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Poster Abstract Booklet for PoWER 2026

1 *Synthesis and Enzymatic Degradation of Carotenoid-Based Semiconducting Polymers*

Kira Boutilier-Young, she/her

Recent research has explored degradable conductive materials which could determine end-of-life fate of numerous products. We can look towards conjugated polymers as semiconductors, as they have already been explored for applications including flexible and transient electronics. Conjugated polymer studies have explored use and properties of bioderived and bio-inspired monomers and their degradation pathways. Despite efforts to achieve degradation with acid, light, and oxidation, there have been no examples to date using enzymes. Carotenoids are conjugated molecules with carbon backbone motifs mimicking polyacetylene and can be degraded with carotenoid-cleavage dioxygenases (CCDs). Our group previously demonstrated synthesis of carotenoid-inspired conjugated polymers, and we have now designed a polymer series employing β-carotene-inspired backbones to take advantage of CCDs. These polymers are synthesized through Horner-Wadsworth-Emmons (HWE)-type polymerization and varied side chains offer ranging hydrophilicities. Thin film degradation studies are conducted to mimic application conditions in electronic devices, and degradation progress is monitored via an array of characterization techniques. Improved hydrophilicity from side chain modification is expected to improve degradation efficiency in aqueous conditions, eliminating dependence on organic solvents. This is the first demonstration of enzymes being used to degrade semiconducting polymers, laying the foundation for external stimulus-free degradation in the natural environment.

2 *Self-Assembly of Chiral π-Conjugated Materials Via Non-Symmetric Sidechain Engineering*

Rachael Warner, she/her

π-Conjugated semiconducting polymers (CPs) are critical components of emerging organic electronics due to their good charge transport properties and tunable optical and mechanical properties. In recent years, chirality has emerged as a transformative concept in this class of materials, providing new avenues for emerging applications across organic electronics. CPs incorporating chiral moieties often exhibit strong chiroptical responses, observed through circular dichroism and high optical rotation, and can function as spin filters via the chirality-induced spin selectivity effect. These properties position chiral CPs as powerful platforms for applications ranging from health monitoring and free-space communications to quantum information and secure encryption. In terms of materials design, incorporating chiral moieties into the sidechains of CPs often provides a direct and effective strategy for inducing intrinsic chirality, as these sidechains inherently interact strongly with circularly polarized light. Notably, a non-symmetric sidechain strategy can potentially enhance these advances by simultaneously controlling molecular packing, supramolecular chirality, and electronic structure.

Building from this modular approach to non-symmetric CPs, this research will push the boundaries of chirality in organic electronics by exploring the combination of naturally sourced chiral citronellyl sidechains paired

with a branched alkyl chain and will probe for their impact on polymer self-assembly. Our research will develop a new class of π-conjugated semiconducting materials through non-symmetric sidechain engineering of chiral moieties, providing a versatile platform to bridge the current synthetic gap in the field. By integrating chirality directly into the molecular framework, we will produce novel materials with tailored functionalities for advanced chiroptical devices. The creation of high-performance polymers that self-assemble into helical architectures not only advances structure-property relationships, but also opens pathways to tunable optoelectronic responses. Furthermore, the utilization of a modular, scalable, and efficient processing strategy allows our research to address current challenges facing chiral π-conjugated semiconducting materials.

3 *From Monomer Design to Bulk Performance in Polyethylene-Like Materials*
Rachel Bianculli, she/her

Understanding how precise monomer structure governs bulk performance is central to polymer design. Here, we investigate structure–property relationships in polyethylene-like materials derived from symmetrically designed α,ω-diene monomers for acyclic diene metathesis (ADMET) polymerization. This strategy enables well-defined backbone architectures with tunable functional group content while preserving polyethylene-like chain character.

Our initial studies focus on symmetric carbonate-containing monomers that introduce controlled polarity and degradable linkages into otherwise hydrocarbon-rich backbones. Using ADMET polymerization, we access linear polymers with systematically varied functional group spacing, allowing us to probe how carbonate content influences thermal, mechanical, and crystallization behavior. Building on these findings, we are extending this approach to additional symmetric monomers incorporating hydrogen-bonding motifs. Through this modular platform, we aim to establish molecular-level design principles for tuning crystallization and bulk performance in polyethylene-like materials via precise monomer architecture.

4 *Side-Chain Engineering of Isoindigo-Based π-Conjugated Polymers for Organic Thin Film Transistors*
Victoria Olga Kis, she/her

Organic polymers with extended π-conjugation within the backbone can transport charge, showing unique optical and electrical properties. Semiconducting polymers are useful materials for various types of devices, such as OFETs, and can be designed to be flexible, stretchable, and synthetically tunable. Their limited solubility in green, low-toxicity solvents often makes them incompatible with sustainable manufacturing, forcing a reliance on chlorinated and high-boiling point solvents. Our group developed carbohydrate-containing semiconducting polymers to improve solubility for processing, they can be useful for OFETs and OECTs due to their intrinsic biocompatibility, abundance of polar functional groups, and structural diversity. The design and synthesis of isoindigo-based semiconducting polymers bearing structurally varied carbohydrate side chains will be presented. The carbohydrate units are introduced via N-alkylation of the isoindigo core using alkyl chain linkers, with the influence of side-chain structure on solubility in greener solvent systems being systematically evaluated using UV–visible spectroscopy, while solid-state organization is examined through atomic force microscopy and X-ray diffraction. OFET devices fabricated from these materials can establish structure–property–function relationships, and OECT devices will probe mixed ionic–electronic transport. By integrating sustainability considerations directly into molecular design, side-chain engineering can enable greener processing routes while maintaining device performance.

5 *On the Thermal Stability of Magic Blue Doped D/A Polymers: De-chlorination Drives De-doping*
Alyssa Shaw, she/her

Molecular doping of conjugated polymers is a key strategy for enhancing the performance of organic electronic devices, particularly thermoelectrics. Doped donor–acceptor (D–A) polymers, which exhibit strong p–p stacking and tunable energetic offsets between the Fermi level and transport band, enable high electrical conductivity (s) while maintaining a favorable Seebeck coefficient (S). Despite their promise, the thermal stability of chemically doped D–A systems remains insufficiently understood, limiting their long-term device reliability. In this work, we investigate the thermal stability of a diketopyrrolopyrrole–thiophene (DPP-T) D–A copolymer doped with the strong oxidant “Magic Blue.” We provide a unique, detailed study of Magic Blue

degradation in a doped polymer system. Temperature-dependent UV–vis–NIR spectroscopy reveals dopant degradation and polaron decay under elevated thermal stress. While the as-cast films exhibit in-plane conductivities of ~30 S cm?[1], annealing at 120 °C for 30 minutes results in more than an order-of-magnitude decrease in conductivity, whereas films remain stable at 80 °C. Thermogravimetric analysis coupled with mass spectrometry identifies chlorine loss from the dopant as a primary degradation pathway, a finding corroborated by X-ray photoelectron spectroscopy. These results demonstrate that although Magic Blue provides high doping efficiency in D–A polymers, improving the thermal robustness of doped DPP-based systems is critical for advancing stable organic thermoelectric devices.

6 *Scalable Room-Temperature Synthesis of StyDex Monoliths for Selective PFAS Removal*
Christine Rukeyser, she/her

Per- and polyfluoroalkyl substances (PFAS) are persistent environmental contaminants found in a wide range of consumer products. As a result, these compounds are now pervasive in global water sources and are associated with serious health risks, including cancer and liver damage. Within the Dichtel research group, we have pioneered the development of novel, selective PFAS sorbents based on β-cyclodextrin (β-CD). Most recently, our group developed a cross-linked sorbent known as StyDex monoliths. StyDex monoliths are hierarchically porous materials whose formation is templated using high internal phase emulsions (HIPEs). I will present a scalable, room-temperature–initiated synthesis method, along with its characterization, and PFAS removal performance across various scales.

7 *The impact of doping on the mechanical properties of semiconducting polymers*
Joyce Ampah, she/her

Flexible organic electronics represent one of the rapidly expanding areas of modern materials research. These devices find applications in wearables, soft robotics, and sensors. Organic semiconducting polymers such as diketopyrrolopyrrole-thienothiophene (DPP-TT) and isoindigo-thienothiophene (Isoindigo-TT) have emerged as key materials for flexible and stretchable electronics due to their low cost, solution processability, and mechanical compliance. However, these materials inherently possess low electrical conductivity especially in comparison to their inorganic counterparts, which can limit device efficiency. Molecular doping, the introduction of an electron acceptor or donor molecule to the polymer backbone to increase the density of mobile charge carriers, provides a direct and chemically tunable strategy to enhance charge transport without extensive backbone or sidechain design. Previous studies demonstrated that nitroaromatic dopants such as 9-(dicyanomethylene)2,4,5,7-tetranitrofluorene (DCN-TeNF) can significantly improve charge transport and device performance in thin film transistors. However, excessive doping can also disrupt π-π stacking and reduce mechanical integrity.

