Utah Polymer Symposium Abstracts

27 May 2026

Hosted by: Brigham Young University

Venue: Engineering Building Room 206

Welcome to the 2026 Utah Polymer Symposium. This event brings together students, faculty, and researchers across Utah to share current work in polymer synthesis, characterization, materials design, processing, simulation, and applications.

UP2026

UTAH POLYMER SYMPOSIUM

Morning Keynote Speaker:

K1: Greg Nordin (Brigham Young University)

Photopolymerization-Based 3D Printing for Microfluidics: Foundations, Techniques, and Recent Breakthroughs

Photopolymerization-based 3D printing (vat photopolymerization) has emerged as a powerful platform for the direct fabrication of complex, fully enclosed microfluidic devices, bypassing the molds, layer alignment, and post-assembly bonding required by traditional microfabrication methods. Despite its promise, widespread confusion remains about the true capabilities of these techniques for producing the intricate, interconnected negative features demanded by microfluidics. This confusion often arises from misinterpreting manufacturer resolution specifications and from limited insight into the underlying photopolymerization processes and their optimization. This presentation provides a clear conceptual framework for understanding what is practically achievable with photopolymerization-based 3D printing and how to effectively harness its potential. We will cover the foundational principles, key techniques using both UV image projection (DLP) and liquid crystal (LCD) resin printers, and the substantial performance gains enabled by full user control over the printing process, resin formulation, and exposure parameters. Recent breakthroughs from our laboratory illustrate the remarkable capabilities now within reach. Examples include microfluidic channels with 2 μm × 2 μm cross-sections, valves with 15 μm × 15 μm active areas, and a single device containing 11,200 valves fabricated with 100% yield. These results highlight how tailored photopolymerization strategies are expanding the frontiers of microfluidic device complexity, functionality, and reliability.

Afternoon Keynote Speaker:

K2: Jessica Kramer Stratton (University of Utah)

Snot, Fish, and Immortality: Bioinspired Polymers That Harness the Power of Nature

Polypeptides are unique materials that harness the synthetic advantages of traditional polymers alongside strategic chemical and structural properties of proteins. Advances in the chemistry of amino acid *N*-carboxyanhydride (NCA) polymerization offer access to diverse polypeptide structures in a scalable manner. The Kramer Stratton Lab uses NCA polymerization to prepare mimics of two fascinating and unique classes of proteins: mucins and antifreezes. Mucins are the key protein component of mucus, saliva, and tears and are valuable therapeutic targets for lubricants, anti-infectives, and cancer. Antifreeze proteins, found naturally in extremophile organisms, bind to the surface of embryonic ice crystals and inhibit their growth. These natural antifreezes have broad applications in cryopreservation for biomedical and food technologies. This seminar will highlight the lab's efforts in chemical synthesis of polypeptides and their application as mucins and antifreezes.

Oral Presentation Abstracts

Oral Session 1:

O.1: Luke Borgia and Preston Hymas (University of Utah)

Solvent-Dependent Interfacial Orientation of PMMA Polymer Brushes Probed by Sum Frequency Generation Spectroscopy

Surface-initiated poly(methyl methacrylate) (PMMA) brushes were synthesized and characterized to investigate solvent-dependent interfacial polymer structures using sum-frequency generation (SFG) vibrational spectroscopy. Brushes were grown on silica nanoparticles and planar prisms via surface-initiated activators regenerated by electron transfer atom transfer radical polymerization (SI-ARGET ATRP) under conditions optimized to achieve tunable film thicknesses suitable for interfacial analysis. Successful, reproducible grafting across both colloidal and planar substrates was confirmed through a combination of thermogravimetric analysis (TGA), transmission electron microscopy (TEM), and ellipsometry. SFG spectroscopy was employed to probe the interfacial structure of the resultant PMMA films while in contact with a series of solvents, including D2O, methanol-D4, acetonitrile-D3, acetone-D6, and perfluorodecalin. Quantitative analysis of polymer orientation relies upon isolation of the methoxy symmetric stretch (-OCH3 vs) near 2955 cm^{-1}, which is typically obscured by overlapping aliphatic C–H resonances. This challenge was addressed by utilization of selectively deuterated PMMA-D5 and modification of the surface functionalization chemistry to minimize residual initiator interference. These two optimizations ultimately enabled clear spectral isolation of the -OCH3 resonance. Building upon this optimized strategy, interfacial orientation was then evaluated via the -OCH3 peak response under ssp and sps polarizations which selectively probe the molecular axis perpendicular and parallel to the surface, respectively. Results indicate the functional group tilt angle is highly correlated with the solvent dielectric. These findings establish a robust experimental platform for investigating buried interfaces with vibrational specificity and provide important insight into solvent-induced structural changes in surface-confined polymer brushes.

