

| Poster # | Title  | Presenter Name |          | Abstracts   |
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| 1        | Temperature-mediated Biofilm Cleaning Efficacy of Self-locomotive Antimicrobial Microrobots (SLAM) | Joo Hun        | Lee      | Biofilms are bacterial communities that produce extracellular polymeric substances (EPS). Biofilms use EPS as a barrier toward antibiotics, which make them very resistant compared to planktonic bacteria. In the past, we developed self-locomotive antimicrobial microrobots (SLAM), MnO <sub>2</sub> -doped diatoms that self-propel in a H <sub>2</sub> O <sub>2</sub> solution by the continuous generation of oxygen bubbles on the hollow channels of the diatoms via decomposition of H <sub>2</sub> O <sub>2</sub> by the MnO <sub>2</sub> catalyst. When SLAM is mixed with H <sub>2</sub> O <sub>2</sub> to treat <i>Pseudomonas aeruginosa</i> biofilm, oxygen bubbles form a swarm and through bubble burst, the particles further facilitate diffusion of antibiotics (H <sub>2</sub> O <sub>2</sub> ) into the core of the biofilm and enhance biofilm removal. After further internal optimization of SLAM, we focused on a sole factor that is crucial in SLAM's performance: bubble kinetics. To study this effect, we examined if reaction temperature affects the rate of SLAM's oxygen bubble generation as thermodynamic changes affect bubble kinetics. We confirmed SLAM particles rupturing and dismantling biofilm (EPS) through bubble burst via optical coherence tomography (OCT) of bubble and biofilm interactions and tested temperature effects in biofilm removal efficacy. We conclude that temperature varies the frequency of oxygen bubble generation and burst, which accounts for the mechanical energy to challenge the energy barrier of EPS, thus varying the efficacy of biofilm removal. This study reveals the fact that SLAM's performance depends on temperature as well as highlights the significance of EPS rupture in biofilm removal. |
| 2        | Investigating the Photophysical Properties of Cis and Trans Poly(p-phenylenevinylene)s (PPVs)      | OLUSAYO        | OGUNYEMI | The growing interest in using the quantum state of light to investigate chemical system has evolved and paved way in advancement in quantum sensing, imaging technologies, microscopy and quantum computing. Non-classical light such as entangled photons has well-defined advantage over classical light in probing chemical system because: it involves the use of low input photons which prevent photobleaching of material or damaging fragile sample, allow effective control of photochemical processes, and it provide access to electronic states that are not accessible by classical light. In this work, we investigated the photophysical properties of the two isomers of PPVs (Poly(p-phenylenevinylene)s which are conductive polymers to understand their charge transfer properties, excited state dynamics and fluorescence lifetime of this polymer using our non-linear optical spectroscopy tools. Our goal is understand the light-matter interaction of the different PPV isomers and elucidate their application in the design of polymer-based light harvesting system, quantum sensing and imaging  |
| 3        | Withdrawn  | Withdrawn      |          | Withdrawn   |

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| 4 | Revealing Adhesion Promotion Mechanism by Probing Covalent Interactions at a Silicone Adhesive/Nylon Interface | Ting | Lin | <p>It is well-known that silane coupling agents can be used as adhesion promoters in silicone adhesives to strengthen adhesion. By designing specific interfacial chemical reactions at buried adhesive/substrate interfaces, we can utilize the robust intramolecular interaction of covalent bonding to enhance adhesion strength and durability. However, it is difficult to elucidate detailed molecular mechanisms of adhesion promotion via interfacial reaction due to the lack of appropriate analytical tools which can probe interfacial reactions in situ at buried interfaces especially for well-bonded adhesive joints. For the first time, we characterized interfacial reactions at the nylon/silicone adhesive interface in situ using sum frequency generation (SFG) vibrational spectroscopy. SFG results elucidated the mechanisms of organo-silane adhesion promotion for silicone at the molecular level. The interfacial chemical reactions between nylon and two alkoxysilane adhesion promoters with varied functionalities (maleic anhydride (MAH) and epoxy) formulated into silicone were observed and investigated. The adhesion strength at the nylon/cured silicone interfaces was substantially enhanced with both silane additives due to the reactions between the organofunctional group of each silane and the reactive groups on the polyamide at the buried interface between the cured silicone elastomer and nylon. This research demonstrated that SFG is a powerful tool to probe and analyze detailed interfacial reactions at buried nylon/silicone interfaces, aiding in the design and optimization of materials with desired interfacial properties. The combined SFG study and adhesion measurement reported here shed light on the adhesion mechanisms at the nylon/silicone interfaces, revealing the effects of silane adhesion promoters on the enhancement of adhesion strength.</p> |
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| 5 | Design of RAFT Agents for Streamlined Measurements of Polymer Chain Conformations and Diffusivity | Sara    | Valdez | <p>Understanding polymer single chain behaviors, including their conformation and diffusion kinetics, is fundamentally important for informing their design and use in various applications. Previous approaches for characterizing chain conformation often use scattering-based methods, however, these techniques rely on complex model fitting. Pairing these results with real-space microscopy/spectroscopy data is essential for obtaining a complete picture of chain behaviors on a molecular scale. Here, to address this need, we will demonstrate a simple and broadly applicable method for synthesizing polymers end-labeled with selective fluorophores, without the need for post-polymerization modifications, facilitated by reversible addition fragmentation chain transfer (RAFT) polymerization. These functional polymers can then be characterized by fluorescence-based methods to understanding their conformation and diffusion kinetics. Particularly, Förster resonance energy transfer (FRET), an established “molecular ruler” in biological sciences, will be used for measuring chain end-to-end distances, directly elucidating chain conformation as a function of polymer molecular weight in a good model solvent. Furthermore, the formed polymers inherently contain a photostable fluorophore for enabling single-particle tracking (SPT) through optical imaging, allowing further diffusive studies on the nanoscale, with potential of looking into the system heterogeneity. Collectively, this work will establish a robust synthetic platform to study single polymer chain behaviors to obtain a more comprehensive understanding of behaviors on the molecular scale.</p> |
| 6 | Formation of Poly(3,4-ethylenedioxythiophene) films via UV irradiation for electronic devices     | Dongmin | Kim    | <p>Novel EDOT monomer containing halogens reacted to Ultraviolet and was polymerized. A patterned electrically conductive film can be formed by using a shadow mask. The film has sheet resistance 10K ohm/sq. After the post treatment with acid, conductivity of film is 300.8 S/cm.</p>  |