This presentation will highlight our recent efforts to probe for the impact of molecular doping on the mechanical properties of DPP and isoindigo-based semiconducting polymers. To advance this objective, we will present a systematic, multi-scale investigation of molecularly doped polymer thin films doped with varying concentrations of DCN-TeNF and characterized using UV-Vis spectroscopy, atomic force microscopy (AFM) and grazing-incidence wide-angle X-ray scattering (GIWAXS). The impact of doping on the mechanical properties of the materials, evaluated using pseudo free-standing film tensile, will also be discussed. Finally, doping-induced variations in charge-carrier mobility under mechanical deformation will also be presented. Together, this study establishes a comprehensive structure-property-performance relationship in DPP-TT and Isoindigo-TT systems.

8 *Flexible and Stretchable CNT-PDMS Strain Sensor for Respiratory Monitoring*
Nisha K C, she/her

Flexible and wearable strain sensors plays crucial roles in health monitoring, as they can maintain their electrical performance while conforming to the body surfaces. Among the plethora of materials and sensors

developed for such applications, flexible sensors based on carbon nanotubes (CNTs) and elastomers are particularly promising due to their good mechanical properties and strong electric response. Specifically, CNTs embedded in Polydimethylsiloxane (PDMS) can form a percolation network which converts mechanical deformation into a measurable electric signal due to variation in conductivity of the carbon-based conductor. Sensors built from CNT embedded in PDMS have also demonstrated high sensitivity and broad detection range suitable for monitoring breath and motion. Previously, our group developed a novel platform to monitor breathing rate by integrating commercial resistive sensor with inertial measurement unit (IMU) data using a sensor fusion technique. While this sensing platform showed strong potential for biophysical metric monitoring, particularly for breathing patterns, the commercial silicon-based sensors used remained challenging to integrate with the human body and lacked the mechanical conformability required to achieve low sensitivity and robustness.

To address these limitations, this research focuses on the development of cost-effective, flexible CNT/PDMS-based piezoresistive strain sensors for real-time monitoring of human breathing patterns. This presentation will highlight key results from this work, with emphasis on the sensor fabrication process and its systematic optimization. Key parameters investigated include substrate thickness, PDMS composition, CNT-poly(3-hexylthiophene) (P3HT) ratio, sensing-layer thickness, and deposition technique. The impact of these variables on device performance, evaluated in terms of sensitivity, response time, and cyclic repeatability, will be discussed, along with demonstrations of the sensors in practical breathing-pattern monitoring scenarios. Overall, this work advances wearable respiratory monitoring by delivering a highly conformable, high-performance CNT-based sensing platform and establishes design principles for next-generation flexible and body-integrated electronic systems.

9 *Engineering polyacrylamide copolymers as less immunogenic alternatives to polyethylene glycol in lipid nanoparticle vaccines*

Priya Ganesh, she/her

Lipid nanoparticles (LNPs) have emerged as promising delivery vehicles for nucleic acid-based therapeutics. Central to many LNP formulations is polyethylene glycol (PEG), a polymer that increases serum circulation time of nanoparticle drug carriers by limiting protein and cellular adsorption, thus improving therapeutic outcomes. Unfortunately, repeated exposure to PEG alongside immunogenic cargo has induced anti-PEG antibodies in many patients, reducing circulation time upon subsequent administration of PEGylated drugs and causing allergy- or hypersensitivity-related side effects in some cases.

In this work, we propose polyacrylamide copolymers as a potential alternative to PEG for LNP-based vaccines. These polymers can be easily synthesized through reversible addition-fragmentation transfer (RAFT) polymerization, a controlled polymerization method particularly suited to synthesizing random copolymers. Because polyacrylamide copolymers have inherent random stereochemistry built into their backbones and because copolymerization of two monomers in random patterns allows for more diversity within the polymer, we hypothesize that polyacrylamides are more resistant to antibody recognition than PEG. After confirming that polyacrylamide copolymers can stabilize LNPs and mitigate complement response similarly to PEG, we evaluate the functionality and immunogenicity of polyacrylamide copolymers in a mouse model, investigate polyacrylamide copolymers as alternatives to PEG in SARS-CoV-2 vaccines, and determine properties of polyacrylamide copolymer-functionalized LNPs in in vitro organoid models of the human immune system. This highly innovative approach directly addresses urgent challenges in immunology and infectious disease.

10 *Self-Driving Lab for Semiconducting Polymer Degradation*

Serena Zuyun Qiu, she/her

Degradable electronics with programmable lifetimes offer a route to next-generation health monitors and environmental sensors that eliminate the need for device retrieval. Imine-based semiconducting polymers are promising candidates because their imine linkages can be incorporated into a thiophene-imine-thiophene (TIT) unit that can undergo acid-triggered hydrolysis while retaining backbone conjugation. In this project, we will design a self-driving lab (SDL) to systematically probe the degradation kinetics of TIT–

indacenodithiophene (IDT) copolymers. Because polymer degradation is difficult to predict, conventional approaches rely on labor-intensive, low-throughput experiments that constrain data collection, reproducibility, and coverage of the relevant chemical space.

We synthesized a library of TIT-based semiconducting polymers with hydrophilic side chains and linear alkyl sidechains or varying lengths to probe how hydrophilicity, aggregation, and planarity influence degradation rates. The degradation of the synthesized semiconducting polymers will be monitored using UV-Vis spectroscopy, where hydrolysis of imine bonds induces a blue-shift as shorter oligomers and monomers are formed. We have developed an automated platform equipped with a robotic arm for essential laboratory tasks, including solution preparation, transferring, mixing, and pipetting, and an integrated UV-Vis spectrometer to monitor polymer degradation. The fully automated workflow consists of preparing polymer solutions, setting up degradation reactions, acquiring and tracking UV-Vis absorbance measurements at set time points, and washing and recycling well plates. Bayesian optimization will be incorporated into the existing automated workflow to establish a full SDL that systematically and autonomously explores a range degradation reaction parameter to identify conditions required to achieve polymer degradation within precise timeframes.

Accelerated degradation studies using the SDL will uncover the relationship between side chain design and degradation kinetics, providing insights guiding the rational design of materials. for programmable transient electronic devices.

11 *Assembly of anionic peptoids via metal ion coordination*
Sonia Mulgund, she/her

While 2D materials like graphene have enabled both observation of novel emergent properties and improved device architectures, there are only a few chemistries that are stable enough to be synthesized and isolated as atomic monolayers. Peptoids (N-substituted glycine polymers) are a structural isomer of peptides whose lack of inherent hydrogen bonding or chirality means that their self-assembly is primarily controlled via side chain design, including into molecularly thin, flat 2D sheets. Peptoid nanosheets are thus a promising route toward solution processing of 2D materials, with varied sequence design enabling diverse functions ranging from protein binding to biomineralization. However, these applications largely take advantage of post-functionalization of the nanosheet surface. Here, we design peptoid nanosheets using metal ion coordination with carboxylate side chains as the driving force for monolayer formation. This new class of peptoid nanosheets can introduce more complex functionality into the nanosheet itself. Hybrid metal-peptoid nanosheets pose an opportunity to access diverse chemistries as 2D materials, providing a pathway toward emergent properties and optoelectronic applications.

12 *Polymerization Solvent Polarity Influences Statistical Copolymer Sequence and Surfactant Behavior*
Anna Makar-Limanov, she/her

Polymeric surfactants are important excipients for stabilizing biotherapeutics. Previous work in our group has identified RAFT-synthesized poly(4-acryloylmorpholine-stat-N-isopropylacrylamide), MoNi, as a versatile excipient for stabilizing biotherapeutic formulations. While copolymer sequence significantly impacts surfactant properties and stabilization performance, the effects of synthesis conditions on sequence distribution remain poorly understood. Using MoNi as a model system, we investigate how polymerization solvent polarity influences copolymer sequence and function. We determine reactivity ratios in different solvents, employ Monte Carlo simulations to model sequence distributions, and correlate these structural differences with dynamic surface tension measurements and insulin stabilization performance. Our work demonstrates that less polar solvents produce copolymers with stronger gradient sequences and enhanced surfactant properties, providing insight into solvent selection for excipient manufacturing.