O.2: Kara Watson (Brigham Young University)

Characterizing High Density Polyethylene (HDPE) with Terahertz Imaging

Polymers have favorable properties for a wide variety of industrial and commercial applications. When stress is applied to the polymer product, however, the material can be strained beyond the elastic limit and structural damage will occur. Defects can also arise in manufacturing processes. Non-destructive tests that can identify damage and defects that can occur in polymers, enable us to better characterize structural integrity and prevent mechanical failure. While simple machine vision inspection can detect visible damage, it is unable to detect internal structural issues, as well as defects or damage that is not visible. Terahertz (THz) frequency light that passes through non-conducting materials can be used to detect defects and damage within the internal structure of polymers, and THz can also distinguish early stages of plastic deformation before visibly apparent. Several commercially available THz imaging systems currently exist that enable THz detection of defects and damage within polymer products, but these THz instruments only produce and detect lower THz frequencies from 1-2 THz. We present a THz imaging system with a broadband THz source including frequencies from 1 out to 6 THz. We demonstrate that frequencies in the range from 3-6 THz are much more sensitive and able to identify defects and damage in high-density polyethylene (HDPE) that has been systematically strained into the plastic region and beyond the max load point. We will show how using a THz hyper spectral imaging system with a frequency range much broader than current commercial instruments significantly increases the defect resolving power in polymers.

O.3: Naomi Elmer (Brigham Young University)

In Situ NMR Characterization for (Meth)Acrylate Photopolymerizable System

In situ nuclear magnetic resonance (NMR) photopolymerization provides a powerful method for studying the kinetics of photocurable systems and their impact on curing characteristics and material properties. For this method a fiber optic light guide is inserted into a 4mm concentric capillary tube, which contains a proton locking solvent D_2O with trace amounts of H2O and acetic acid. To allow uniform light transmission in the sample, the cable tip is roughened using sandpaper. The fiber optic and capillary are placed in a 5mm NMR tube with a polymer resin sample and then inserted into the NMR probe to be analyzed after irradiation exposure. This configuration allows manipulation of curing conditions while monitoring conversion in situ. The bulk polymerization of hexyl acrylate (HA) with a photoinitiator, diphenyl (2,4,6-trimethylbenzoyl) phosphine oxide (TPO), has been studied with different photoinitiatior concentrations, flash time intervals, and light intensity. Polymerization is monitored by tracking NMR peak shifts and intensity changes to determine a relative rate constant (kp') and ultimate monomer conversion. Additionally, this work quantifies dark curing which takes place following light exposure. Even after exposure to a light source, radicals are still present allowing continued cure with remaining monomer. Future studies will focus on improving reproducibility and assessing the effects of additional factors including temperature, monomer structure, and crosslinking agents.

O.4: Jerry Chen (University of Utah)

Additive Manufacturing of True Silicone Elastomers

Due to its unique chemical and mechanical properties, silicone is a much sought-after material in many fields such as medical devices, soft robotics, electronics, and many consumer products. Currently platinum-cured silicone parts are typically manufactured through casting or molding via thermally initiated hydrosilylation reactions which is very labor intensive and offers limited design freedom. In this work, we developed a new reaction scheme that can be incorporated into a commercially available platinum-cured silicone system, enabling direct conversion of traditional silicone resin into photocurable resins suitable for vat photopolymerization with micron- and submicron-scale resolution.

Oral Session 2:

O.5: Alysha Allgood (University of Utah)

Photopatterning of Functional Nanomaterials for Next-Generation Optoelectronic Devices

Currently, microelectronics are fabricated through a primarily subtractive process that relies on sequential rounds of thin film deposition, photoresist patterning, and etching. This places inherent limitations on the types of structures that can be formed and the methods used to produce them. Expanding the capabilities of a direct, high-fidelity photopatterned additive approach without reliance on photoresists would enable new device creation, less resource intensive processes, and new device topologies. To address this need, a new nanomaterial-based photosensitive precursor that can be directly patterned into functional 2D and 3D structures was developed.