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| 7 | Shear Flow-Induced Crystallization of Polyethylene & its Fading Memory            | Arshiya | Bhadu | <p>An interval of shear flow can accelerate the crystallization kinetics of semi-crystalline polymers, and this phenomenon is referred to as flow-induced crystallization (FIC). It remains contentious, however, how the acceleration is related to shear and whether or not the effects of shear are stable for crystal-mobile polymers. Here we study the effects of an interval of shear flow on the crystallization kinetics of high-density polyethylene (HDPE). We quantify HDPE crystallization by the Winter-Pogodina criterion that the storage modulus <math>G'</math> crosses the loss modulus <math>G''</math> in an oscillatory shear time sweep. Acceleration of crystallization kinetics only occurs when shear is applied to the polymer melt below Strobl's zero-growth-rate temperature of 132 C for HDPE. That effectively limits the study of HDPE's FIC to the 123-130 C range. Flow-induced nuclei formed during the start-up of steady shear are observed to delay edge fracture when shear is applied at lower temperatures, which we hypothesize is due to the formation of interconnections between FIC precursors that stabilize against elastic instabilities. Janeschitz-Kriegl et al. have reported that the nucleation rate is controlled by the specific mechanical work applied to a melt during shear, and we find that is the control variable for FIC of HDPE, just as it is for isotactic polypropylene, PEEK, and polyamides. Unlike these other semicrystalline polymers, the FIC precursors of HDPE are not stable and completely disappear on annealing for one hour at 129 C, which we hypothesize to be connected to the crystal mobility of HDPE.</p> |
| 8 | Elucidating structure-property relationships of cellulose-based crosslinked films | Li      | Tao   | <p>Barrier packaging materials comprised of petroleum-based plastics are scarcely recycled, leading to solid waste accumulation and environmental contamination. Cellulose is an abundant and versatile bio-based polymer, making it a promising alternative for barrier packaging applications. However, its barrier and mechanical properties are strongly dependent on moisture content and consequently the ambient relative humidity (RH), limiting its application space. The moisture sensitivity of cellulose can be tuned over a wide range by introducing crosslinks to prevent water uptake, but relationships between the chemical structure of the crosslinker and bulk film properties are not well understood. In this work, we crosslink carboxymethyl cellulose (CMC), a commercially available cellulose derivative, with biodegradable polycarboxylic acids to elucidate structure-property relationships of the crosslinker and bulk films. So far, we have found that CMC films crosslinked with 25 wt% of citric acid (CA) have much lower water vapor permeability (WVP) than polyethylene terephthalate (PET) at 50% and 65% RH, making CMC-CA films a potential alternative for petroleum-based plastics. Our next steps will be to explore the impact of structural variations (such as parent chain length, number of reactive sites, and isomeric variation) of different polycarboxylic acids on the water barrier property of the bulk films. This work will provide foundational design principles for the development of new renewable materials to reduce our dependence on petroleum-based plastics.</p>   |

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| 9  | Depiction of free-energy landscape of polyethylene crystallization through molecular dynamics simulation | Linghao | Shi       | Crystallization has long been an important topic in the polymer science. The intrinsic chemical feature apart from small molecules endows polymers with unique crystal characteristics. An essential factor would be semi-crystallinity, namely the coexistence of amorphous and crystalline areas. It is widely acknowledged that polymer adopts a chain-folding scenario to crystallize. Over the decades, several theories have been put forward to illustrate the mechanism. However, a comprehensive model hasn't been developed. Thus, deeper insights are required to complete the whole picture. Recently, it is found that a nematic phase could emerge at the transition from isotropic liquid to crystalline solid. But direct observation from experiments is yet hard to accomplish. Therefore, computer simulation is a promising method to explain the mechanism. This work aims at utilizing molecular simulation to portray the free energy landscape of polyethylene. Targeting at the phase transition among isotropic, nematic and crystal phase, we could reach a more enlightening idea of the crystallization of polymers.  |
| 10 | Computational Approaches to Intrinsically Circular Polymer Design  | Shivani | Kozarekar | Plastics production has doubled over the past two decades with only 9% of associated waste being recycled, partially because current commodity plastics are hard to recycle at scale. A proposed solution is the development of intrinsically circular polymers (ICPs) which are designed to be easily recyclable. These polymers can be chemically converted to their pure monomer form at mild conditions, allowing for efficient and sustainable plastics upcycling. While designing such polymers, it is important to consider the thermodynamic property known as ceiling temperature ( $T_c$ ); it is one of the key parameters that can be used to determine if a polymer has intrinsic circularity. To facilitate the design of ICPs, this research aims to use a variety of computational methods to calculate and predict $T_c$ . Density functional theory is used to calculate $T_c$ using thermodynamic parameters, and machine learning is used to predict the ceiling temperature range a novel polymer falls into. Additionally, kinetic Monte Carlo simulations are used to predict chain distributions, molecular weight, and ceiling temperature of copolymers. This research could lead to the development of novel polymers with intrinsic circularity, making sustainable plastic production more efficient. These polymers could potentially replace current polymers in a variety of applications and address current waste disposal issues. |

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| 11 | Thermoelastic behavior of thermally crosslinked high-cis-1,4-polybutadiene                     | Sayan | Basak            | <p>Polymers exhibiting reversible elongation upon cooling (EUC) and contraction upon heating (CUH) can be used to develop actuators, fasteners, dampers, grippers, swimmers, sealants, etc. In this work, the thermoelastic behavior of a thermally crosslinked elastomer, high-cis-1,4-polybutadiene has been investigated over a range of strain and temperature. Above ambient temperatures EUC and CUH are observed under load due to the phenomenon of thermoelastic inversion. At sub-ambient temperatures, the crystallization of the polymer produces additional additive contributions to these effects. Efforts to achieve EUC and CUH in this elastomer in the absence of an external load using bilayer films and competitively crosslinked double networks will be discussed.</p>  |
| 12 | Competitive formulation of a poly(catechol-styrene)-based adhesive for underwater applications | Cindy | Atencio-Martinez | <p>Marine mussels can strongly adhere to multiple surfaces in wet environments. They do so by secreting an adhesive comprised of a mixture of proteins that contains catechol groups in the form of the amino acid 3,4-dihydroxyphenylalanine (DOPA). Thus, marine mussels have served as an inspiration to synthesize biomimetic polymers used for underwater adhesion. Previous research efforts have incorporated catechol moieties into several polymer chain hosts such as acrylic acid and lactic acid to show strong adhesion in dry and wet conditions. Here, poly(catechol-styrene) (PCS) was synthesized using a novel suspension polymerization protocol that produces batches of up to 60 grams in an academic setting. Then, PCS was chemically and thermally characterized using <sup>1</sup>H Nuclear Magnetic Resonance Spectroscopy (<sup>1</sup>H NMR), Gel Permeation Chromatography (GPC), and Differential Scanning Calorimetry (DSC) techniques. The underwater adhesion performance of PCS was benchmarked against a commercial adhesive, and bonding strengths were quantified on a variety of low and high energy substrates via lap shear stress testing. This study shows catechol groups were the essential functionality used to provide competitive underwater adhesion when compared to a commercial glue. Our new synthetic approach, as well as the use of a biomimetic adhesive, may help bring us closer to having an ability to tailor polymers for underwater bonding.</p> |