13 *Strain-Stiffening Bottlebrush Polymer Hydrogels for 3D Cell Culture*
Monica Ohnsorg, she/her

Biomimetic strain-stiffening hydrogels offer a unique synthetic extracellular matrix platform to isolate the impact of hydrogel pore structure, viscoelasticity, and nonlinear elastic behavior on cellular mechanosensing.

Specifically, bottlebrush polymer containing hydrogel networks have been tailored to exhibit nonlinear elastic (strain-stiffening) behavior at critical stresses within the biologically relevant stress regime and support 3D cell encapsulation and culture. Building on this work, a polyethylene glycol-based bottlebrush polymer hydrogel, crosslinked using photo-initiated thiol-ene chemistry, was tuned to closely replicate the modulus and strain-stiffening profile of a collagen type-1 hydrogel network. Because the bottlebrush polymer hydrogels undergo minimal stress-relaxation compared to the collagen type-1 hydrogel, we can then use this synthetic platform to investigate the role strain-stiffening biomechanical feedback in the presence or absence of stress-relaxation during more complex biological processes such as stem cell differentiation.

14 *Creating tunable and processable polyurethanes from polypropylene and bio-derived alcohols*
Mercie Hodges, she/her

With less than 10% of plastics in the USA recycled, mitigating plastic waste is paramount. One method is upcycling waste polyolefins into materials with greater value and longevity. This not only reduces waste, but also conserves virgin feedstocks and, by creating products with increased lifespans, minimizes virgin material consumption. This project seeks to create tunable and reprocessable polyurethane (PU) thermosets from polypropylene (PP) and bio-derived alcohols. PUs are durable materials, commonly used in construction, insulation, and textiles, and are generally synthesized from petroleum feedstocks. Utilizing waste resources to create PUs would therefore reduce this usage of petrochemicals. This research builds on previous work demonstrating PU synthesis from PP that has been commercially grafted with maleic anhydride (PPMA). Amination of the anhydride with ethanolamine generates an alcohol functional group on the polymer (PPOH), which can be crosslinked with a diisocyanate to generate a PU network; the addition of a urethane exchange catalyst makes the materials reprocessable. However, these materials retain a high degree of crystallinity from the parent PP; this work modifies these networks by co-crosslinking PPOH with bio-derived alcohols. The introduction of alcohols disrupts the materials' crystallinity and thereby changes the network properties. Varying the degree of crosslinking, and type and amount of alcohol added, causes tunable shifts in materials properties which can be seen by differential scanning calorimetry, dynamic mechanical analysis, small-angle x-ray scattering, and rheology. Further, the urethane exchange catalyst adds reprocessability, reducing the accumulation of plastic waste.

15 *Radical Deamination of Primary Amines for Initiation of Controlled Polymerization*
Megan Driscoll, she/her

Selectively initiating controlled polymerizations using common functional groups is a powerful route to synthesizing advanced polymer architectures. Amines are one of the most common functional groups in small molecules, pharmaceuticals, and biomolecules, and thus are valuable substituents to use for initiating controlled polymerizations. In this study, we present the facile initiation of a controlled radical polymerization from the α-carbon of a primary amine via an electron donor–acceptor (EDA) complex-triggered radical deamination. Through this method, polymers were successfully grafted from a variety of amino acid derivatives. The resulting polymers had good matching between theoretical and experimental molar masses, narrow molar mass distributions ($Đ \sim 1.1–1.2$), and exceptional α-chain end fidelities. This method was trialed on a model dipeptide, demonstrating the viability of EDA-RAFT in the synthesis of peptide–polymer conjugates.

16 *Initiation of Atom Transfer Radical Polymerization from Redox-Activated Functional Groups*
Izzy McClements, she/her

Initiating controlled radical polymerizations directly from common functional groups is desirable for synthesizing advanced polymer architectures, such as surface grafts and polymer conjugates. Previously, photocontrolled atom transfer radical polymerization (ATRP) has been performed with alkyl halide initiators, limiting its utility in these advanced polymer applications. In this study, we demonstrate the initiation of photo-ATRP directly from the α-carbon of primary amines. We employ an iridium photocatalyst to trigger radical de-amination of redox-activated primary amines, initiating controlled radical polymerization in the presence of an exogenous bromide source under visible light irradiation. The resulting polymers have narrow molar mass distributions ($Đ \sim 1.2$-1.3), good agreement between theoretical and experimental molar masses, exceptionally high α-chain-end fidelities (>99%), and active bromide ω-chain-ends. This study lays the

groundwork for utilizing non-alkyl halide initiators to initiate well-controlled ATRP polymerizations, opening the door for the use of redox-activated functional groups as ATRP initiators for creating advanced polymer architectures.

17 *Grafting Polymer Brushes from Nylon Surfaces via Hydrogen Atom Transfer*
Tyler Ball, she/her

The direct functionalization of nylon surfaces with well-defined polymer brushes would enable access to functional materials for advanced biomedical and industrial applications. To this end, we developed a surface-initiated hydrogen atom transfer reversible addition fragmentation chain transfer (SI HAT-RAFT) polymerization to directly graft from nylon surfaces under mild conditions. Hydrogen abstraction by a triplet-excited thioxanthone catalyst initiates polymer chains, which are capped by a bistrithiocarbonate moiety and shuttled into RAFT polymerization. Our method is amenable to (meth)acrylic and acrylamide monomers and various commercially relevant nylon substrates, and we demonstrate spatial control over the polymerization by patterning nylon surfaces with polymer brushes. Finally, we explored the ability of our method to modify surface properties by measuring water contact angles with select polymer grafts and demonstrate that hydrophilic polymer brush modifications inhibit bovine serum albumin adhesion.

18 *Effect of Counterion Coordination on Hydrazine-Catalyzed Ring Opening Metathesis Polymerization*
Madison Neukirch, she/her

Hydrazine-catalyzed metal-free ring-opening metathesis polymerization MF-ROMP) possesses great potential in synthesizing materials free of metal contaminants, but this thermal polymerization method is currently limited to monomers with ultra-high ring strain. In our efforts to improve this initiation strategy, we observed a rate acceleration in our model cyclobutene polymerization with the addition of a hydrogen bond donor (HBD). We hypothesize that this rate acceleration is due to anion binding by the HBD, creating a looser ion-pair of the cationic chain end and the counterion, thus lowering the lowest unoccupied molecular orbital of the active species. We aim to verify this claim and explore the utility of anion-binding in MF-ROMP reactions with previously unaccessed monomers, lower temperatures, and other catalyst structures

19 *Hydrogen Bond Donor Controlled Stereoselective Cationic Polymerization of 2,3-Dihydrofuran*
Maeve Reilly, she/her

Stereoselective polymerizations offer a method to alter polymer properties by changing the stereochemistry of the polymer backbone. Previously, reports of 2,3-dihydrofuran (DHF), a cyclic vinyl ether, showed that alteration of backbone stereochemistry led to changes in the glass transition temperature and tensile strength. Recently, we developed a method of stereoselective organocatalytic cationic polymerization of DHF through the use of a hydrogen bond donor. Adjustment of hydrogen bond donor identity led to high cis-selectivity in poly(DHF) with increased glass transition temperatures and tensile strength. Additionally, lower molecular weights were needed to reach comparable strengths and toughness as previous reports. Thermal, mechanical, and rheological testing of cis-selective poly(DHF) was conducted to showcase its viability as a competitive, sustainably sourced thermoplastic.

20 *Cyclic Block Copolymers via Living Ring Expansion Metathesis*
Lucy Miller, she/her

Cyclic block copolymers are a unique class of macromolecule due to topology- and microstructure-dependent properties which imbue these polymers with a host of unique capabilities. Ring-Expansion-Metathesis Polymerization (REMP) is a versatile initiator-mediated method to synthesize cyclic polymers, in which macrocyclic Ru-alkylidene or Ru-benzylidene initiators react with cyclic olefin monomers to produce cyclic polymers through a multi-step metathesis mechanism ending in intramolecular metathesis, or backbiting, to release the cyclic polymer. However, complex intermolecular secondary metathesis processes occur ubiquitously throughout REMP and lead to sequence randomization of polymers, preventing a “living” process and the synthesis of cyclic block copolymers. This poster presentation will highlight our efforts to develop a complete mechanistic understanding of REMP with Ru-benzylidene initiator Pyr-CB6, allowing us to modulate the occurrence of intramolecular and intermolecular secondary metathesis through thermal control and inhibition by pyridine. Through kinetic analyses, we demonstrate that REMP with Pyr-CB6 is a living

process, and that backbiting can be controlled through thermal gating. At lower temperatures when backbiting is inoperative, the Ru-alkylidene-containing polymer can be trapped or extended with additional monomer. Subsequently, we develop a process to synthesize cyclic multiblock copolymers via a facile sequential monomer addition, demonstrating the initiator-mediated synthesis of cyclic block copolymers.

