen's research interests cover such diverse topics as soft robotics, mechanical metamaterials, multistable structures, energy harvesting devices, biomimetic materials/devices, mechanics of morphogenesis, and cancer biophysics.. Chen's research has been supported by NIH, NSF, ONR, Society in Science, and American Academy of Mechanics.

Polymeric Micelles for Controlled Delivery of Hydrogen Sulfide and their Biological Activities

Urara Hasegawa*

Department of Materials Science and Engineering, The Pennsylvania State University

Abstract:

Hydrogen sulfide (H2S) is an important signaling molecule that is involved in many physiological processes in human body. With the discovery of its biological significance in cardiovascular, nerve and immunological systems, the potential for its use as therapeutic agent has attracted growing attention. One of the challenges in H2S-based therapy is the lack of the delivery systems that can deliver H2S at the target site in a controlled manner. To address this issue, we developed polymeric micelles bearing H2S donating anethole dithiolethione (ADT) groups and evaluated their H2S release profiles as well as biological activities. In this presentation, we will present design, synthesis and characterization of polymeric micelles with ADT groups. We will also discuss how the release profiles from the micelles affect the biological activity of H2S in angiogenesis, ischemic cell damages, and cancer development.

Biography:

Urara Hasegawa is an assistant professor in the Department of Materials Science and Engineering at Penn State. She received her B.S. and M.Eng. in Applied Chemistry from Waseda University and earned her Ph.D. in Biomedical Science from Tokyo Medical and Dental University. She worked as a postdoctoral fellow at École Polytechnique Fédérale de Lausanne and served as an assistant professor at Osaka University, Kansas State University, and then Penn State. Hasegawa's research focuses on the development of polymeric nanomaterials for delivery of drug and bioactive signaling molecules. Her work has been recognized with several awards including NSF CAREER award.

Polymer vs. Rubber Asphalt: From Lab to Practice

Zhanping You, P.E., Ph.D., F.ASCE, F.EMI

Department of Civil and Environmental Engineering, Michigan Technological University, Townsend Drive, Houghton, MI, USA

Abstract:

Polymer modified asphalt has been recognized as a good paving material for asphalt roads. However, the cost of additional polymer in asphalt makes the field application more expensive. An alternative and less expensive approach is using waste tire rubber in asphalt materials. Rubber recycled from waste tires has been used in the pavement industry for decades. However, due to many factors, there are still quite a few misunderstandings about the use of various technologies in engineering waste tire rubber in asphalt. In this study, we have studied polymer asphalt emulsions and tire rubber asphalt emulsion as well as hot rubber for chip seal for roads. We also investigated the polymer modified asphalt mixture and tire rubber modified asphalt mixtures in wet and dry processes. We compared the advantages and disavantages of these applications. The research team also expanded the research work from models and lab work to field pilot projects. Quite a few pilot projects that used recycled tire rubber were constructed as asphalt pavements in the state of Michigan.

Biography:

Zhanping You earned his PhD in Civil Engineering from the University of Illinois at Urbana - Champaign in 2003. Zhanping You is a Distinguished Professor in the Department of Civil and Environmental Engineering at Michigan Technological University. Zhanping You has completed research projects related to road materials, pavement engineering, and sustainable building materials. He has led research projects from engineering practice of roads to pavement science with funding from federal, state, and local agencies. Zhanping You earned the prestigious Michigan Tech Research Award in 2019 and University Distinguished Professorship. He was named as Fellow of ASCE in 2020, Fellow of ASCE's EMI in 2021, and Fellow of the International Association of Advanced Materials in 2020.

Design and Fabrication of Polymer Thin Film-type Sensors for Collecting Bioinformation from Surfaces

Shinji Takeoka*

Faculty of Science and Engineering, Waseda University, Japan

Abstract:

Free-standing polymer thin films with a thickness of 10 to several hundred nanometer can be easily prepared by the application of printing technology and have a unique property that they can be applied to biological surfaces without using adhesives or glues because of their very low bending rigidity and high by intermolecular force due to surface contact. In addition, various functions can be constructed by superimposing a plurality of thin films. In our laboratory, we developed biosensors that can image temperature, pH, or oxygen distribution on biological surfaces in real time by stacking thin films of different functional fluorescent molecules. For thin-film sensors that can be attached to a biological surface, it is important to design functional fluorescent molecules, polymers as a matrix of those molecules, the composition of composite film and fabrication using printing technology, as well as a molecular design and a thin-film structure from the viewpoint of the kinds of biological tissues to be measured. In addition, composite thin films of PEDOT: PSS and elastomer have been developed as skin-contact electrodes for electromyography during exercise and electrocardiogram during bathing. The polymer thin film-type sensors for bio-applications would be attractive to collect bioinformation unperceivably as more advanced wearable devices.