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| 13 | Highly Thermostable Blue Thermally Activated Delayed Fluorescence Based on Metal-Organic Frameworks | Jung-Moo | Heo | <p>Organometallic phosphorescent materials have been extensively studied since the Organic Light-emitting Diodes (OLEDs) development to utilize triplet excitons in light emission processes with a high external quantum efficiency (EQE). Although green and red light-emitting phosphors have been actively used in OLEDs, blue light-emitting phosphorescent materials have the limit of a short device lifetime. Blue Thermally Activated Delayed Fluorescence (TADF) emitters have recently been developed as a comparable alternative to organometallic phosphors. However, small organic TADF molecules usually suffer from quenching and low resolution due to non-radiative decay routes such as aggregation-caused quenching (ACQ), vibrational quenching, and oxygen quenching of triplets. In this aspect, metal-organic frameworks (MOFs) provide a promising strategy to promote blue-emitting luminescence due to their rigid and crystalline structure, effectively reducing non-emissive quenching of triplet excitons. In addition, the light-emitting characteristics of MOFs can be easily tuned by adjusting the metal ions, clusters, and linkers to form one-, two-, or three-dimensional structures. However, only a few studies of MOF-based TADF have been reported. Here we demonstrate a unique blue TADF emitter based on MOFs using a heavy metal ion (<math>\text{Cd}^{2+}</math>) to promote intersystem crossing (ISC). We synthesized MOF-74s using various transition metals (<math>\text{Mn}^{2+}</math>, <math>\text{Fe}^{2+}</math>, <math>\text{Co}^{2+}</math>, <math>\text{Ni}^{2+}</math>, <math>\text{Cu}^{2+}</math>, <math>\text{Zn}^{2+}</math>, <math>\text{Cd}^{2+}</math>) with dihydroxy terephthalic acid (DHTA) as a linker and investigated their photophysical properties. Highly thermostable blue TADF was observed in MOF-74(Cd) only, which supports our rational design and opens a new feasible TADF material design strategy.</p> |
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14 Promoting adhesion property and coating stability of bioinspired dopamine derivatives via rationally designed polydopamine-disulfide copolymer system Meng-Hsun Lee

Polydopamine (PDA), a mussel inspired surface independent adhesive molecule, has been used for various applications since its fascinating demonstrations in 2007. With abundant catechol and amine functional groups along the polymer backbones, PDA coating is widely used as primary coating for surface functionalization. In its quinone state, PDA is potentially amenable to Michael addition with amine and thiol groups. With inherently weak sulfur-hydrogen bond and high electron density of the S atom, thiol possesses higher Michael addition reactivity. Accordingly, thiol-modified PDA coating has been used for numerous applications including membrane modification hydrogel, and drug delivery. However, despite broad application of PDA-thiol systems, multi-functional thiols have not been explored in connection with PDA. Herein, we demonstrated a novel PDA-disulfide copolymer system, which can promote both coating stability and adhesion property of PDA and PDA derivative coating. PDA coating is easily decomposed in a strong base condition because the cation- $\pi$  interaction, one of the major film forming mechanisms, is nullified under strong base conditions ( $\text{pH} \geq 9.8$ ). Moreover, although some dopamine derivatives, such as levodopa, have the catechol unit, the functional group known to mainly contribute to the adhesive property of PDA coating, do not show the same good coating property as dopamine. Therefore, we investigated if multi-thiol additives, such as 1,8-octanedithiol, can effectively crosslink PDA by means of Michael addition between PDA and multi-thiol additives, rendering a more robust coating. Additionally, because dithiol additives can form disulfide polymers by themselves under a mild base condition, we anticipated that the flexible disulfide polymer can not only soften the rigid PDA backbone, which provides better contact between polymer and the surface, but also extend the chain length of the resulting polymer. The extended chain length will induce more effective intermolecular entanglement and assembling of PDA oligomers, thereby enhancing the coating capability and film stability.



15 Complex and Hierarchical Surface Patterning Achieved Though Metal Templates Facilitating Bulk Phase Separation and Surface Wrinkling

Sabrina

Curley

Developing complex interfaces within water collection and adhesive substrates fields continues to captivate researchers as they devise new synthesis methods, frequently turning to templates and masks. Still, limitations exist with this approach when it comes to implementing hierarchical structuring in surface features, often requiring additional processing steps for these individual lengthscales. Here, metallic templates are used to achieve gradient bulk phase separation in polymeric coatings while the precursor resin's intrinsic wrinkling ability forms mesoscale features. This process utilizes a difference in surface energy between untreated glass and steel to facilitate bulk phase separation, leading to samples exhibiting a difference of over 40 degrees in their measured contact angles on top and bottom surfaces. Resins with a proclivity for phase separation, consisting of acrylonitrile and 1,6-hexanediol diacrylate (HDDA) monomers with inert poly(methyl methacrylate) (PMMA) were selected as a model system for this study, its advantageous wrinkling ability established as a combination of oxygen radical quenching and phase separation during photopolymerization on surface feature formation. Combining these processes into one sample allows for intriguing patterning abilities where a multitude of features and surface chemistries become possible using a single resin formulation. Complex surface design becomes possible through the combination of the macroscale separation from the metal template along with the intrinsic mesoscale wrinkling of the resin, achieving multiple lengthscales of patterning simultaneously. Understanding the variety of parameters that influence the individual phenomena of polymerization kinetics, radical availability, phase separation onset, internal stresses, and interfacial energies only becomes more complex as they become even more intertwined in this new type of sample. Probing different processing factors (e.g., degree of crosslinking, PMMA loading, reaction rate) enables optimization of this combined bulk phase separation and surface wrinkling process to yield regions of vastly different characteristics within a single sample and using a single precursor resin.

16

Micron- to nano-crumpled MXene-based multilayers to regulate cell function for accelerating bone cell growth

Mohammad

Asadi Tokmedash

Although orthopedic implants are considered suitable replacements for missing, damages or degenerated, parts of a body (such as joint, bone and cartilage, in case of injury, degenerative disease and trauma), slow and insufficient tissue regeneration is still a critical issue that could lead to mechanical loosening and implant failure. To tackle this problem, one possible approach is to use surface topographies with periodic features that can have effective interactions with mammalian cells to tune the cell function. Here, we demonstrate the crumpled MXene/hydroxyapatite (HAP) multilayers that can be fabricated through layer-by-layer approach on a shrinkable substrate, for the first time, to investigate the interactions between the crumpled MXene-based films and mammalian cells. MXene is a 2D sheet-like nanomaterial with osteoconductivity, biocompatibility and antimicrobial properties, and HAP is the main inorganic component of hard tissue in the body which is biocompatible and highly osteoconductive. The multilayer MXene/HAP films form a periodic structure whose wavelength and amplitude could be easily tuned by the choice of the number of bilayers, so that nano- to micron-structures can be fabricated to study the nano-bio interactions at the implant interface. Specifically, we will assess proliferation, morphology, adhesion, viability, and differentiation of preosteoblast cells growing on the surface structures with different feature sizes. Our design is taking advantage of both the use of osteoconductive materials, using MXene and HAP, and topography, benefiting the cell differentiation. Compared to other fabrication patterning methods such as lithography, this method is simple, cheap, and scalable with nano-scale control. This well-designed study can potentially help the field of tissue engineering to benefit from topographical strategies, using a simple and scalable method, and osteoconductive materials to increase the success rate of implants.