21 *Leveraging Forestry Residue Feedstock Selection to Optimize Lignocellulosic Biorefinery Performance*
Alison Shapiro, she/her

Forestry residues are a highly attractive feedstock to produce sustainable bioproducts due to their broad availability at low costs, yet their inherent compositional variability remains a major hurdle to widespread valorization. Understanding the impact of biofeedstock dynamics on biorefinery performance is therefore crucial to inform process decisions, minimize environmental impacts, and improve economic viability for commercial biorefineries. In this study, we performed techno-economic analysis and life-cycle assessment on a model integrated reductive catalytic fractionation (RCF)-molten salt hydrolysis process using a set of forestry residue feedstocks that varied in phenophase, species, and tree part. We demonstrated that phenolic minimum selling prices (MSPs) can be reduced by >7x via biofeedstock selection (i.e., choosing American beech bark in the senescence phenophase vs. American beech twigs in the leafed phenophase) and that just a 20% decrease in RCF reactor pressure could decrease the phenolic MSP by 4x. We also showed that all forestry residues produced net-negative greenhouse gas emissions relative to their petrochemical counterparts, but a further 4x reduction in emissions can be achieved through feedstock optimization. This work highlights both the promise of forestry residues as a profitable and sustainable feedstock and the potential of biofeedstock selection to improve overall biorefinery performance.

22 *Multi-scale Structural Design of Polymers as Ligands for Redox-Active Metals*
Heidi Huynh, she/her

Redox-active metals can transition between multiple oxidation states, making them essential for a variety of material functions, including biochemical sensors, rechargeable batteries, and stimuli-responsive soft materials. These applications often require consideration of additional properties such as solubility, spatial organization, bulk stiffness, and stress relaxation.

Synthetic polymers contain many structural elements that enable the programming of their composition, architecture, and functionality. These include side-chain chemical structure as well as topology, meaning that polymers possess a modular, multi-scale molecular structure. This structure could enable polymers to mimic the molecular-scale functions of current ligand systems, namely, the precise modulation of electrochemical properties and reactivity, while also enabling coupled structural and functional design.

To this end, I will discuss the multi-scale design of polymers to modulate their thermodynamic and kinetic redox behavior.

23 *Lignin-Based Cascade Degradable Linear Polycarbamates*
Chenfangfei Shen, she/her

With emerging developments in organic synthesis reaction and method, polymer synthesis is no longer confined to starting with commercially available monomer. In the past decade, organic self-immolative polymers (SIPs) that degrade via electron cascade upon removal of end cap have been gaining increasing attention. Some classes of SIPs provide enhanced polymer degradability as well as chemical recycling as monomers are regenerated during degradation. However, SIPs still largely rely on commercially available non-renewable starting materials such as petroleum derivatives. This study focuses on incorporating lignin derivatives, vanillin and syringaldehyde, upon chemical transformations, into linear cascade degradable polymers. The synthesis revealed unexpected reactivity difference between vanillin and syringaldehyde. The synthesized self-immolative polycarbamates is composed of alternating units of lignin derivatives and a self-cyclizing linker, N, N'-dimethylethylenediamine. Once the end cap has been removed, the polycarbamates were susceptible to degradation under mild conditions. The degradation behaviors were monitored and quantified via nuclear magnetic resonance spectroscopy analysis. Higher degradation was achieved for the syringaldehyde-based polycarbamate compared to the vanillin-based SIP, possibly due to additional electron

donation effect from the extra methoxy moiety on syringaldehyde. Overall, the results demonstrate the promise of incorporating biobased materials into conventional SIPs through organic synthesis.

24 *Formulation and 3D Printing of PVDF-Containing Photocurable Resins for Digital Light Processing*
Megan Mcgeehan, she/her

Poly(vinylidene fluoride) (PVDF) exhibits strong piezoelectric activity in its β phase; however, its limited solubility and susceptibility to processing-induced phase transformations hinder compatibility with widely used extrusion-based Additive Manufacturing (AM) techniques. As a result, controlling crystalline phase distribution during fabrication remains a key challenge for preserving electroactive functionality. The objective of this work is to develop an AM strategy that enables the fabrication of PVDF-based materials while preserving and tuning their crystalline phases under mild processing conditions. The influence of resin composition and processing parameters on phase stability is investigated, demonstrating that DLP enables the fabrication of high-resolution architectures without inducing phase degradation. In addition, pre-printing and post-printing treatments, including solvent precipitation and thermal annealing of the printed composites, are employed to deliberately tune PVDF crystallinity.

25 *The Staudinger-Bertozzi Ligation for Post-Polymerization Modification of Conjugated Polymers*
Nicole Amborski, she/her

Post-polymerization modification (PPM) is the chemical modification of a polymer after polymerization and results in the changing of its molecular structure. PPM allows synthesis of polymers that are not readily available from their monomeric forms and allows for library syntheses of various related polymers from a common precursor. Typically, this is done by introducing a reactive functional group to the monomer that does not react under the polymerization conditions, but rather in some subsequent reaction. This project aims to use the traceless Staudinger-Bertozzi ligation as a PPM to introduce new side-chain functionality to a polyfluorene-based conjugated polymer (CP). The Staudinger-Bertozzi ligation is a useful tool because it is biocompatible, high-yielding, selective, and has a high functional group tolerance, allowing for a wide variety of modifications to the precursor polymer. In this project, ester derivatives of 2-(diphenylphosphaneyl)phenol (DP3) were reacted with polyfluorene-azide (PF-N3), forming an amide bond and releasing nitrogen gas along with the resulting phosphine oxide as a byproduct. The ligation was first tested using benzyl azide, to allow for facile determination of the ligation kinetics on a small molecule scale. The ligation was successful as determined by TLC and 1H NMR using the octyl and benzyl esters of DP3, after 24 hours at 40 °C with TEMPO included as an oxygen scavenger to mitigate oxidation of the phosphine starting material, producing the corresponding amides. Further optimization is under way to decrease the formation of unwanted byproducts, as well as extend this system to other DP3 derivatives. The ligation was also successful on the polymer scale with PF-N3, after 24 hours at 55 °C. I also aim to make functionalized single-walled carbon nanotube (SWNT) dispersions with PF-N3 and perform the ligation on the PF-N3-SWNT complexes, which opens the door to device fabrication using SWNTs. This poster will highlight the versatility and robustness of the Staudinger-Bertozzi ligation as a PPM and compare it to currently used PPM reactions.

26 *Symmetry-Dependent Quadrupolar Aromatic Interactions Drive Optoelectronic Activity in Peptide Coassemblies*
Sheng Wei Tang, she/her

This work investigates symmetry-dependent quadrupolar aromatic interactions as a molecular knob for manipulating π-electron unit organization within biomolecular assemblies. Complementarity of aromatic rings with reversed quadrupoles was conferred between peptide-flanked quaterthiophene (4T, donor) and perylene diimide (PDI, acceptor) by installing either phenylalanine (F) or pentafluorophenylalanine (F5) residues. We systematically investigate how the presentation of quadrupolar aromatic pairs affects the optoelectronic properties of peptidic materials. In parallel, molecular simulations of coassembled structures were conducted to gather insights into the structural properties of the optoelectronic peptides here. Our experimental findings and molecular simulations together highlight the importance of F5/ F + F5 interactions and asymmetric supramolecular unit presentation in increasing the propensity for co-linear stacking of coassembled π-units, in which peptides are likely to arrange in an in-register fashion. The symmetric designs, where peptide motifs have a tendency to coassemble with registry shift, demonstrate more dynamic

structural and photophysical property changes than the asymmetric designs when subjected to thermal annealing. Improved photocurrent generation is observed in asymmetric coassembled peptides in film samples, especially when complementary F+F5 interactions are present. Overall, we demonstrate the utility of quadrupolar complementarity in peptides to template the discrete assembly states and bulk properties of water-processable bioelectronic systems.

27 *Investigating Structure-Property Relationships of Poly(Ionic Liquids) for Gating Materials in OTFTs*
Vittoria-Ann DiPalo, she/her

Poly(ionic liquids) (PILs) are attractive dielectric materials for low-power organic thin-film transistors due to their high capacitance, printing compatibility, and recyclability capabilities. Molecular structure of PILs heavily influence their performance in an OTFT, making their chemical tunability a major advantage for dielectric material development. PILs can be synthesized using various monomers, polymer architectures, functionalization groups, crosslinking agents, and counter ions to impart changes in thermal, mechanical, and electronic properties.