Biography:

2005-, Professor of Faculty of Science and Engineering, Waseda University (2005-2007 Dept. Applied Chem., 2007- Dept. Life Sci. and Med. Biosci., 2010- Joint Maj. Adv. Biomed. Sci. Tokyo Women's Med. Univ. & Waseda Univ.), 1995-2004 Assoc. Prof. (Waseda U.), 2020-, Director of TWIns, 1998-1999 Visiting Fellow, U. Penn. Sch. Med., USA, 1993-1994 Assis. Prof. (Waseda U.), 1991-1993 Res. Assoc. (Waseda U.), 1990-1991 Fellow, JSPS, 1991. Eng., Maj. Appl. Chem., Grad. Sch. Sci. & Eng., Waseda Univ., Editor of Polym. Adv. Technol., MRS Commun., Front.Bioeng. & Biotech., Okuma Award (2011).

Nanocellulose- Ag/Agcl Nanoparticles as an Energy Storage Paper

Ana B. Morales- Cepeda[1*], Luis Alejandro Macclesh del Pino Perez[1]

[1]Tecnológico Nacional de México/ Instituto Tecnológico de Ciudad Madero, México

Abstract:

Films of Cellulose Nanofibers (CNFs) were prepared, silver nanostructures (Ag/AgCl nanocubes) were incorporated in a ratio of 1 - 20 wt% into its organic matrix. With the increase of Ag wt% the crystalline species corresponding to Ag/AgCl increased. The diffraction pattern in 2ϴ= 44.7° planes belonging to Ag (2 0 0) shifts to 2ϴ= 45.45° with planes AgCl (2 2 0) due to Ag increment; furthermore, with the silver increase, the fibers gain a higher arrangement. The SEM images showed cubic structures that are formed by smaller cubic nanostructures. Electrochemical Impedance determined the films electrical resistance being 551 Ω cm2, 62.6 Ω cm2, 3.78 Ω cm2, 7.9 Ω cm2, and 15.8 Ω cm2 for concentrations 1 wt%, 5 wt%, 10 wt%, 15 wt%, and 20 wt% respectively; besides, obtaining the CPE from films, demonstrating that they possess electrical conduction and energy storage capabilities

Biography:

Dra. Morales-Cepeda is a Doctor of Science degree from the University of Ulm in 2004, in Germany. She joined the Technological Institute in 1993, where she is currently a permanent C researcher, an active member of the Mexican Academy of Sciences, level I in the National System of Researchers. Her research lines include areas related to polymers (Cellulose and PLA) and materials

Natural Fiber Reinforced Composites: Mechanical and Physicochemical Properties

Bishnu Acharya

Department of Chemical and Biological Engineering, University of Saskatchewan, SK, Canada

Abstract:

Global environmental concerns, as well as the rapid depletion of non-renewable fossil fuel-based resources, have prompted research into the development of sustainable, environmentally friendly, and biodegradable materials for use in a variety of high-end applications. To mitigate the environmental setbacks caused by nonbiodegradable materials, the development of biocomposites with improved mechanical performance is gradually gaining momentum. Natural fibers such as hemp, flax have been well incorporated into biocomposite development. Nonetheless, the impact of functional moieties in their life cycle cannot be underestimated. In this presentation, a detailed discussion of the characteristics and components of biocomposites will be discussed. The treatment of composite materials (alkali and acetylation) as well as several manufacturing processes (hand layup, 3D printing, extrusion, etc.) and applications of biocomposites, which are not limited to the aerospace industry, packaging, biomedicine, etc., will be presented. Biocomposites having excellent durability, performance, serviceability, and reliability must be produced to expand their applications.

Biography:

Bishnu Acharya is an Associate Professor in the Department of Chemical and Biological Engineering at the University of Saskatchewan and Saskatchewan Ministry of Agriculture Research Chair in Bioprocess Engineering. His research expertise lies in the area of bioprocessing and conversion, particularly in the emerging area of conversion of biomass to bioproducts for chemical, material, and energy applications by adopting a circular bioeconomy approach. Acharya research investigates biomass characterization, thermochemical, biological, and chemical synthesis processes for the conversion of low value biomass to high value bioproducts.. Acharya is awarded with Engineers PEI – Engineering Excellence Award (2019) for his professional contribution towards the development of innovative bioproducts from nuisance biomass. His scholarly achievements are recognized with UPEI Faculty Association - Scholarly Achievement Award (2019), and Graduate Faculty Appreciation Award (2018).