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| 17 | Microgel-Based Optoelectronic Systems for Continuous, Real-Time Biochemical Sensing at Organ Interface | Chuqi | Huang | <p>Endogenous distribution of biochemical molecules and their reaction pathways constitute the essential metabolic mechanisms of all living organisms and biological systems, of which closely monitoring subtle variations not only brings deep insights into understanding fundamental biological processes but also leads to the invaluable diagnostic basis for timely therapeutic procedures with high precision. Thus, developing biochemical sensors that enable in vivo, continuous conversion of information on the concentration and/or structural transformation of targeted biochemical species into measurable signals represents a rapidly expanding field in recent years and opens new opportunities toward smart health and precision medicine. Most commercially available instruments for biochemical sensing can exhibit their broad utilities in a wide range of industrial and societal needs, with high accuracy and sensitivity. However, their bulky form, high cost, and complicated operation procedures preclude effective and convenient usage. Recently developed on-body biochemical sensors including sweat sensors, electrochemical sensors, and graphene sensors. Each of these has limitations including low biocompatibility and flexibility, electrode poisoning, and poor consistency. Compared with those aforementioned technologies, systems based on stimuli-responsive polymers represent an attractive emerging direction in biochemical sensing, mostly due to their intrinsic soft mechanism, independence from power consumption, low cost, superior biocompatibility, and ease of fabrication. Here, we propose an implantable, multi-modality biochemical sensing system based on an optoelectronic platform embedded with stimuli-responsive microgels into a hydrogel matrix to achieve continuous, direct, and real-time sensing and monitoring of biochemical species at wounds, deep tissues, and internal organs, with high sensitivity, precision, and stability. The proposed concept integrates optoelectronic sensing technology with smart polymeric materials with stimuli-response properties to form an array of sensing units in a soft, highly biocompatible, and miniaturized architecture to achieve multi-modality sensing simultaneously and continuously.</p> |
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| 18 | A Novel Strategy for Fabricating Nanostructures from Microstructured Molds by Global Shrinkage of Hydrogels | Boonjae     | Jang  | <p>With the development of manufacturing technology for micro/nanostructures, various types of functional surfaces based on micro/nanostructures have been developed. In addition, the demand for the application of functional surfaces with micro/nanostructures is increasing significantly in our lives and industrial fields. However, one of the important limitations of the functional surfaces is their low productivity, such as only small area samples can be made, due to the high cost of making large area master molds. To overcome these problems, many studies have been conducted to develop a new method for manufacturing a large-area mold and roll-based continuous manufacturing of a micro/nanostructure and implementing types of roll-to-roll (R2R) systems. In this study, we propose a novel fabrication method for large-scale nanostructures from the submicron-structured mold using global shrinkage of the hydrogels. The physically crosslinked hydrogel of the polyvinyl alcohol containing water and glycerol was prepared on the master mold having the submicron grating structures (linewidth: 842 nm) by the freezing-thawing method. Through the drying process of water, the nanograting (linewidth: 707 nm) was made due to the shrinkage of the hydrogel network. After three cycles of this fabrication process, a 28% decrease in the line width of the nanograting was achieved. In addition, the period of the nanograting was also reduced by 21% because this method is a "substrate-free method". With these results, this fabrication strategy could give various insights into macro/nanomanufacturing systems as well as nanoimprint lithography (NIL).</p> |
| 19 | Synthesis, polymerization, and characterization of terpenoid acrylates                                      | Krishnaveni | Ajith | <p>Bio-based terpenes have recently attracted great interest as monomer feedstock for new polymers. An interesting class of molecules are linear terpenoids with a hydroxyl end group (e. g., geraniol, farnesol, phytol and their hydrogenated analogs). Their reaction with acryloyl chloride gives an acrylate monomer, which when polymerized produces a polymer with short, polyisoprene-like sidechains. The potential utility of these polymers is that the side-group increases the thickness of the polymer chain, which increases their entanglement molecular weight. Polymers with very high entanglement molecular weight are of interest in the fabrication of super-soft elastomers with low modulus. This work discusses our efforts to prepare terpenoid-based acrylate monomers, polymerize these monomers by reversible addition fragmentation chain transfer (RAFT) polymerization, and measure their viscoelastic properties using oscillatory shear rheology to assemble master curves through time-temperature superposition.</p>   |

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| 20 | Tuned Polyacrylamide-based Gel Morphology and Chemistry for Crystal Growth  | Akul | Seshadri | <p>Superabsorbent polymer (SAP) hydrogels are crosslinked polymer networks capable of absorbing, holding, and releasing several times their mass in water. This behavior gives rise to interesting transport behavior and mechanical properties, making SAPs useful in concrete curing, biomedical applications, biological systems, oil recovery, and agricultural systems to name a few. Here, we aim to nucleate and grow ceramic crystals within a hydrogel matrix through varying gel chemistry and morphology. The resulting system has direct applications for internal cement curing and subsequent carbon emission reduction. Furthermore, the growth behavior of inorganic material in a gel has analogues for the growth of hard tissue in a soft biological matrix. Polyacrylamide (PAM) based gels were synthesized or treated to create varying chemistries and morphologies to see their effect on crystal growth. Polymerized gel chemistry was verified with Fourier Transform Infrared Spectroscopy (FTIR). Gels were treated in a variety of ionic solutions and pre-crystal solutions. Morphology of the gels before and after treatment was characterized with Small Angle X-Ray Scattering (SAXS). The results and implications of these experiments will be presented.</p>  |
| 21 | Highly functional lignocellulosic materials for rare earth element removal and recovery via facile dual oxidation | Mica | Pitcher  | <p>Rare earth elements (REE) are a group of 17 metallic elements which are becoming increasingly important due to their role in many advanced applications, including permanent magnets, catalysts, electric cars, wind turbines, and fluorescent lamps. Despite the demand, there is a shortage in resources, environmentally friendly processing, and reliable recovery strategies. Therefore, sustainable removal and recovery of REE is an immediate and unmet environmental, industrial, and economical challenge worldwide. We have utilized a selective dual oxidation procedure of cellulose fibrils, the most abundant and renewable biopolymer on earth, for the removal and recovery of neodymium (Nd), one of the most critical REE. We show how the dual oxidation of various lignocellulosic sources yield three distinct products, including nanoparticles, fully solubilized polymers, and microproducts, bearing up to 6 mmol of carboxylate groups per gram, which is ~ 500% beyond the theoretical charge content of cellulose nanocrystals (CNC). Among these products, as a proof-of-concept, carboxylated cotton microfibers removed ~ 92.5 mg of Nd per gram from a dilute Nd solution in less than 5 min, and notably, we were able to recover approximately 64% of it via pH adjustment. We also demonstrate how anionic hairy nanocellulose (AHNC) formed via this dual oxidation selectively removes ~ 264 mg g<sup>-1</sup> of Nd within seconds, which, to the best of our knowledge, is among the adsorbents with the highest removal capacity at the shortest contact time. Together, our bio macromolecular engineering approach combined with the biorenewability of cellulose and an ambient, low-cost unit operation enable sustainable nanotechnologies for the removal of Nd from industrial wastewater, e-waste, and NdFeB permanent magnet leachates.</p> |