This research looks to determine how polymer structure influences capacitance, ionic conductivity, polarization rates, and overall dielectric performance when integrated into organic thin-film transistors (OTFTs). Identifying these structure-property relationships will help optimize the balance between high capacitance and insulating properties when developing PILs for OTFT applications. This work encompasses all steps of material development from synthetic procedure, material characterization, and device integration, to create and expand a dataset relating specific polymer structures to device performance. Subsequently, OTFTs fabricated with the different PIL materials will be used to assess interfacial quality and electron mobility in regard to PIL gating materials. Together, these studies will provide a comprehensive understanding of structure–property relationships in PIL dielectrics and demonstrate their utility for making high-performing OTFTs.

28 *High-throughput synthesis of ABA triblock copolymers via photoiniferter polymerization*
Patricia Calvo, she/her

Hierarchically structured polymer materials are increasingly important for biomaterials, tissue engineering, and soft functional materials, where multiscale organization can impart properties not accessible in conventional polymer networks. Amphiphilic ABA triblock copolymers are particularly attractive building blocks for such systems because they self-assemble into micelles, gels, and other architectures that serve as precursors to hierarchically ordered hydrogels. Our work focuses on developing efficient synthetic strategies to access well-defined ABA triblock copolymers using bifunctional RAFT chain transfer agents and photoiniferter polymerization. A direct comparison of conventional thermal RAFT and photoiniferter polymerization reveals that photoiniferter conditions significantly improve end-group retention, reduce dispersity, and enable the synthesis of higher molecular weight polymers—features critical for efficient triblock chain extension. These methods support a broad monomer scope, including styrenics, acrylates, and acrylamides, enabling access to triblock copolymers with diverse hydrophobic and hydrophilic chemistries. Two complementary synthetic approaches are employed: one constructs the central block first followed by simultaneous growth of the outer blocks, while the other proceeds in reverse by synthesizing the outer blocks prior to middle-block chain extension. Integration of these strategies with high-throughput robotic polymerization enables rapid generation of triblock copolymer libraries for the discovery of hierarchically structured hydrogels and functional biomaterials.

29 *Single-Resin Fluorescent Photopatterning from Thin Films and Aqueous Polymer Dots*
Yimin Zeng, she/her

Microscale photopatterning of fluorescent materials is essential to technologies such as optoelectronics, sensor arrays, and bioimaging. However, most existing methods depend on complex multicomponent and non-aqueous resins. In this poster, I will present a single-resin approach based on only two materials: an aminated polydimethylsiloxane (PDMS-NH2) and a conjugated semiconducting polymer. In this system, the semiconducting polymer serves both as the fluorescent emitter and as a singlet-oxygen photosensitizer, enabling light-induced crosslinking of the polymer matrix. Microscale fluorescent patterns can be produced

from spin-coated thin films, as well as directly from aqueous solutions using nanoscale polymer dots (Pdots). To our knowledge, this is the first example of fluorescent photopatterning using Pdots, providing a greener and more versatile route to luminescent materials for imaging and sensing applications.

30 *End-Functionalizing Cellulose Nanocrystals to Direct Interfacial Interactions in Biology*
Garima Sharma, she/her

In drug delivery, elongated systems often exhibit distinct cellular uptake, circulation and interfacial interactions compared to spherical nanoparticles, yet the roles of particle shape and spatial organization of surface chemistry remains poorly understood. Cellulose nanocrystals (CNCs) are highly crystalline, rod-like nanoparticles derived from renewable cellulose sources and have attracted interest for biological and interfacial applications as sustainable alternatives to synthetic nanocarriers. Their crystalline structure allows selective chemical modification at one end of the particle, while maintaining a highly reactive surface that can be further functionalized, making CNCs an effective model system for studying shape- and chemistry-dependent interactions. In this work, we develop a synthetic platform that allows independent chemical modification of the CNC surface and reducing end. CNCs were isolated to ensure reproducible material properties, after which a protection-deprotection strategy was developed to selectively convert the reducing-end aldehyde into a primary amine. Successful end-group modification was confirmed via fluorescein isothiocyanate (FITC) labelling. In parallel, poly (oligo (ethylene glycol) methacrylate) (POEGMA) was synthesized using atom transfer radical polymerization and applied as a stealth polymer for CNC surface modification to reduce non-specific protein adsorption and enhance colloidal stability in biological environments. Together, these steps yield CNCs bearing a protected or functionalized end group alongside a chemically tuneable surface. As this project progresses, the end-functionalized CNCs will be used to selectively conjugate transferrin at the particle tip while maintaining a stealth-coated surface, enabling direct comparison of end- and surface-modified CNCs. This platform provides a versatile and sustainable framework for probing how spatial control of surface chemistry on rod-like nanoparticles governs interfacial behaviour and cellular interactions.

31 *Polymer biosensors for monitoring reactive oxygen species in disease*
Lucia Huang, she/her

Reactive oxygen species (ROS) levels become elevated at diseased sites (e.g. cancer, infection, and inflammation), making ROS insightful biomarkers for health monitoring and diagnostics. However, due to their short-lived and labile nature, ROS biosensors require modular material designs that enable localized residence at diseased sites and transduction of transient ROS signals into stable, detectable readouts under physiological conditions. To address this challenge, we developed a class of ROS-responsive polymer probes that transition from colourless to fluorescent in the presence of ROS, providing an optical readout for easy detection and a flexible platform to readily tune sensitivity, stability, and biocompatibility. We synthesized a library of polymers with ROS-responsive fluorescence and versatile materials properties (e.g. hydrophilicity, charge, etc.) by copolymerizing our ROS-responsive dye monomer with other vinyl monomers through radical polymerization. These ROS-responsive copolymers respond at physiologically relevant ROS levels and timescales (100% signal intensity after 1 hour exposure to 1 mM H2O2) and generate concentration-dependent fluorescence with sensitivity down to 10 μM H2O2. To demonstrate the biosensing potential of this ROS-responsive polymer platform, we used these polymers to develop an ingestible biosensor that monitors gastrointestinal inflammation in inflammatory bowel disease (IBD) through stool colour. After ingestion, rats with colitis excreted visibly fluorescent stool, indicating the presence of inflammation. Image analysis of the stool samples revealed that fluorescence intensity was correlated with lipocalin-2 levels, a protein biomarker of inflammation. Overall, this work establishes a platform to access highly designable ROS-responsive polymers for improved inflammation monitoring in IBD, with broader application in health monitoring and beyond.

32 *Precision photopatterning via wavelength- and intensity-gated poly(p-phenylene vinylene) photoisomerization*
Mary Yenca, she/her

The development of photopatternable organic semiconductors with tunable, stimuli-selective optoelectronic properties is central to advancing next-generation electronic devices. However, current photopatterning

approaches are challenged by complex multicomponent formulations and limited resolution. Moreover, achieving selective access to multiple solid-state emissive states under discrete stimuli remains a significant challenge. Herein, we address these limitations with the introduction of a divergent synthetic platform combined with stereoretentive ring-opening metathesis polymerization (ROMP) to access well-defined arylated poly(p-phenylene vinylene)s (PPVs) with living characteristics and precise structural control. Through this systematic functionalization, the photoreactivity of these materials is extended into the visible region, enabling wavelength-selective photoisomerization in solution and intensity-dependent responses in the solid state. This unprecedented photoreactivity can be harnessed to access to stereoblock copolymers with controlled architectures. Finally, we demonstrate that these materials enable multi-emissive photopatterning with high spatial resolution, where emission profiles are tunable through modulation of block composition and olefin geometry in conjunction with light intensity, providing a versatile platform for advanced optoelectronic applications.

33 *Conjugated Poly(tetrazine) Decorated with Azido-alkyl Groups Enables Orthogonal Sidechain and Backbone Modification while Dispersing Carbon Nanotubes*

Tate Mazurkewich, she/her

Single walled carbon nanotubes (SWNTs) have gained a large amount of interest as they possess excellent electrical properties, mechanical strength and have a high surface area for functionalization. They currently have applications such as thin film transistors, sensors, and optoelectronic devices.1 Challenges in processing SWNTs lie in their lack of solubility and electronic purity—as they inherently are a mixture of semi-conducting (sc) or metallic (m) species.2 Dispersion of SWNTs and sorting according to electronic properties has been done by non-covalent and covalent functionalizing of the surface. Non-covalent methods are advantageous as they preserve nanotube structure. Conjugated polymers have been shown to be effective in selectively interacting with sc-SWNTs, while enabling further functionalization of the resulting complex.3 Previous work has demonstrated the dispersion efficacy of poly(fluorene) and the ability to derivatize the resulting complex using strain promoted azide alkyne cycloaddition chemistry (SPAAC) on sidechains post-polymerization.4 In addition, we have recently demonstrated that poly(tetrazines) can be derivatized along their backbones via inverse electron demand Diels-Alder (IEDDA) chemistry.5 However, there are no examples demonstrating the ability to modify both sidechains and the backbone of a single polymer, while on the nanotube surface. This presentation will introduce a polymer that can be modified along its backbone and on its sidechains through orthogonal SPAAC and IEDDA chemistry, introducing unprecedented chemical versatility to the polymer-SWNT complex.