Preparation and *In Vitro* Evaluation of Floating Tablets of Hydroxypropyl Methylcellulose Using Anredera cordifolia Ten Leaf Extract As a Model Drug

Cokorda Istri Sri Arisanti[1,2*], Made Vira Monika[1], I Dewa Gede Wijaya Kusuma[1], I Gusti Ngurah Jemmy Anton Prasetia[1] and Dewa Ayu Swastini[1]

[1]Pharmacy Department, Faculty of Mathematic and Natural Science, Udayana University, Kampus Bukit Jimbaran, Badung, Bali, Indonesia; 2Doctoral Program, Faculty of Pharmacy, Universitas Padjadjaran, Sumedang, Indonesia

Abstract:

This study aimed to develop a hydrophilic matrix-based controlled-release gastro retentive drug delivery system (GRDDS) for Anredera cordifolia Ten leaf extract, a herbal medicine widely used to treat gastric ulcers. Floating tablets are one of the GRDDS approaches that can float for a long time without being affected by the gastric emptying rate and increase the bioavailability of the drug. This current research endeavors toward formulating Anredera cordifolia Ten leaf extract floating tablet formulations (F1-F6) employing different viscosity grades and concentrations of hydroxypropyl methylcellulose (HPMC K4M and HPMC K100M). The pre-compression characteristics (flow rate, angle of repose, Hausner's ratio, and Carr's index), as well as post-compression characteristics

(appearance, hardness, friability, weight variation, lag time, total floating time, swelling index, and in vitro drug release) of the formulations, were comprehensively studied. The results showed that using different grades and concentrations of HPMC affected tablet precompression and post-compression characteristics. Increasing HPMC concentration affects decreasing floating lag time, increasing total floating time and swelling index but decreasing the cumulative release of the active substances from floating tablets. Increasing the viscosity of HPMC reduces the rate of release of the active substance from the tablet significantly. This study on Anredera cordifolia Ten extracts as a floating tablet would provide effective gastroprotection. It can be a promising approach to drug delivery in the upper gastrointestinal tract.

Biography:

Current activity as lecturer at Departement of Pharmacy, Faculty of Mathematics and Natural Sciences, Udayana University, belongs to Pharmaceutical Technology group and now joining doctoral program at Faculty of Pharmacy, Universitas Padjadjaran, Sumedang, Indonesia. Our current research is exploring drug dellivery system espesially modified release dosage forms like floating tablet containing natural product compounds. I also interest to to develop a herbal and a cosmetics product that containing natural pigmen and antioxidant.

Polymer Hole Transport Materials for Perovskite Solar Cells

Xiaojing Hao[1*], Xu Liu[1], Jiangtao Xu[2]

[1]School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, Australia

[2]School of Chemical Engineering, University of New South Wales, Sydney, Australia

Spiro-OMeTAD is one of the most widely used organic semiconductors in optoelectronic technologies, continuously delivering record-breaking power-conversion efficiencies for perovskite. Among the past reported 12 world record efficiencies for PSCs, all record efficiency cells above 24% efficiency used the doped spiro-OMeTAD as hole transport materials (HTM). To attain sufficient conductivity and efficient hole extraction as hole-transport-material (HTM), spiro-OMeTAD is usually chemically doped with lithium bis(trifluoromethane)sulfonimide (LiTFSI). However, this doping step requires an activation process by sufficient exposure of the blend films to ambient atmosphere. Additionally, the hygroscopic nature of lithium dopant and the HTM films' crystallization caused by lithium dopant negatively impact HTMs' and their devices' lifetime. Designing alternative HTM and associated interfaces is necessary to further improve the overall stability of high efficiency perovskite solar cells. In this work, polymer HTMs used for perovskite solar cells will be discussed.