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| 22 | PLA/Graphene Composites for Electromagnetic Metamaterial Absorbers | Kanat | Anurakparadorn | <p>The expansion of electrical and electronic components utilization can lead to the increase in electromagnetic interference (EMI) pollution. This results in demand for cost-effective EMI shielding materials that reduce the sensitivity of high-speed electronic circuits to the undesired radiation. Here, EMI shielding metamaterial consisting of PLA-based composites with conductive graphene nanoplatelets (GNPs) were introduced. The metamaterial structures with periodic pores have been designed using combined electromagnetic-based computational modeling and optimizations to enhance absorption and operation bandwidth. Benefited by the resonances that are generated by the interaction between periodical pores, the resulting metamaterials can offer greater absorption, are comparatively lighter in weight, and require lower production cost than traditional metal sheet or composite foams.</p> <p>In this work, the electrical permittivity and magnetic permeability of the GNPs/PLA composites were fabricated via twin-screw extrusion with different loading contents. The composites were compression molded into plaque samples and characterized by scattering parameter method. These properties were input in the computational models through the optimization algorithm to design the periodic porous structure. The optimized loading at 7.5wt% GNPs the maximum reflection loss (RL) around -22 dB. The metamaterial structure of the 2 mm thick composite with periodic cylinder pores provides a significant increase in the maximum RL to -60 dB with less material in the unit cell. These results indicate that the method of making periodic porous structures can improve absorption and operation bandwidth of shields significantly.</p> |
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| 23 | Additive manufacturing of carbon enabled by a robust plastic precursor platform                          | Paul  | Smith | <p>Industry 4.0 is revolutionizing the way that companies manufacture products and additive manufacturing (AM) is rapidly becoming a core integrated technology. AM has successfully penetrated multiple industrial sectors and is constantly extending to new applications which demand expansion of the material design space. Most work in materials development for AM focuses on polymers, metals, and ceramics. Despite the critical importance of carbon materials in many applications, AM of carbon has not yet been applied at scale. The most established systems for AM of carbon rely either on the extrusion of carbon-containing slurries followed by solvent removal or UV-assisted AM of carbon precursors which then undergo pyrolysis. While these approaches have laid a strong groundwork for lab scale AM of carbon they tend to share commercial limitations in their scalability, cost and dimensional accuracy of the resulting carbons. This work will present our contribution to establishing additive manufacturing capabilities for carbon materials. We will report approaches to control AM of carbon structures using commodity polymer precursors and fused deposition modeling (FDM). In particular, we will explore how homopolymers and blended systems allow for control over the dimensional accuracy, mechanical properties and composition of the resulting carbons. Additionally, we will extend this approach to the upcycling of reclaimed polymer waste as carbon precursors and examine the potential of these materials as joule heating components. These results will inform the development of structured carbon materials through AM.</p> |
| 24 | Synthesis of Hydrophobic Self-healing Linear Polymer based on UV Reversible [2+2] Cycloaddition Reaction | Jinho | Kim   | <p>The hydrophobicity of the surface was adjusted through the number of saturated carbon (<math>C_nH_{2n}</math>) or fluorine (<math>C_nF_{2n}</math>) contained in the linear self-healing polymer. The changes in surface energy and self-healing property due to the backbone structure of the polymer were confirmed through analysis.</p>   |

25 Probing the Relaxation Dynamics of PEG-based Hydrogels Alyssa

VanZanten

Hydrogels are a widely studied class of soft material with applications ranging from ion-exchange membranes to water capture devices to drug delivery systems. Hydrogels are commonly utilized in these applications because of their unique ability to typically withstand the mechanical deformation associated with swelling and de-swelling. This indicates that hydrogels can be designed to be durable and well-suited to switchable behaviors that require both stress generation and dissipation. In contrast to the fully swelled, equilibrium state, limited research has been performed to understand the unsteady-state swelling regime prior to achieving equilibrium, especially for free-swelling gels (e.g., gels that are not adhered to a substrate). When designing long-lasting, switchable properties, understanding the mechanisms that elastic polymer networks utilize to dissipate internal stresses is critical. Here we show that combining gel theory (i.e., Flory-Rehner polymer solution thermodynamics) with empirical observations (i.e., the impacts of cross-linking, solvent quality, and geometry on wrinkle dynamics) allowed us to gather information about the relaxation dynamics involved in hydrogel swelling. Studying wrinkle behavior as a function of time provided insight into the strain mismatch that builds due to non-equilibrium swelling. Investigating the impact of solvent quality, cross-linking, and geometry on wrinkle dynamics revealed that the rate of imbibement during swelling is the main determinant of the internal stresses the material experienced. Combining these experimental results with osmotic pressure modeling allowed for a broad understanding of the relationship between network relaxation and swelling dynamics. With this knowledge, future design of hydrogel systems can be improved by utilizing the connection between polymer network relaxation and swelling mechanics. Engineering dynamic surface properties, while also mitigating unwanted instability, opens the door for emerging technology such as smart anti-fouling and sensors.



The ability to print living materials in architected geometries enables superior control over cell functionality that will surely enhance the future of biofuel, pharmaceutical, and biocatalyst production. Bulk living materials – or biocompatible hydrogels with encapsulated microbes – may face the challenge of slow mass transfer that limits their production capacity. Cell functionality can be greatly improved when living materials are fabricated in precise geometries such as lattices & scaffolds, which also favor biocatalysis. Here, we present a novel uniaxial electrospinning approach to developing microfibrinous poly(ethylene glycol) (PEG) constructs for single cell-level encapsulation and bioprocess intensification. This approach allows PEG microfibers to be generated from an aqueous solution of poly(ethylene glycol) diacrylate (PEGDA), which cannot be conventionally electrospun on its own. By adding a sufficient amount of salt, surfactant, and high molecular weight poly(ethylene oxide) (PEO) to the solution; we can obtain micron sized PEG/PEO fibers loaded with viable yeast cells and having an average fiber diameter of 0.8  $\mu\text{m}$ . Upon photo-curing with a water-soluble initiator, the PEO can be washed away to produce swellable PEG microfibers with encapsulated microbes. Since yeast can be genetically modified to produce a variety of other valuable products, like biofuels or pharmaceuticals, this material could find use as a biocatalyst in industrial processes or as a platform for designing bioinspired materials with other lifelike functions.