34 *Dendritic Light Harvesting System for Energy Transfer to Single-Walled Carbon Nanotubes*

Emma Hämäläinen, she/her

Semiconducting SWNTs (sc-SWNTs) are carbon-based nanomaterials that exhibit fluorescence in the near-infrared (NIR) region, which is advantageous for bioimaging applications. However, a major issue in utilizing SWNTs in bioimaging is their low quantum yield, resulting in weak NIR emission. To address this, the present study proposes a novel supramolecular assembly for efficient light energy harvesting and energy transfer via Förster resonance energy transfer (FRET) for the enhancement of NIR emission. The assembly consists of a dendritic antenna system wrapped around sc-SWNTs. The periphery of the dendritic antenna is decorated with chromophores that act as initial donors, where from the energy is funneled to the polyfluorene acceptor, followed by energy transfer to the SWNTs.

Synthetic work involves preparation of polyester dendrons of different generations that are peripherally functionalized with coumarins. The dendron core is functionalized with dibenzocyclooctyne (DBCO), which allows for click-chemistry reaction with the azide-functionalized polyfluorene. Finally, the dendritic structures are wrapped around SWNTs. Characterization techniques involved are NMR, MS and spectroscopic methods such as absorption and fluorescence spectroscopy. The aims are to investigate the differences that varying dendron generation bring forth in terms of light energy harvesting and energy transfer, as well as enhancement of the SWNT emission in the NIR.

35 *Engineering a Hyaluronan-based Bioink for 3D Bioprinting of Cardiac Tissues*

Shumaim Barooj, she/her

Background: Three-dimensional (3D) bioprinting enables fabrication of cell-laden constructs that better mimic native tissue than 2D culture, especially for human pluripotent stem cell–derived cardiomyocytes (hPSC-CMs). However, many bioinks struggle to balance print fidelity with cytocompatibility. Here, I engineer a hyaluronan (HA)-based bioink using oxime click chemistry to support high-resolution printing and stem cell function.
Methodology: HA was modified with aldehyde groups and characterized by ^{1}H NMR and gel permeation chromatography. Bioprinting was performed using a FRESH support bath, with crosslinker in the bath and cells mixed into the polymer phase. The bioink encapsulated hPSC-CMs with cardiac fibroblasts. Viability was assessed via LIVE/DEAD staining, and function via calcium transient imaging and electrical stimulation.
Results: The optimized HA bioink showed shear-thinning behavior, rapid gelation, and minimal swelling. Printed constructs maintained shape integrity for 28 days with high cell viability. Near-instant gelation enabled precise layer-by-layer printing, achieving a printing ratio of 1.1.
Significance: Our innovative HA-based bioink, crosslinked via oxime chemistry, enables the fabrication of robust 3D constructs with mechanical properties suitable for bioprinting while sustaining viable cells. The success of this system highlights its potential applicability to other tissue systems, broadening its impact in the field of tissue-engineered biomaterials.

36 *Design and Synthesis of Chemically Recyclable Polyolefin-Like Materials*
Isabella Vettese, she/her | they/them

The accumulation of single-use plastics waste is one of the most pressing pollution challenges today. To address this growing crisis, it is necessary to develop new materials with sustainability and recyclability in mind. Chemical recycling offers an attractive solution to the plastic waste problem; however, a large fraction of plastics used today are polyolefins that are challenging to fully chemically recycle. To overcome these limitations, polyolefin-like materials were designed with cleavable functional groups interspersed along the backbone. A tandem ring-opening metathesis polymerization (ROMP)-hydrogenation method was employed to synthesize polyethylene-like telechelic diol macromonomers of controlled molecular weights (3, 5, 10, 15 kDa), and these macrodiols then were further polymerized with difunctional companion monomers to form hydrolytically stable, polyethylene-like polymers. The thermal characteristics of these polymers were characterized using differential scanning calorimetry, and their mechanical properties were explored using rheology and tensile testing. Molecular modelling simulations were also conducted to elucidate the hydrogen bonding and crystallization behavior of these polymers. Finally, it was shown that these polymers could be readily depolymerized using established chemistries, and the recovered macromonomers subsequently could be repolymerized to prepare second-generation polymers with properties comparable to the virgin materials. Overall, the structure-property relationships of these more sustainable, polyethylene-like polymers were systematically explored, and the inclusion of cleavable moieties within the polymer backbone vastly improved the susceptibility of these novel materials to existing chemical recycling strategies. Thus, the framework established through this work can inform the development of a more circular plastics economy, particularly for difficult-to-recycle polyolefins.

37 *Actin-mimetic cellulose nanocrystal and carboxymethyl chitosan hydrogels with trainable mechanical properties*
Kaitlin Landy, she/her

In nature, actin proteins polymerize to form cytoskeleton filaments, which are further crosslinked into networks that continuously adapt to stimuli and enable the robust mechanical properties of cells. Mechanical properties of actin networks can be systematically altered via mechanical training processes in which shear training stresses induce bundling of the filaments, ultimately increasing network stiffness. In this work, actin-mimetic hydrogels were designed using a model system of highly abundant biopolymers to elucidate which viscoelastic parameters enable mechanical training. Hydrogels comprised of a semiflexible o-carboxymethyl chitosan matrix and rigid, rod-shaped cellulose nanocrystals were synthesized and characterized via rheology. The role of hydrogel composition and training stress magnitude were investigated, and an additional dynamic covalent crosslinker, dibenzaldehyde-terminated telechelic poly(ethylene glycol), was introduced to further enhance the response to training. Polarized optical microscopy before and after training reveals the

emergence of birefringence in trained gels, supporting the hypothesis of cellulose nanocrystal alignment as the mechanism of stiffening during training. Overall, this work enhances our fundamental understanding of mechanical training in soft materials and can inform the design of artificial muscle-like materials in the future.

38 *A Customizable Antibody Delivery Strategy Using Fc-affinity Ligands*

Noor Bahsoun, she/her

Therapeutic antibodies for degenerative retinal diseases require frequent intravitreal injections, increasing patient burden and procedural risk. Sustained delivery systems could reduce injection frequency while preserving efficacy, yet achieving tunable, controlled release of intact biologics remains a key challenge. To address this, we developed a hyaluronan (HA)-based hydrogel platform functionalized with Fc-binding peptide ligands designed to control the release of human IgG1 antibodies. Two ligands with distinct binding affinities were synthesized via solid-phase peptide synthesis and characterized by biolayer interferometry. Molecular docking complemented these measurements by modeling ligand-Fc interactions and contextualizing observed affinity differences. Ligands were then conjugated to HA via inverse electron-demand Diels-Alder chemistry and crosslinked through oxime chemistry to form injectable hydrogels. Bevacizumab served as the model antibody, with release kinetics quantified by ELISA.

The two ligands exhibited distinct Fc-binding affinities, producing measurably different release profiles from crosslinked HA hydrogels. These affinity differences altered antibody mobility within the network, directly influencing diffusivity and retention behavior.

Together, these results demonstrate that Fc-binding ligands embedded in HA hydrogels enable tunable antibody release without modifying the therapeutic protein, offering a broadly applicable platform for extended ocular delivery of Fc-containing biologics.

39 *Manipulating semicrystallinity in dynamic, pluripotent networks*

Camaryn Bennett, they/them

Pluripotent materials can access a variety of states from a single feedstock. Pluripotent synthetic materials have been achieved in thia-Michael based dynamic networks via tempering. In a typical tempering process, the percentage of thia-Michael bonds can be systematically altered depending on tempering temperature, which is subsequently lock in during quenching. In this work, the goal was to explore the addition of semi-crystalline polymeric crosslinkers to access dynamic semi-crystallinity networks to examine how the addition of crystallinity impacts the tempering and mechanical properties of these materials.