The Modification of Waste Tire Rubber for Mercury Adsorbent

Supitcha Rungrodnimitchai* and Sirinapa Mayod

Department of Chemical Engineering, Faculty of Engineering, Thammasat University, Thailand

Abstract:

Waste tire rubber (WTR) become a serious environmental problem because a huge amount of WTR is produced each year and it is non-biodegradable. In this study, WTR was modified to be an adsorbent for mercury ions by using an oxidation reaction in the mixture of the HNO3/NaNO2 system followed by sulfur impregnation. WTR was modified at 30$_{o}$C with different parameters. %CHNS/O analysis revealed that %O increased after the oxidation reaction. After sulfur was impregnated on M-WTR, it was found that the sulfur impregnation caused a larger pore structure than M-WTR but the number of pores decreased. %CHNS/O analysis revealed that %O decreased after the sulfur impregnation, which was consistent with FT-IR analysis results. In the adsorption of mercury ion, it was found that the adsorption efficiency and the adsorption capacity increased with the increase of temperature and increase of sulfide ion concentration of sulfur impregnation. For adsorption kinetics, the mercury ion adsorption by using R-WTR agreed with the pseudo-first-order model but M-WTRs fitted well with the pseudo-second-order model. For adsorption isotherm, the mercury ion adsorption by using R-WTR agreed with Freundlich isotherm M-WTRs were fitted well with Langmuir isotherm. The results suggested that the chemical modification of WTR could produce an effective adsorbent for mercury ions.

Biography:

Supitcha Rungrodnimitchai obtained a bachelor's degree, a master's degree, and a Ph.D. from Osaka University, Japan. Currently, she works as an assistant professor at Thammasat University, Thailand. Supitcha Rungrodnimitchai is an innovative scientist with 20+ years of research experience across inorganic and organic chemistry. Her recent research work has focused on biopolymers and functional adsorbents. She emphasized introducing functional groups such as phosphate, amines, and carboxyl groups leading to special functions into the molecular level of the raw materials such as waste tire, cellulose fibers, and carbon materials, using the microwave heating technique to perform many reactions in a shorter time and higher efficiency.

Performance Improvement of Thermoplastic Starch-Based Materials

Rangrong Yoksan*

Department of Packaging and Materials Technology, Faculty of Agro-Industry, Kasetsart University, Bangkok, Thailand

Abstract:

Due to global environmental awareness, many countries have banned and/or reduced the consumption of single-use plastic products such as grocery bags, straws, cutlery, stir sticks, etc., which are mostly produced from non-biodegradable petroleum-based plastics. In addition, alternative materials are being sought to replace petroleum-based plastics for single-use and disposable products. Thermoplastic starch (TPS) and its blends with biodegradable polyesters, including polylactic acid (PLA), polybutylene adipate-co-terephthalate (PBAT), and polybutylene succinate (PBS) are good candidates and have the potential to replace petroleum-based plastics in some applications in which biodegradability and sustainability are required. Although TPS is cost-competitive, its performance limits practical applications. Here, we demonstrate that the mechanical and barrier properties of TPS can be improved by blending with other polymers and concomitant with simultaneously biaxial stretching. The relationship between microstructure and properties is also discussed.

Biography:

Rangrong Yoksan is currently working as a lecturer in the Department of Packaging and Materials Technology, Faculty of Agro-Industry, Kasetsart University, Thailand. She has her expertise in compounding, characterization, properties testing and converting processes of biobased and biodegradable polymers; blends and composites of bioplastics; fabrication of polymeric and metal nanoparticles; encapsulation of bioactive compounds; and active packaging materials.

Radical-Mediated Ring-Opening Polymerization for Semi-Crystalline Thermoplastic Additive Manufacturing

Alex J. Commisso[1*], Gopal Reddy Sama[2] and Timothy F. Scott[2]

[1]University of Michigan, USA; [2]Monash University, Australia

Abstract:

Conventional approaches to stereolithographic 3D Printing (SLA) employ liquid resins based on multifunctional (meth)acrylates and epoxides that afford highly cross-linked thermoset polymer networks upon polymerization. Unlike cross-linked polymers, thermoplastic polymers enable facile post-print processing, modification, and recycling. Nevertheless, rapid solidification of mechanically robust, 3D printed thermoplastics remains a significant challenge. In this work, a rapid solidifying thermoplastic stereolithographic resin was designed utilizing radical-mediated, ring-opening, semi-crystalline 7- and 8-membered cyclic allylic sulfides. Thermoplastic printed parts displayed minimal anisotropy, were capable of being printed in multiple orientations, and displayed mechanical properties not dissimilar from the bulk materials. Finally, demonstrating their potential as a recyclable resin, printed parts could be melted down and remolded. This work introduces a new class of materials employable for the growing field of thermoplastic stereolithography.

Biography:

Alex Commisso is currently a PhD candidate in Chemical Engineering at the University of Michigan and a visiting researcher at Monash University in Melbourne, Australia. He received his B.S. in Chemical Engineering from the University at Buffalo (SUNY) in 2017. Working with Prof. Tim Scott, his research primarily revolves around developing novel photo chemistries for stereolithographic additive manufacturing and stimuli-responsive material.