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| 27 | Synthesis of ordered mesoporous materials from nanostructured thermoplastic elastomers | Mark | Robertson | Mesoporous materials have demonstrated enhanced performances across many applications in comparison to disordered, microporous materials, attributed to their larger pore sizes and improved ordering for enhanced transport of guest molecules within pore channels. The synthesis of ordered mesoporous materials (OMMs) generally relies on the self-assembly of surfactants or block copolymers with a precursor through solvent evaporation to establish a well-ordered nanostructure prior to pyrolysis. While effective, these methods are generally limited to obtaining small mesopore sizes and require large amounts of volatile solvent, hindering their large-scale use in various practical systems. This work focuses on addressing these challenges by establishing a new platform for synthesizing a library of OMMs from low-cost, widely available polymer precursors through a simple method. Specifically, nanostructured thermoplastic elastomers can be directly employed to act as a precursor for OMM production. This is accomplished through a sulfonation-induced crosslinking reaction which occurs in the bulk to selectively crosslink the majority phase of thermoplastic elastomers. Upon pyrolysis, the minority phase can be decomposed to form pores, while the matrix can either retain their chemical identity or be converted to carbons. The heterogeneous nature of the sulfonation-based crosslinking reaction gives rise to a complex interplay between nanostructural rearrangement of precursor morphology and the increasingly restricted mobility. This interplay is investigated to establish fundamental process-structure relationships, allowing the versatile use of our approach for the production of mesoporous polymers, carbons, and silica with controlled pore size and functionality. |
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| 28 | Nanocomposite Janus particles for complex information display                                      | Zenghao | Zhang | <p>Particle-based display systems are a type of reflective or absorptive display, typically actuated by electrical fields or magnetic fields. One type of magnetic responsive display, composed of suspended magnetic particles with compartmentalized colors, can change color when observed from a specific viewpoint due to particle rotation led by magnetic torque. Here, we fabricated poly(lactic-co-glycolic acid) (PLGA) based magnetic Janus microparticles by first producing biphasic fibers using the electrohydrodynamic (EHD) jetting techniques, then microtoming the fibers into micro-cylinders, followed by sonication to form microparticles. The Janus particles compose magnetic fillers (SPIONs and NdFeB) to provide magnetic properties in one compartment, and white pigments (TiO<sub>2</sub>) to provide color contrast on the other side. Different magnetic properties ranging from superparamagnetic to ferromagnetic can be achieved by changing the ratio of the magnetic fillers, and the corresponding stabilities of the magnetic remanence and magnetization intensities can be controlled. By leveraging different magnetic remanence stabilities of the Janus particles and different magnetic field profiles and intensities, we presented not only the simple “on-off” transition, but also the display of graphic patterns both temporarily and permanently, selectively actuating different particles in the same field, and graphic encryptions. This work explored multiple methods to control and program the magnetic properties of the Janus particles, as well as the actuation magnetic fields, and presents novel actuation modes for particle-based display systems.</p> |
| 29 | Carbodiimide Chemistry for Modification of Hyaluronic Acid with a Model Crystal Violet DNA Aptamer | Jennie  | Paik  | <p>The biocompatible and biodegradable nature of polysaccharide hydrogels makes them ideal for use in subcutaneous applications. When combined with the robust fluorescence of dye-binding DNA aptamers, a completely biocompatible sensing material can be visualized. These applications often require soft, shear-thinning gels obtained through low crosslink density; however, the large swollen pore sizes (&gt;300 <math>\mu</math>m) of these gels allows free diffusion of DNA aptamers out of the gel matrix. One possible solution is through covalent grafting of DNA aptamers to the polysaccharide backbone. The carboxylic acid functionality on the linear glycosaminoglycans (GAGs) such as hyaluronic acid (HA) facilitates extensive functionalization through relatively mild pathways such as carbodiimide chemistry; this allows for grafting of not only functional molecules but also sensitive macromolecules such as DNA Aptamers that may not survive under harsh reaction conditions. Using a model fluorescent dye/aptamer system selective towards crystal violet (CV30S), we determined reaction conditions that allowed carbodiimide-facilitated grafting of amine-terminated CV30S onto the <math>\beta</math>4-glucuronic acid carboxylic acid of HA, demonstrated possible form factors (injectable gel vs. bead) for such a system, and demonstrated the fluorescence activity of these systems.</p>   |

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| 30 | Physics in biofilm matrix  | Kyoungjin | Seo  | <p>Oral biofilms is main instigator of many oral diseases, and many people has been studied. Pasted 10 years, WHO reported nearly 90% of adults ages 20 to 64 years have had decay in their teeth, and dental caries are due to biofilm forms on the tooth surface.</p> <p>Biofilm formation has been known because of driven of free sugar. When bacteria meet sugar, they started to form EPS (extracellular polymeric substance) matrix. In oral environment, there are many species in oral bacteria that form biofilm in which consist of matrix and bacteria cells and <i>S. mutans</i> (<i>Streptococcus mutans</i>) is dominant. Biofilm matrix is consist of polymer and it can behave as polymer. However, the physical interaction of matrix is not studied widely.</p> <p>In this study, we figure out the biofilm swelling is driven by osmotic pressure. To address this challenge, we grow the macrocolony on the agar plate.</p>  |
| 31 | Dual-Wavelength Digital Light Processing Toward Multimaterial Printing | Kyle      | Chin | <p>Additive manufacturing (AM), commonly referred to as 3D printing, is a powerful method for controlling the placement of molecular building blocks—providing increased flexibility in the design, function, and manufacturing of objects. In many AM techniques, object formation is dictated by material deposition directly to specified locations. In contrast, vat photopolymerization (VP) AM builds objects through patterned curing of a homogeneous liquid from a material reservoir. This difference makes multimaterial VP challenging. Engineering approaches, such as swapping of resin vats or fluidic devices, have been the predominate solution. In this talk, I will discuss a chemistry-oriented approach to multimaterial VP that incorporates orthogonal photochemical pathways into resin design. Toward this aim, I will describe the design of various resin formulations that achieve controlled stiffness, disparate solubility, and localized acidity with applications in creating stimuli responsive materials, dissolvable supports, and multicolor architectures.</p> |

Stretchable Self-Healable Semi-conducting Polymer Perovskite Quantum Dots Composite for Light-Emitting Diodes

Carlos

Figueroa Morales

A device application for electronic skins (e-skins) is the real-time display of physiological signals. Researchers have investigated how to fabricate the e-skins to be like human skin. Current progress in skin-like stretchable displays uses organic components that are prone to crack formation and chemical aging. This is detrimental to the device's performance and lifetime. A promising approach for future commercialization is a highly emissive material that can self-repair its mechanical and electrical functions and sustain high efficiency. The emergence of self-healing chemistry is a promising approach for the materials to repair themselves using highly dynamic intermolecular forces. The well-studied, ureido-pyrimidinone (UPy) molecule has self-healable properties due to high dimerization via quadruple hydrogen bonding. For the fabrication of an autonomous self-healable, stretchable, and high luminescence e-skin display, we provide a side-chain polymer engineering approach using perovskite quantum dots (PQDs) as the emitting material. We will make a composite film of PQDs and an engineered semi-conducting polymer with the UPy molecule. The strategy is to graft the long alkyl side-chain of the semi-conducting polymer to the UPy molecule using a diazirine functionalized cross-linker 1,4-bis(2-(3-(trifluoromethyl)-3H-diazirin-3-yl) ethyl) benzene (DZ). The other composite component, PQDs, is a promising light-emitting material for outdoor displays. They provide high luminescence, high efficiency, low cost, easy synthesis, and easy tunability of different colors. The combination of the engineered semi-conducting polymer and the highly efficient emissive material in a composite will be used to fabricate autonomous stretchable and self-healable LEDs for e-skins applications.