O.6: Phillip Lampkin (University of Utah)

Polyazabicyclobutanes: Stimuli-Responsive Curable and Deconstructable Materials

Cationic polymerization of azabicyclo[1.1.0]butanes yields linear homopolymers with backbones composed of repeating azetidine units. The reactivity and properties of linear polyazabicyclo[1.1.0]butane homopolymers were examined. Our goal was to learn how highly strained azetidine units in polymer backbones with aromatic or alkyl sidechains respond when exposed to light or heat. A linear polyazabicyclo[1.1.0]butane with benzoyl side chains was deconstructed when exposed to ultraviolet or visible light, while an analogue with sidechains comprised of ketones connected to long n-alkyl chains was unreactive under the same conditions. Exposure of either material to visible light and an oxidative photocatalyst facilitated rapid deconstruction. The polyazabicyclo[1.1.0]butane homopolymer with long n-alkyl ketone sidechains was melt processable, enabling materials testing. Shear rheology suggested that heating at temperatures greater than 120°C resulted in crosslinking or remodeling of the polyazabicyclo[1.1.0]butane backbones. Additionally, we observed that processed polyazabicyclo[1.1.0]butane samples could be remolded at elevated temperatures, yielding new samples with significantly altered material properties. Tensile analysis of recovered n-alkyl ketone polyazabicyclo[1.1.0]butane samples cured for 16 hours at 120°C revealed a 10-fold increase in elongation at break relative to brittle samples melt processed at 80°C. Cured n-alkyl ketone polyazabicyclo[1.1.0]butane materials were deconstructed using visible light and a photocatalyst. Our results suggest that embedding of azetidine moieties into linear polymer backbones might be a strategy to endow materials with both stimuli-triggered deconstructability and upcyclability.

O.7: Zehao Jin (University of Utah)

Chain Length and Crystallization History Govern Solid-State Photopolymerization of Semi-Crystalline PEG-Urethane Dimethacrylate Oligomers

Crystalline photoreactive oligomers are usually expected to polymerize slowly because translational and segmental motion are restricted; however, crystal packing can also define a reactive local environment. Here we report a homologous series of Triethylene glycol (PEG 150)-HDI-based polyurethane dimethacrylate oligomers (PUMA-730, -1200, -1600, and -2900, numbers denote molecular weight) that are solids at room temperature and photocure below their melting transitions. End-group proton nuclear magnetic resonance (^{1}H NMR), gel permeation chromatography (GPC), and differential scanning calorimetry (DSC) establish systematic control over molecular weight, dispersity, and oligomer crystallinity. Real-time Fourier transform infrared spectroscopy (RT-FTIR) at 405 nm, correlated one-to-one with polarized optical microscopy (POM) and DSC, shows that room-temperature solid-state polymerization slows and reaches lower conversion as molecular weight increases, despite increasing crystallinity. For PUMA-1600, a higher crystallization temperature yields higher crystallinity, leading to faster polymerization and higher conversion. Sequential solid-to-melt irradiation reveals that the solid-state plateau is pathway-limited rather than a chemical endpoint, while melt-state photopolymerization provides a mobility-controlled comparison. These results demonstrate that polyurethane oligomers can undergo efficient solid-state photopolymerization and that chain length, crystallization history, and reaction pathway can be used as coupled design variables to program crystallinity and conversion within chemically identical networks, providing a strategy to tailor structure and properties for advanced photopolymer applications.

O.8: Laurel Smith (Brigham Young University)

Surface Functionalization of 3D Printed Microfluidics for a Mosquito-borne Disease Viral Nucleic Acid Capture Assay

Digital light processing resin 3D printing offers key advantages for the development of lab-on-a-chip microfluidic devices. High resolution printing of micron-order negative features enables sample and reagent volume reduction, while high resolution positive feature printing increases surface area when needed. Drawing on photoinitiated radical reactions on print surfaces, sections of interest can be covalently functionalized to-suit. We are developing a method to functionalize PEGDA-based 3D printed interior surfaces with acrydite-capture nucleic acids corresponding to chikungunya (CHIKV), a mosquito-borne virus currently lacking reliable and accessible diagnostic tools. In our developing point-of-care diagnostic assay, target viral CHIKV nucleic acids are immobilized through hybridization with corresponding capture nucleic acids covalently attached to 3D printed interior structures. Fluorescent tagging and microscopy allow detection and quantification of loaded viral nucleic acids at the nanomolar level.