Chain Architecture and Conformation of the Ring Opening Co-Polymerization of Bio-Based Monomers

Rina Tannenbaum*

Stony Brook University, Department of Materials Science and Chemical Engineering, Stony Brook NY, USA

Abstract:

We describe a novel ring-opening co-polymerization of D,L-lactide and glycolide monomers initiated by nano-hydroxyapatite, nHAP, to form PLGA polymer. A chemical linkage was formed

between the nHAP particles and the growing chains of the PLGA polymer, allowing the secure anchoring of the polymer chains on the surface, resulting in a brush-like structure emanating from the nHAP moiety. The progress of the polymerization was monitored by 1H NMR spectroscopy and the results demonstrated that the overall reaction followed second order kinetics. The initial polymerization proceeded with the random uptake of monomers, generating a random copolymer. However, in later stages, as the minority monomer in the feed solution was exhausted, there was an exclusive uptake of the majority monomer, generating a block architecture. This direct correlation with monomer concentration indicates that there was no preferential monomer uptake due to the chain ends and the incorporation of the monomers was random, deeming this an "ideal" copolymerization, thus generating a polymer with mixed random and block architectures. When this novel nHAP-initiated reaction is compared to the traditional ring-opening polymerization reaction of D,L-lactide and glycolide without an initiator (control reaction) under otherwise identical conditions, a completely different reaction profile is observed. To further probe the mechanism of co-polymerization and chain architecture, we evaluated the effect of various initiators on the co-polymerization kinetics. Energy minimization calculations coupled with monomer concentration variations showed that the sequence and preference of monomer uptake is dependent on the chemical properties of the initiators and the initial monomer pair-wise bonding energies.

Biography:

Tannenbaum is a full professor in the Department of Materials Science and Chemical Engineering at Stony Brook University in New York. She received her D.Sc. in chemical engineering from the Swiss Federal Institute of Technology in Zürich. To date she has published over 200 peer-reviewed articles, reviews and conference proceedings. She is the recipient of numerous awards and a member of the editorial board of several professional journals. Tannenbaum's areas of interest are soft matter and complex fluids, bio-based functional materials, nanocomposites from renewable resources, plastics recycling and catalysis.

Semi-Fluorinated Aromatic Ether Polymers and High Yield Carbon Precursors for Extreme Performance Applications

Dennis W. Smith, Jr.*[1], Ernesto Borrego[1], Gustavo Munoz[1], Will Johnson[2], Josh Brown[3], and Charles Pittman[1]

[1]Department of Chemistry, 2Swalm School of Chemical Engineering, 3Department of Aerospace Engineering, Mississippi State University, USA

Abstract:

Two platform technologies including (1) semi-fluorinated aromatic ether polymers from fluoroalkenes and (2) polynapthalene networks and high yield carbon composites therefrom are presented in addition to new approaches for the preparation of hexafluoro-i-propylidene (6F) polymers from the acid mediated polymerization of hexfluoroacetone hydrate and diphenyl ether. Perfluorocyclobutyl (PFCB), fluorinated aryl vinylene ether (FAVE), and perfluorocycloalkene (PFCA) aryl ether polymers are prepared via step-growth polymerization of fluoroalkenes affording processable, optically tunable, thermally stable, and thermally crosslinkable fluoropolymers without the use of post-curatives. Polynapthalene networks are produced via thermal cyclopolymerization of bis-o-diynylarene (BODA) monomers affording intermediate resins which can be melt processed, thermally cured, and pyrolyzed to high yield carbon-carbon composites. Synthesis, properties, and applications are presented.

Biography:

Smith earned a PhD from the University of Florida, joined Dow Chemical as Post-Doctoral Fellow in Germany, then as Dow Project Leader in the USA. Prior to moving to MSU as Department Head in 2017, he was Professor of Chemistry and MSE at Clemson University then Robert A. Welch Distinguished Professor at the University of Texas at Dallas. Smith is Fellow of the ACS, Fellow of IUPAC, Cottrell Scholar, past center director, and past chair of ACS POLY. He has published 153 refereed journal articles, graduated 25 Ph.D. students, and given over 200 invited lectures in 23 countries.