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| 33 | Wear-Resistant Bilayer Surface Design for Scale-independent De-icing | Jiayue  | Huang     | <p>Ice accretion is hazardous in a wide range of areas, such as aircrafts, wind turbines and refrigerator coils. To solve this important problem, surfaces which avoid droplet pinning, including superhydrophobic surfaces (SHSs) have been extensively studied for years. However, such surfaces can still undergo frost formation, and they may not have enough mechanical durability for the different applications where ice accretion needs to be reduced. Here we introduce bilayer surfaces with a highly elastic polyurethane base layer and a thin, durable capping layer with a high Young's modulus. This kind of surfaces display a unique and highly desirable combination of low interfacial strength and low interfacial toughness, which enables scale-independent shedding of ice with minimal applied force, as well as high mechanical durability. By controlling the thickness and effective shear modulus of base and capping layer and combining the experimental results with simulation, here we systematically investigate the mechanisms that imbue icephobicity to our bilayer systems, and optimize the material design to achieve good scale-independent ice-shedding performance.</p> |
| 34 | Synthesis of carboxylic acid terminated polymyrcene                  | Trishna | Chengappa | <p>Living anionic polymerization is a well-known method to prepare chain-end functionalized polymers with narrow molecular weight distribution. This work is focused on the synthesis of carboxylated polymyrcene from the anionic polymerization of myrcene and termination with carbon dioxide. Myrcene is a bio-based monomer with a structure similar to isoprene. The side-group on polymyrcene produces a thicker, less-entangled chain. The addition of a functional end-group offers the potential to use the polymer as a building block in more complicated chain architectures, such as graft and block copolymers. The challenge in termination with carbon dioxide in anionic polymerization is that the lithium carboxylate is still reactive towards the living chain end, potentially producing dimers through the formation of a ketone mid-chain functional group. The reaction conditions to favor lithium carboxylate formation, including the addition of a polar modifying solvent, the method of CO<sub>2</sub> addition, and the reaction temperature, will be discussed.</p>  |

35      Withdrawn                      Withdrawn                      Withdrawn                      Withdrawn

36      Surfaces with Instant, Persistent, and Broad-spectrum Antimicrobial Efficacy      Taylor                      Repetto

Surfaces contaminated with infectious bacteria and viruses contribute to transmission and pose a significant threat to global public health. Common liquid spray disinfectants kill microbes in seconds to minutes, yet they require reapplication often. Surfaces that rely on heavy metals or metallic nanoparticles for antimicrobial efficacy remain antimicrobial over a long period of time but take hours to kill pathogens leaving time for disease transmission. There is currently no surface that can provide instant and persistent antimicrobial efficacy against a broad spectrum of bacteria and viruses. Inspired by the naturally antimicrobial secondary metabolites secreted by plants, we created a new class of highly durable polyurethane surfaces capable of rapid disinfection (>4-log reduction in minutes) of various pathogens, including *Escherichia coli*, *Pseudomonas aeruginosa*, methicillin-resistant *Staphylococcus aureus*, and SARS-CoV-2. These surfaces maintain this efficacy over several months and under significant environmental duress due to the chemical stabilization of the natural antimicrobial components within the polyurethane. Additionally, we show that the surfaces can be applied to surfaces using various commercial techniques such as spray-, flow-, or brush- coating allowing for a wide range of potential applications.

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| 37 | Electrochemical Upcycling of Poly(vinyl chloride)           | Rahul  | Jha | <p>Despite being the third highest production volume polymer, poly(vinyl chloride) (PVC) has the lowest recycling rate in most countries. Leakage of carcinogenic plasticizer (in plasticized PVC) and generation of hydrochloric acid possess safety hazard that limit its recycling via mechanical recycling and pyrolysis, respectively. Among various chemical recycling methods, electrochemical approaches include direct use of electrons, which is inexpensive, non-toxic and has a small ecological footprint. Recently the McNeil group reported a redox-mediated approach to recover chlorine atoms of PVC under electroreductive conditions and then directly repurposed as feedstock in a tandem electrooxidative chlorination reaction. However, the unstable redox mediator led to use higher PVC loading (8 equivalents) as compared to the mediator (1 equivalent) to improve the reaction efficiency. To overcome the mentioned challenges, we envision identifying a more stable redox mediator to lower the PVC loading. In our investigation, N-substituted phthalimides show promising results as a redox-mediator to dechlorinate PVC. Infrared spectroscopy of dechlorinated PVC indicates presence of olefin in the polymer backbone. Elemental analysis confirms &gt; 80% dechlorination of PVC. Tuning reaction parameters reduced the PVC loading down to 2 equivalents. The efforts to repurpose dechlorinated PVC to value-added commodity polymers are ongoing.</p> |
| 38 | Reducing Polymer Adhesion with UV Irradiation for Recycling | Yuchen | Wu  | <p>Despite being the third highest production volume polymer, poly(vinyl chloride) (PVC) has the lowest recycling rate in most countries. Leakage of carcinogenic plasticizer (in plasticized PVC) and generation of hydrochloric acid possess safety hazard that limit its recycling via mechanical recycling and pyrolysis, respectively. Among various chemical recycling methods, electrochemical approaches include direct use of electrons, which is inexpensive, non-toxic and has a small ecological footprint. Recently the McNeil group reported a redox-mediated approach to recover chlorine atoms of PVC under electroreductive conditions and then directly repurposed as feedstock in a tandem electrooxidative chlorination reaction. However, the unstable redox mediator led to use higher PVC loading (8 equivalents) as compared to the mediator (1 equivalent) to improve the reaction efficiency. To overcome the mentioned challenges, we envision identifying a more stable redox mediator to lower the PVC loading. In our investigation, N-substituted phthalimides show promising results as a redox-mediator to dechlorinate PVC. Infrared spectroscopy of dechlorinated PVC indicates presence of olefin in the polymer backbone. Elemental analysis confirms &gt; 80% dechlorination of PVC. Tuning reaction parameters reduced the PVC loading down to 2 equivalents. The efforts to repurpose dechlorinated PVC to value-added commodity polymers are ongoing.</p> |