O.9: Billy Chen (University of Utah)

Multi-objective optimization of thiol-(meth)acrylate networks for flexible electronics

Flexible electronic encapsulants require the simultaneous optimization of low dielectric constant, high Tg, with high levels of degradability which are intrinsically competing properties. To this end, photocurable thiol-(meth)acrylate networks were systematically optimized using commercially available multifunctional monomers by varying factors such as molecular architecture, functionality, and stoichiometry.

Methacrylates consistently lower dielectric constant relative to acrylates, with further reductions achieved at higher (meth)acrylate content and methacrylates with lower functionality. In contrast, increased network heterogeneity leads to higher Tg due to competing step- and chain-growth pathways. Degradability follows the opposite trend: acrylate-rich and acyclic thiol formulations exhibit significantly higher mass loss, while methacrylate-rich networks are more resistant. Notably, tan δ emerges as a predictive descriptor of degradability, with all formulations exhibiting tan $\delta > 0.4$ showing >85% mass loss.

These results establish a multi-objective optimization framework for thiol-(meth)acrylate networks. Importantly, tan δ can now serve as a predictive proxy for degradability, allowing rapid screening via DMA measurements (<2 h) in place of conventional degradation experiments that can take up to 24 h. This provides a practical and scalable pathway for accelerating the discovery and deployment of low-k, high Tg, degradable polymer encapsulants for flexible electronic applications.

Oral Session 3:

O.10: Lauren Kelly (University of Utah)

Probing the Characteristics of Animal-sourced Mucins to Improve Mucus Models

The human body secretes up to 10 L of mucus per day to line tissues in the respiratory, gastrointestinal, urinary, and reproductive tracts. This secretion is a viscoelastic hydrogel that serves as a first line of defense against pathogens and regulates the transport of molecules to the underlying epithelium. Mucus has broad impacts in human health as it houses the microbiome, regulates fertility, is a barrier to drug delivery, and undergoes biophysical changes in mucus-related diseases like cystic fibrosis and sinusitis. Despite these roles in human health, mucosal barriers remain challenging to study due to insufficient models that diverge biophysically and biochemically from human mucus. Mucin biopolymers are the gel-forming component of mucus. Mucins interact with each other to form a complex polymeric network that makes mucus a hydrogel. Mucins consist of a polypeptide backbone dominated by proline and densely glycosylated threonine/serine that results in a rigid, extended conformation. Glycosylation is controlled by over 1000 genes and is influenced by environmental factors and disease, causing these patterns to exhibit incredible heterogeneity across species and tissues. These complex yet essential glycoproteins are challenging to synthesize and invasive to collect from humans but can economically be collected from animals such as cows, pigs, and, snails. Previous work has shown that animal mucins provide a biochemically relevant and highly scalable means to create synthetic mucus but suffer from harsh purification which leads to batch-to-batch variation and reduced gelling abilities. I aim to improve the application of animal mucins in mucus models by streamlining an approach to characterize the size, carbohydrate content, and other features of commercially available animal mucins. Using this information, I will create scalable and tunable mucus-mimicking hydrogels, restoring the gelling ability of animal mucins by adding biologically relevant crosslinkers.

O.11: Ashley Spencer (Brigham Young University)

A Reduced-Order Framework for Modeling Nonsolvent- and Vapor- Induced Phase Separation Enabling Direct Comparison with Experiments

Porous polymer materials are used in many industries to assist in applications such as filtration, protective coatings, and artificial organ scaffolds. These porous materials, commonly made on the industrial level through either nonsolvent-induced phase separation (NIPS) or vapor-induced phase separation (VIPS), have a variety of structural characteristics that make predictive system models invaluable. These materials, however, contain complex hierarchical structures that require significant temporal and monetary investments to model accurately. These models are necessary to most efficiently aid experimentalists in developing their desired porous polymer materials. Current physics-based models, although simpler, only provide general qualitative rather than quantitative predictions, showing general trends, yet lacking accuracy when compared to experimental polymer materials. To address this, a simpler two-part model combining phase separation and diffusion can be used. We have developed the first part of this model, relying on Flory-Huggins theory to produce phase diagrams for systems in which there are multiple regions of finite miscibility (ie: finite miscibility between the nonsolvent and polymer). As the degree of polymerization of the polymer increases these regions of miscibility merge together. This merging of the spinodal and binodal curves necessitates two different solving methods to predict realistic binodal curves. These phase diagrams are able to closely predict the binodal curves at low volume fractions of solvent, but as the volume fraction increases it becomes less accurate. This is due to the imitation that as the degree of polymerization and Flory-Huggins interaction parameter (χ) increases the calculation of these curves becomes increasingly difficult. Future work will implement an analytical approach to approximate these curves at higher values of χN.