Assessment and Optimization of Graphene Nanoplatelets Dispersion and Nano-Filler Loading in Bio-based Polymer Nanocomposites

Sahrim Ahmad and Ruey Shan Chen

School of Applied Physics, Faculty of Science and Technology, Universiti Kebangsaan Malaysia UKM Bangi Selangor

Abstract:

The incorporation of graphene nanoplatelets (GNPs) has attracted massive attention in polymer nanocomposite production. In this work, GNPs reinforced nanocomposites of liquid natural rubber (LNR) toughened poly (lactic acid) (PLA)/poly (aniline) (PANi) were fabricated through melt-mixing using internal mixer. The effects of ultrasonic treatment period, mixing rotor speed and GNPs loadings in PLA-LNR/PANi was investigated.A premix ultrasonication of LNR/PANi with GNPs for 1 h was found to be the most effective period as compared to the longer sonication time. The best melt-mixing of the materials was achieved at 100 rpm, in accordance to the tensile properties as well as homogeneous dispersion and distribution of nano-filler as shown in thermogravimetry analysis. Results revealed that the optimum loading was found at 0.4 wt.% of GNPs with excellent enhancement in tensile strength (25 MPa), tensile modulus (1188.9 MPa) and thermal stability of the nanocomposite, as proven by ANOVA statistical analysis.

Precision Deconstruction of Condensation Polymers using Organocatalyst in Tailored Ionic Liquids

Chao Guan1*, Ilja Popovs[1], Tomonori Saito[1], Sheng Dai[1]

[1]Chemical Sciences Division, Oak Ridge National Laboratory, USA

Abstract:

More than 400 million metric tons of plastics are globally generated every year, but only ~9% of them are recycled. The performance of those recycled products inevitably diminishes because of the undesired oxidation and degradation in the traditional mechanical recycling process. Therefore, it is urgent to develop new energy-efficient methods to upcycle waste plastics rather than downcycle them. Condensation polymers, such as polyesters, polyurethanes, polyamides and polycarbonate, are considered the most ideal candidates for precise degradation due to their relatively high reactivity. In this work, we try to reveal the precision depolymerization mechanism of condensation polymers by tailored organocatalyst in various solvent media, including ionic liquids. Specifically, the functionality, structure and decomposition of the polymer is systematically investigated to produce well-defined building blocks. Thus, the fundamental principles for controlled depolymerization of macromolecules are uncovered.

Biography:

Chao Guan is currently a Postdoctoral Research Associate at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. He received a Ph.D. degree from King Abdullah University of Science and Technology (KAUST). Prior to joining Oak Ridge National Laboratory, he was a Postdoctoral Research Associate at University of Connecticut (UConn) and a Research Scientist at the University of New Mexico (UNM). His research interests include Polymer Upcycling, Conjugated Polymer, Organometallic Catalysis, and Ultra-High-Molecular-Weight Polyethylene (UHMWPE).

Effect of Surfactant-introduced Ionomers on PTFE-based Reinforced Composite Membrane for PEMFC

Dong-Heon Han*, Seung-Ju Oh, Jae-Uk Yoon, In-Sun Woo, Jin Woo Bae

Future Convergence Engineering, School of Energy, Materials and Chemical Engineering, KOREATECH, Republic of Korea

Abstract:

PTFE(Polytetrafluoroethylene)-based reinforced composite membranes have been attracted for polymer electrolyte membrane fuel cell (PEMFC) due to their higher durability and lower cost than ionomer membrane. However, the repulsion between hydrophobic porous PTFE membrane and hydrophilic ionomer causes the incomplete impregnation problem. Consequently, this problem deteriorates the performance and durability of PEMFC due to increasing ohmic resistance and hydrogen crossover of PTFE-based reinforced composite membrane. In this paper, we developed

ionomer solutions with surfactants, which could improve impregnation by reducing the repulsion between hydrophobicity and hydrophilicity. The surfactant-introduced ionomer solutions were directly impregnated on PTFE membrane and then applied to membrane electrode assembly(MEA) for PEMFC. It was confirmed that the presence of surfactant improved the impregnation of porous PTFE-based reinforced composite membrane due to increasing wetting properties of ionomer solutions into porous PTFE membrane and thus reduced the ohmic resistance and hydrogen crossover of PEMFC. Also, the surfactant introduced into the PTFE-based reinforced composite membrane could increase the performance and durability of PEMFC effectively.

Biography:

As graduate students, Dong-Heon Han, Seung-Ju Oh, Jae-Uk Yoon, and In-Sun Woo joined the KOREATECH and are working with Prof. Jin Woo Bae. Jin Woo Bae was born in Seoul (South Korea) in 1979. He received his Ph.D. in School of Chemical and Biological Engineering in 2012 from the Seoul National University (South Korea). In 2019 he joined the KOREATECH, where he is an assistant professor of the School of Energy, Materials and Chemical Engineering.