40 *Bio-derived, amphiphobic coatings for a circular economy*

Liat Kugelmass, she/her

Every disposable paper cup is coated. Paper, an inherently hydro- and oleophilic material, requires a coating to achieve desired water and oil barrier properties. Because commercial coatings rely on fossil-derived polymers (e.g., polyethylene), the end-of-life options for the composite are often restricted to non-circular options (i.e., landfill or incineration). In response to evolving regulations, particularly for single-use packaging, bio-derived polymers and materials have emerged as more sustainable coating alternatives. DNA stands out as an attractive bio-polymer for coatings due to availability from food and agricultural biomass wastes, though it suffers from inherent amphiphilicity and instability. Resolving these pitfalls, we present the novel utility of DNA-cationic lipid self-assemblies as green, circular coatings, finding unrecognized application of a decades old interaction best known for DNA extraction. Coatings based on DNA-cationic lipids result in a material system following green chemistry and engineering principles (e.g., non-hazardous synthesis, energy efficient, excellent atom economy, easy separation, green solvent compatibility, etc.). Coating performance is tunable by varying the cationic lipid structure, yielding hydrophobic and oleophobic properties measured by standardized and industry-accepted methods. Moreover, we demonstrate the coating is recoverable and closed-loop recyclable by multiple methods (i.e., dissolution or salt-triggered dissociation), enabling reuse of both the coating and cellulose material. Ultimately, we demonstrate how the design of bio-macromolecular systems can simultaneously support the circular economies of emerging bio-polymers and commodity materials.

41 *Sugars to Structures: Synthesis and Solution Assembly of Cellulose Oligomer-Based Block Copolymers*
Claire Hendrikx, she/her

Cellulose is the most abundant renewable polymer, and cellulose oligosaccharides (COs, i.e., short cellulose fragments) retain the stereoregularity and strong hydrogen-bonding interactions of native cellulose while exhibiting selective solubility under mild aqueous conditions. These features allow COs to assemble into ordered, crystalline carbohydrate structures. However, the conditions which govern these well-defined CO assemblies remain poorly understood, and establishing these relationships is essential for developing predictable, biodegradable carbohydrate-based materials. Crystallization driven self-assembly (CDSA) is a powerful method for producing uniform nanostructures from block copolymers and provides a compelling framework for directing CO-based assembly. In this work, we establish the foundational synthetic platform required to apply CDSA principles to CO-containing systems. Using CO-b-poly(oligo(ethylene glycol) methacrylate) (POEGMA) as a model system, we first generate CO fragments of uniform length via top-down sulfuric-acid hydrolysis of microcrystalline cellulose. From here, the COs are site specifically end-functionalized with an alkyne group and coupled to azide-terminated POEGMA using copper-catalyzed click chemistry. These block copolymer unimers are also characterized to confirm structure and composition. This presentation highlights the first step enroute to elucidating structure-assembly relationships in CO-based block copolymers. By establishing well-defined, renewable building blocks, this work lays the groundwork for future studies of carbohydrate-driven self-assembly and the rational design of cellulose-based materials with predictable, tunable properties. Ultimately, this research provides a green pathway for expanding the functionality of renewable polymers, supporting the growth of a circular bio-economy through predictable and tunable material design.

42 *Investigating the role of electrochemical mediators in redox-active disulfide materials*
Athena Christodoulou, she/her

Electroactive materials, which display changes in mechanical or functional properties in response to electricity, are a promising innovation for applications ranging from drug release devices to impact mitigation. Incorporating stimulus-responsive bonds into a polymeric network provides a design route to such materials, as the resulting network's crosslink density, and thus, properties, can be controlled via external stimuli. Disulfide bonds have been extensively explored in enabling heat-, light-, and chemically- responsive property changes in polymers, but their use in electrochemically controlled systems has been limited due to their intrinsically sluggish redox kinetics. This work explores the use of electrochemical mediators as electron shuttles to improve disulfide redox kinetics and efficiency, with the goal of accessing redox-active disulfide-based materials. Cyclic voltammetry studies are used to screen candidate mediator species and experimental parameters to optimize the mediated reduction of disulfide molecules and validate the mediation mechanism using the electrocatalytic kinetic zone diagram. Polymer particles containing these disulfide moieties are then synthesized and their interaction with the corresponding mediator is studied to evaluate the use of electrochemical mediation in facilitating the redox response of functional polymer networks. Overall, this work establishes a mechanistic understanding of electrochemically mediated disulfide reduction and implements this process in disulfide polymer particles, expanding the scope of feasible chemistries for redox-active polymeric systems with implications in energy storage and electroactive materials.

43 *Initiator-Free Photopolymerization of Alpha-Lipoic Acid: Toward Single-Component Photocurable Polymer Networks*
Hailey Duggan, she/her

Crosslinked polymer networks cured through photo-initiated polymerization are widely used in applications ranging from packaging to biomedical surfaces and cosmetics due to their rapid processing and scalability. However, conventional systems rely on photoinitiators and multifunctional acrylate chemistries, which compromises biocompatibility, limits recyclability, and relies on fossil fuel derived volatile monomers. Consequently, there is a growing interest in initiator-free and more sustainable photopolymerization strategies that enable tunable material properties while simplifying formulation. In this work, alpha-lipoic acid (LA) is explored as a versatile building block for the development of single-component, bioderived, photo-

curable polymer coatings. Its five-membered disulfide ring exhibits intrinsic photoactivity and can undergo ring-opening polymerization under ultraviolet (UV) irradiation, enabling initiator-free network formation. Two complementary material design strategies are investigated. In the first, a library of crosslinker and monomer derivatives of LA are used to prepare photo-cured coatings with tunable properties. In the second, thiol-ene "click" chemistry is incorporated into LA-based derivatives to eliminate the need for crosslinkers, enabling self-polymerizable networks composed entirely of one functional monomer. The curing kinetics, thermal properties, mechanical properties, and surface wettability of the coatings can be modulated through adjusting the coating composition. Furthermore, the presence of disulfide linkages enables the controlled chemical deconstruction of the network, providing a pathway for end-of-life material management. Collectively, this work establishes alpha-lipoic acid as a multifunctional, bioderived monomer platform for the design of initiator-free UV-curable polymer networks, offering a sustainable alternative to conventional acrylate-based coating systems.

44 *Redox-active phthalimide copolymers as anodic materials for all-organic batteries*

Sheila Keating, she/her

Current state-of-the-art energy storage devices rely on geographically limited, critical raw materials like lithium and cobalt. Carbon-based, all-organic polymeric batteries as alternative energy storage devices enable critical metal-free energy storage by sourcing their electrode components from more earth-abundant elements. However, there are a number of challenges that need to be met before widespread use, a major target being increased cell energy density (voltage and charge capacity). In this work we aim to increase cell voltage by developing low reduction potential non-conjugated polymer anodes. Specifically, we use the phthalimide-based redox active moiety as the voltage-determining redox motif (-1.8 V vs Ag/Ag+) and explore a series of side-chain functionalized polymers with different phthalimide-based pendants. We then synthesize crosslinked polymer electrodes and study their electrochemical performance using cyclic voltammetry and three-probe galvanostatic charge-discharge in a variety of electrolytes. We see through structural changes in our redox motif we can enhance stability, charge accessibility, and therefore energy density.

45 *Study of Poly(dimethylsiloxane) Crosslinking: A Thermal, Mechanical and Spectroscopic Characterization Approach*

Audrey Villeneuve, she/her | they/them

The shaping of polymers through 3D printing involves significant trial and error. It is therefore essential to study the physicochemical properties of printable polymers in order to identify optimal printing parameters and to reduce material waste and processing time. In this work, direct ink writing (DIW) is the preferred method for printing poly(dimethylsiloxane) (PDMS). PDMS is a polymer whose solidification depends on chemical crosslinking of prepolymers, a process that can be modulated by temperature. The primary objective of this project is to study the kinetics of PDMS crosslinking in the context of 3D printing using rheology, infrared spectroscopy and differential scanning calorimetry (DSC). Once the printing parameters are determined, it will be possible to add compounds/particles into the polymer matrix to obtain functionalized 3D printed objects (ex: silver nanoparticles for flexible electronic).

46 *Advanced chemistries for membrane materials*

Keanna Yu, she/her; Allison Suichies, she/her

Membranes are central to addressing global challenges in water scarcity, resource recovery, and sustainable chemical separations. The Advanced Membranes Lab at the University of Toronto develops novel membrane materials by integrating polymer chemistry, nanostructured design, and data-driven discovery. Through tuning chemical composition and architecture via different techniques of synthesis and fabrication, molecular transport and selectivity can be tailored to specific applications.