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| 39 | Investigation of polyethylene weathering with a combination of analytical techniques | Shuqing | Zhang    | <p>For many products such as those used for food packing and electronics, it is necessary to separate adhesives from various substrates to recycle metals and other materials. Therefore, it is important to develop a method to reduce the adhesion of different components in these products at the end use of the products. In this study, we developed a self-assembled debonding layer which can successfully reduce the adhesion between silica and silicone as well as epoxy adhesives. The preparation process was investigated using sum frequency generation (SFG) vibrational spectroscopy, x-ray photoelectron spectroscopy (XPS), and contact angle goniometry. The experimental data shows characteristic signals from each step of the reactions to build the debonding layer. After UV irradiation exposure, substantial adhesion decrease was observed, due to the chemical bond breakage at the interface. This study built a foundation for future development of an interfacial debonding layer that reduces adhesion of polymer adhesives with UV irradiation.</p>   |
| 40 | Polysaccharide Blends as Sustainable Alternatives                                    | Isabela | Coutinho | <p>Plastic makes up a good portion of solid waste due to its increased use, posing potential risk to environmental health and resource sustainability. Among plastics, polyethylene is one of the most used due to its broad application. There are emerging studies on the environmental weathering of polyethylene to establish knowledge of the fate of plastic debris and to devise strategies to mitigate plastic accumulation. In this study, polyethylene samples were subjected to individual or combined treatments of simulated solar exposure and in situ exposure in lake deployment (experimental freshwater lake systems in North America) at different levels. Analyses based on a combination of characterization techniques were applied to measure the physical and chemical changes of the samples. The results reveal the structural changes of the polyethylene materials based on an increased hydrophilicity, greater number of polar groups, increased degree of crystallinity, and higher elastic modulus. It was found that the structural changes are dependent on both sample properties (e.g., density) and experimental treatment conditions (e.g., UV exposure time, lake deployment depth). This research demonstrated that the combined use of various analytical tools provides a more complete picture of the polyethylene degradation process and systematic knowledge of the environmental fate of plastics.</p> |

41 Capturing microplastics with polarity-matching adhesives Henry

Thurber

Petroleum-based polymers have become indispensable in many industries, including packaging, biomedical, and automotive. However, these polymers are obtained from non-renewable sources, and their recycling faces several economic and technical difficulties. Therefore, the accumulation of polymer waste is an urgent concern. As an alternative, polysaccharides are an interesting class of biopolymers due to their abundance, renewable sources, biodegradability, and, in many cases, biocompatibility. However, polysaccharides often do not exhibit the same performance as conventional polymers, especially in terms of cost and mechanical and barrier properties. One approach to overcoming these limitations is to blend polysaccharides with other biodegradable polymers. In this study, blends of polysaccharides with a variety of other biodegradable polymers were investigated. For example, cellulose acetate butyrate (CAB) is a hydrophobic cellulose derivative that forms transparent films and is widely used in biomedicine. However, its applications are limited due to its brittleness. Thus, CAB can be blended with poly(L-lactic acid) (PLLA) or polycaprolactone (PCL), which are two biodegradable polymers, to improve its mechanical properties. At the same time, PLLA and PCL have relatively low glass transition temperatures ( $T_g$ ), around  $60^\circ\text{C}$  and  $-60^\circ\text{C}$ , respectively, whereas CAB has a  $T_g$  around  $150^\circ\text{C}$ . Therefore, higher-temperature applications can be targeted when blending these polymers. Polymer blends are also known to be immiscible, which negatively affects their properties. Therefore, the use of targeted block copolymers of polysaccharides and other biodegradable polymers was also investigated in this work. Small-angle laser light scattering (SALLS) and phase-contrast optical microscopy (PC-OM) were used to study the morphology of the blends. Thermal stability, thermal transitions, and thermomechanical properties were assessed by thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), and dynamic mechanical analysis (DMA), respectively.

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| 42 | Effects of caffeyl alcohol on the synthesis and degradation of lignin copolymer films                      | Ethan         | Fink  | <p>Conventional lignin plays a major role in plant development, comprises a significant portion of lignocellulosic biomass and forms complex heterogeneous polymer structures which are resistant to chemical degradation. As a result, most of the conventional lignin generated from biomass refining is discarded. This study investigated a less common monolignol, caffeyl alcohol, which was copolymerized with coniferyl alcohol and p-coumaryl alcohol. The monolignols were copolymerized into a dehydrogenative polymer (DHP) lignin by horseradish peroxidase immobilized onto the surface of a gold coated sensor for a quartz crystal microbalance with dissipation monitoring (QCM-D) instrument. Polymerization and film degradation were studied via the QCM-D system. As the proportion of caffeyl alcohol present for polymerization increased, the amount of DHP lignin formed decreased. Degradation by a chelator-mediated Fenton system revealed the percentage of copolymer film degraded increased as caffeyl alcohol concentration present for polymerization increased. Enhanced degradability was attributed to more linear copolymer segments comprised of caffeyl alcohol which were less crosslinked than conventional DHP lignin copoly</p>      |
| 43 | Pyrolyzed Soybean Hulls (PSBH) as a potential conductive filler in High-Density Polyethylene/CB composites | Udayan Jayant | Dabke | <p>Conventional lignin plays a major role in plant development, comprises a significant portion of lignocellulosic biomass and forms complex heterogeneous polymer structures which are resistant to chemical degradation. As a result, most of the conventional lignin generated from biomass refining is discarded. This study investigated a less common monolignol, caffeyl alcohol, which was copolymerized with coniferyl alcohol and p-coumaryl alcohol. The monolignols were copolymerized into a dehydrogenative polymer (DHP) lignin by horseradish peroxidase immobilized onto the surface of a gold coated sensor for a quartz crystal microbalance with dissipation monitoring (QCM-D) instrument. Polymerization and film degradation were studied via the QCM-D system. As the proportion of caffeyl alcohol present for polymerization increased, the amount of DHP lignin formed decreased. Degradation by a chelator-mediated Fenton system revealed the percentage of copolymer film degraded increased as caffeyl alcohol concentration present for polymerization increased. Enhanced degradability was attributed to more linear copolymer segments comprised of caffeyl alcohol which were less crosslinked than conventional DHP lignin copolymers.</p> |

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| 44 | Investigating ceiling temperatures of polyphthalaldehyde derivatives | Vaidehi  | Shastri | Electrically Conductive polymer composites find a variety of applications in electronics and packaging. Current research focuses on environmentally friendly alternatives to carbon-based fillers like Carbon Black (CB) and other inorganic fillers. Biochar, i.e., pyrolyzed biomass, has emerged with great potential due to its high carbon content and thermal stability. Due to the low conductivity of biochar, it needs to be coupled with high-conducting fillers like CB. In this study, the effect of Pyrolyzed Soybean Hulls (PSBH) [Biochar] on the electrical conductivity and mechanical properties of HDPE/CB composites was studied. The effect of particle size of PSBH and various processing parameters like Rate of Mixing (RPM), Mixing time, and Processing temperature were also investigated. Results reveal an increase in conductivity on the incorporation of PSBH. The mechanical properties also improved. Electrical conductivity data probed towards possibly replacing CB with PSBH to a certain extent. |
| 45 | Measuring Microplastics in the Atmosphere of Michigan                | Madeline | Clough  | The term microplastic, referring to small pieces of plastic between 1 and 5000 $\mu\text{m}$ , has gained traction in recent years as researchers quantify these pollutants in our food, water, soil, and air. Nevertheless, exposure levels and transmission routes of microplastics in the atmosphere remain relatively unknown, in stark contrast to more thoroughly investigated environments like natural waters and soils. Through community partnership with high schools in various regions of Michigan, we employed atmospheric sampling techniques to obtain particulates from our air. The collected particles were then characterized using optical microscopy, infrared spectroscopy, and Raman spectroscopy to assess microplastic size, shape, color, and composition. In this work, we aim to elucidate regional exposure, sources, and transport pathways of airborne microplastics, prompting a call-to-action in research and policy realms alike.   |