Control of Temperature Coefficient of Resistance of Graphene Composite for Rapid Heating Elements

Sung-Hoon Park* and Ji-Hwan Ha

Soongsil University/ Department of Mechanical Engineering, Korea

Abstract:

Carbon based nano composites have been widely studied as a rapid and flexible heater unit due to its superior heating performance and electrical properties. Composites consisting of a polymer and a conducting filler show either a positive (PTC) or a negative temperature coefficient (NTC) of resistance during heating, depending on several factors. However, most one- or two-dimensional nano-carbon based composites show a NTC behavior causing overcurrent and fire. In this study, we developed a PTC and zero temperature coefficient of resistance (TCR) graphene composites for thermal stability and reliable temperature control. The thermal performances and electrical properties could be easily controlled by the degree of alignment of graphene in the matrix. Robust mechanical shear forces involved to control degree of alignment of filler.

Biography:

Sung-Hoon Park done Ph.D. in Materials science and engineering (2009, University of California San Diego) and is a Senior engineer at Samsung Advanced Institute of Technology and worked as Associate Professor, Soongsil University (2015~current)

Sol-Rec2: Novel Methods for Delamination of Pharma Blister Packs and other Multi-Layer Materials for Recycling Purposes

Pascal Negre

IPM2, France

Abstract: Not available

In Carbonated forms of Biominerals Fibril in Hydro-entangling Polymeric Absorption with Oxide and Hydroxide

Abstract:

Granule forms of compounded polypropylene have been demonstrated the potential of using chemically treated particles as precipitated calcium carbonate (PCC) in the dispersion blend. To concern the nonwovens such as formed aesthetic properties, mechanical properties, and the formation interface with more than two different fibers made materials, this study proposed the microsphere climate of adding mineral, surfactant, or optical sensitive antioxidant. In this research, carbonate or rare metal oxide surface treatment. Such carbonate in either calcium carbonate or hydroxide for an alkane environment. Using inorganic decorating, the epitaxial crystalline also interact with polyolefin such as isotactic PP in the elongational spinline strength. Our previous study by differentiated scanning calorimetry DSC does approve that the consistent melting temperature. Therefore using chemical solvent or sol-gel methods, this continue on the polylactic acid PLA or biodegradable materials in a comparison statistical evaluation on the sediment of any precursor additive. It also interests whether sporadically dispersion or the longitudinal dispersion along 3D printing base materials would bring higher strength. To solve elements sediments along the microporous medium, the following presentation our team will be focusing on polymer materials deformation by spinning force. As collect aspirator speed, or some other external condition may change overall extension, we may impose the assertion of base pair active micelles to intact with other biocompatible mediums. As nucleotide peptide cleavage could easily find microcavity on the medium substrate, so by topographic analysis it would gain some of atomic force microscopy AFM for pattern analysis. Our next approach would an simulation of polymeric forming to evaluate rigidity in bending and standing strength in Maple and Mathworks.

Synthesis of Multi-metallic Clusters Using a Dendrimer Reactor

Kimihisa Yamamoto

Tokyo Institute of Technology, 4259 Nagatsuta, Yokohama, Japan

Abstract:

Dendrimers are highly branched organic macromolecules with successive layers or “generations” of branch units surrounding a central core. Organic inorganic hybrid versions have also been produced, by trapping metal ions or metal clusters within the voids of the dendrimers. Their unusual, tree-like topology endows these nanometer-sized macromolecules with a gradient in branch density from the interior to the exterior, which can be exploited to direct the transfer of charge and energy from the dendrimer periphery to its core.

We show that tinchloride, SnCl2 and FeCl3 complexes to the imines groups of a spherical polyphenylazomethine dendrimer in a stepwise fashion according to an electron gradient, with complexation in a more peripheral generation proceeding only after complexation in generations closer to the core has been completed. By attaching an electron-withdrawing group to the dendrimer core, we are able to change the complexation pattern, so that the core imines are complexed last. By further extending this strategy, it should be possible to control the number and location of metal ions incorporated into dendrimer structures, which might and uses as tailored catalysts, building blocks, or fine-controlled clusters for advanced materials. The metal-assembly in a discrete molecule can be converted to a size-regulated metal particle with a size smaller than 1

nm as a molecular reactor. Due to the well-defined number of metal clusters in the subnanometer size region, its property is much different from that of bulk or general metal nanoparticles. The chemistry of metal clusters on the sub-nanometer scale is not yet well understood because metal clusters, especially multi-metallic clusters, are difficult to synthesize with control over size and composition. The template synthesis of multi-metallic sub-nanoclusters is achieved using a phenylazomethine dendrimer as a macromolecular template.