Recent publications highlight innovations in ultra-thin polymeric selective layers, including interfacially polymerized nanofilms and sulfonated polyamide composites with high charge density, enabling improved ion selectivity and permeability. Novel chemistries such as thiol–ene photopolymerization introduce tunable functional groups for highly selective ion-exchange membranes.

The lab pioneers “solid carrier-based membranes”, a material that embeds chelating agents used in solvent extraction within polymers to achieve orders-of-magnitude improvements in ion selectivity for separation of similar physicochemical properties like Co/Ni and Cu/Ni.

The lab extends the range of traditional reverse osmosis (RO) to the treatment of high-salinity brines via the development of enhanced RO membranes. The use of novel polymers allows for compaction-resistant, highly water-permeable membranes with high salt rejection. The adoption of a self-driving laboratory project aims to combine robotics and machine learning to accelerate membrane testing, discovery, and optimization.

47 *Development of a Green & Less Corrosive Anti-Dust Coating*
Yalda Chehrehsaz, she/her

Dust accumulation poses significant challenges in industries such as wood sawmills and solar energy, causing safety hazards, equipment failure, and increased maintenance costs. Existing anti-dust coatings often rely on corrosive or toxic chemicals and may lack durability or sustainability. This research presents an eco-friendly formulation for durable, less corrosive dust-repellent coatings that reduce dust adhesion and facilitate removal. The coating uses a sol–gel silica network derived from tetraethyl orthosilicate (TEOS), where citric acid replaces hydrochloric acid as the catalyst. This substitution increases solution pH, reducing corrosion on metallic substrates and improving environmental safety. Citric acid also promotes crosslinking within the silica network, producing a denser and harder film. Surface energy is further reduced using fluorine-free long alkyl chains to investigate their impact on dust removal performance, which was evaluated using tilting angle measurements at which dust layer was removed from the surface. The resulting coatings exhibit lower surface energy, enhanced hydrophobicity, increased hardness, and improved dust removal performance.

48 *NaCl Residue Accumulation on Non-wetting Micropillar Surfaces*
Fariba Vaez Ghasemi, she/her

Superhydrophobic and super-liquid-repellent surfaces have attracted significant attention for applications requiring self-cleaning, anti-fouling, and corrosion resistance. By combining hierarchical micro-/nano-scale roughness with low-surface-energy chemistries, these surfaces promote droplet mobility and limit sustained liquid–solid contact, making them attractive for marine infrastructure, solar panels, and heat-exchange systems. However, macroscopic water repellency does not necessarily imply complete liquid removal at the microscale.

However, the apparent perfection of these surfaces at the macroscopic scale conceals a more complex microscopic reality. Recent studies have shown that even when droplets roll off completely, small liquid residues can remain on the surface texture. These microscopic residues typically arise from capillary bridge rupture and variations in the local receding contact angle during droplet motion, challenging the conventional notion of a truly self-cleaning surface. While such residues are typically transient for pure water, saline droplets introduce an additional challenge: evaporation leaves behind salt crystals that can persist on the surface. Under realistic marine or coastal conditions, these deposits can absorb atmospheric moisture, sustain localized wetting, and act as initiation sites for corrosion, potentially undermining the long-term protective performance of superhydrophobic coatings.

In this work, we investigate the formation, accumulation, and evolution of NaCl residues arising from repeated saline droplet deposition on microstructured superhydrophobic surfaces. Using doubly re-entrant micropillar (DRP) arrays, we examine the role of surface geometry, surface chemistry (uncoated versus PDMS brush-coated), and droplet dynamics in controlling residue localization and salt crystal buildup over successive exposure cycles. Our results show that residue accumulation is highly localized at pillar edges and is strongly influenced by surface chemistry, with coated structures exhibiting reduced residue retention and delayed crystallization. Electrochemical measurements further indicate that crystallization-induced wetting transitions can promote localized corrosion activity, highlighting the limitations of relying solely on macroscopic repellency as a metric for corrosion protection.

49 *Waste Not, Want Not: Using Waste to Displace Petroleum-Based Polymers*
Flora Mei, she/her

Polyurethanes (PU) are polymers that are widely used for both structural and non-structural applications. However, they can suffer from issues such as foaming, leading to reduced mechanical strength, and high cost. They are non-renewable, petroleum-derived polymers. Fillers are often used to enhance properties and reduce cost. We were interested in enhancing sustainability by utilizing fillers derived from post-consumer waste that is diverted from landfill. Ground glass particles (GGP, < 4 microns) were produced from Blue Box waste in a large ball mill (by Opta Glass, Waterdown ON). The high surface energy glass neither properly dispersed in commercial polyurethanes nor enhanced PU physical properties. Better success was achieved by surface modifying the glass with silane coupling agents, particularly APTES (3-aminopropyltriethoxysilane) that rendered the glass surface coated with aminoalkyl groups (GGP-a). Strips of polyurethane containing varying mass ratios of filler were made and characterized by their tensile strength, with reduced foaming in the PU when GGP-a was used as the filler. While unmodified GGP allowed the PU to be displaced without affecting the tensile strength of the elastomer, modified GGP-a showed an increase in tensile strength performance. We will examine the range of physical properties that can be attained by the use of these fillers and discuss the benefits in sustainability that result.

50 *A Model System for Probing How Polymer Thermal Properties Influence Microplastic Formation and Behavior*
Aisha Biobaku, she/her

Millions of tonnes of plastic waste are generated across Canada each year, with only a small fraction effectively recycled, contributing to growing landfills and environmental contamination. As plastics break down over time, they degrade into microplastics and nanoplastics, which pose a unique threat due to their extremely small size. These particles can spread easily through water, soil, and air, and can even cross biological barriers, posing a threat to ecosystems across the globe. These plastics can also enter the food chain through sources such as fish and untreated drinking water, raising serious concerns for both environmental and human health. Due to the problems posed by microplastics and nanoplastic, there is an immediate need to study the behavior of these particles and how they persist in the environment. An area that remains under-investigated is the relationship between the glass transition temperatures of common polymers and polymer blends and the properties and behaviour of the micro and nano plastics they generate. Here, I will present a model system for studying the relationship between glass transition temperature and microplastics properties. In this study, we prepare methacrylate plastics with systematically varied glass transition temperatures. This is achieved by preparing a series of copolymers of polymethyl methacrylate (high T_g) and polybutyl methacrylate (low T_g). The composition and molecular weight of synthesized polymers is characterized by Nuclear Magnetic Resonance Spectroscopy and gel permeation chromatography, respectively. The glass transition temperature of the polymers is characterized as a function of copolymer composition by differential scanning calorimetry (DSC). Lastly, microplastics are prepared from the plastics through several methods, including precipitation and controlled mechanical breakdown. The size and characteristics of the microplastics are then characterized. In future studies, this model system will serve as a platform for studying how polymer composition and thermal properties influence microplastic and nano plastic behaviour and environmental persistence.

51 *From Patterning to Packaging — Qnity materials Across the Semiconductor Value Chain*
Preeti Chadha-Mudraboyina, she/her

to be submitted

52 *Enhancing Spiropyran Mechanophore Reactivity Through Cooperative Substituent Effects*
Lauren DiLoreto, she/her

With the utilization of mechanochromic mechanophores, force can be probed by tracking optical responses because of force-induced structural changes to the mechanophore. This enables a visualization of material stress, making these force active units useful in stress sensing and damage detection applications. Spiropyran, a common mechanophore, is converted to a coloured merocyanine species through the breaking of a labile C – O bond under force. However, spiropyran has limited mechanosenstivity as only a few units are

activated because of the way force is transduced through polymer materials. Two main strategies have been employed to address this limitation including matrix modification and structural effects. Specific structural changes to spiropyran include optimizing the pull position to effectively transduce force to the C–O bond and substituent effects. The substituent effects on the pyran ring have been extensively explored in the literature, indicating that electron-withdrawing substituents can stabilize the negative charge on merocyanine, making the mechanophore activate under less force. However, the substituent effects on the indole ring have not been studied in polymer materials. This work utilizes electron-donating substituents on the indole ring in conjunction with an electron-withdrawing nitro group on the pyran ring, with both substituents working cooperatively to increase spiropyran sensitivity. Hammett analysis was employed to quantify the electron-donating properties of the substituents. Small molecule thermodynamic studies applied Eyring Transition State Theory and found that the Gibbs Free Energy of the transition state for spiropyran ring opening is lowered using electron-donating substituents. In polymer materials incorporated with spiropyran, a similar trend was observed, where increasing the electron-donating ability of the substituent increased the colour response quantified by RGB analysis as a function of tensile strain, demonstrating that cooperative substituent effects were successful in improving the sensitivity of spiropyran force probes.