Selected Properties of 3D Printed Clarinets

Bernd Weidenfeller[1]*, Uwe Arlic[2], Katrin Weidenfeller[3]

[1]Clausthal University of Technology, Germany; [2]Soluterials GmbH; [3]Medical University of Varna, Bulgaria

Abstract:

The influence of the material and its treatment during the preparation of a musical wind instrument on its sound is controversially under discussion for a long time by professional and amateur musicians. However, the acoustic pressure of standing waves in wind instruments causes appreciable vibrations in the walls of instruments and the acoustic pressure of standing waves in wind instruments causes appreciable vibrations in the walls of instruments. To connect the sound of instruments with materials properties we prepared clarinets by 3D printing with various materials. With ABS we used a typical material for plastic clarinets as well as copper or spruce filled PP. Printing parameters like infill pattern and wall thickness were varied as well as printing temperature. Afterwards the sound of the clarinets was recorded using an instrument microphone, an audio interface and Audacity recording software. The frequency spectra and the formants of some musical tones were extracted and compared. After finishing these investigations we cut samples from the 3D printed instruments for measurements of dynamic modulus, damping behavior, electron microscopy, calorimetry and thermogravimetry. From damping behavior the activation energies of damping processes and the basic frequencies were estimated. Finally, the material's data were correlated with the sound data.

Biography:

Bernd Weidenfeller is professor in the Department of Materials at Clausthal University of Technology. He received his diploma in physics from University of Münster. His research interests are internal friction of materials, magnetism and physical properties of polymers and polymer composites. Actually he investigates the correlation between sound and damping behavior caused by materials of musical instruments. In addition to his scientific collaborations with scientists in Argentina, Brazil, the Czech Republic, France and the USA, he has served in these areas as a consultant. Weidenfeller has authored around 90 papers in his research fields in peer reviewed international journals.

Use of Lignocellulosic Waste from Garlic as a Reinforcer of Polymer Matrices

José Luis Rivera-Armenta[1]*, Beatriz Adriana Salazar-Cruz[1], Ana Cecilia Espindola-Flores[2], Cynthia Graciela Flores-Hernández[3]

[1]InstitutoTecnológico de Ciudad Madero/Tecnológico Nacional de México, México

[2]Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada (CICATA)/Instituto Politécnico Nacional, México

[3]InstitutoTecnológico de Queretaro/Tecnológico Nacional de México, México

Abstract:

Recently, the lignocellulosic materials have gained interest, because they are a rich source of cellulose and nanocellulose, which have applications areas such as energy storage. The use of different types of organic waste is n area that has grown due the fact that interesting results have been reported, regarding the improvement of mechanical, thermal and conductive properties, among others. The garlic is a seed wide used as seasoning, whit interesting properties, due is considerad antioxidante, antimicrobial, among other properties. The garlic husk, recently has been studied as support for contaminant remotion in water, but still few works report it as polymer matrix reinforcer, so in present the use of garlic husk particles is reported on two different polymers: Polypropylene (PP) and Styrene-butadiene copolymer (SBS), composites were prepared by melting mixing. The garlic husk was milled to decreasing the particle size, and was added to polymers in different content (from 2 to 10 phr(parts per hundred), the composites thermal properties of composites were evaluated by means Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA), Dynamic Mechanical Analysis (DMA) and morphological aspects with X ray diffraction (XRD) and Scanning Electron Microscopy (SEM). Results show that thermal stability was modified by presence of garlic husk partlcles, the crystallinity of PP was improved and an increase in thermomechanical properties also were improved with garlic husk particles.

Biography:

José Luis Rivera-Armenta has a BSc in Chemical Engineering, a MSc in Petroleum Technology and Petrochemicals, and a Ph.D. in Chemical Engineering, all from Instituto Tecnológico de Ciudad Madero, México. Since 2003, he has been a full-time professor in postgraduate programs at ITCM.. He has been responsible for several research projects sponsored by CONACYT (México) and TECNM (México). He has advised 10 PhD., 20 master´s degrees, and 5 bachelor´s degree theses. He has published 56 articles, 6 book chapters, and has edited 4 books and 1 special issue journal, also he is an active reviewer for several journals.

Nanocellulose and its Energy Applications

Carlos Castro

CONACYT, Mexico

Abstract: Not available

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