O.12: Francesca Lombardi (University of Utah)

Architectural Effects on Depolymerization

Plastic waste accumulation negatively impacts ecosystems and human health; therefore, it is beneficial to improve our understanding of polymer recycling methods to reduce waste. An attractive method to recycle post-consumer plastics is depolymerization, which involves breaking down a polymer into its constituent monomer. Beyond its application with end-of-life plastics, depolymerization can also be used as a monomer storage method. Both of these approaches benefit from an improved foundational understanding of the depolymerization process to achieve maximum efficiency. Depolymerization rates and monomer recovery can be optimized via manipulation of polymer properties such as architecture, which is the structural arrangement of a polymer chain. This work is focused on star architecture polymers, which feature a central core with three or more polymer "branches" or "arms" which propagate from that central point. A series of linear and star architecture poly(methyl methacrylate) samples with varied branching were synthesized with thermally labile end groups. These end groups are capable of inducing depolymerization at relatively low temperatures (<250 °C). The more branched polymer stars yielded greater monomer recovery (25 ± 3%) than the control (13 ± 5%). This suggests that an increase of thermally labile end groups allows for increased monomer unzipping.

O.13: Andrew Chen (Brigham Young University)

Reactive Dissipative Particle Dynamics Simulations of Polymerization and Crosslinking Kinetics

Polymerization-induced microphase separation (PIMS) has emerged as a powerful route for synthesizing nanostructured polymers with versatile applications depending on the mechanical properties they possess. However, the predictability of PIMS has not been well known due to the intricate connections between polymerization kinetics and cross-link reaction kinetics. In this work, we developed Reactive Dissipative Particle Dynamics (RDPD) algorithm that captures the polymerization kinetics not included in conventional Dissipative Particle Dynamics (DPD). To justify this algorithm, RDPD simulations were first created with varying polymer interaction parameters, polymerization rates, and cross-link concentration. Then each simulation was executed until it reached its equilibrium morphology. By comparing the obtained morphology with that for nonreactive block copolymer systems, we can quantify the impact of polymerization as a driving force in contrast with thermal effects. This capability of predicting final morphology of PIMS using RDPD will allow researchers and manufacturers to precisely design the polymer material with desired mechanical properties.

Oral Session 3:

O.14: Kevin Stewart (University of Utah)

Side-Chain Engineering in Frontal Ring-Opening Metathesis Polymerization

Frontal ring-opening metathesis polymerization (FROMP) is a thermally autonomous polymerization method in which a localized reaction front propagates through monomer via self-sustained thermal runaway, enabling rapid and energy-efficient polymeric material synthesis. While control over FROMP has traditionally emphasized catalyst selection and bulk thermodynamics, the role of monomer side-chain architecture in governing front behavior and material performance remains largely underexplored. This seminar will present recent advances showing how side-chain engineering of norbornene monomers provides a general strategy for structure–property tuning in FROMP without altering backbone chemistry. Examples will highlight how subtle changes in side-chain length, connectivity, and functionality influence front propagation, stability, and viscoelastic response, establishing side-chain design as a powerful and tunable handle for advancing the scope of FROMP-based materials.

O.15: Aaron Bigelow (Brigham Young University)

Constructing Equilibrium Phase Diagrams of Simulated Polymer Systems at Equilibrium through Free Energy Calculations

Polymer nucleation and crystallization have been researched for over 50 years yet questions about the mechanisms of these phenomena remain. Given that millions of tons of semi-crystalline polymers are made every year, understanding how crystallization happens can have a significant effect in the field. Previous theories about nucleation and crystallization have been insufficient at describing observations in experiments. Therefore, a complete theory explaining polymer crystallization is incomplete.

Observing the details of nucleation in an experiment is difficult with current technology. This is due to the complexity and timescale of polymer nucleation. Polymer chains are complex because of their entanglements and branching structure. Current experiments use methods that observe the effects of nucleation and crystallization, but not the phenomenon itself. Experiments also either perturb the system or use significant supercooling to induce nucleation.

This work uses molecular simulations to study polymers. Simulating polymers has advantages that include direct observation of polymer chains, complete control over the system, and running simultaneously. However, simulating polymers at low temperatures and high densities is difficult. Previous work using Wang-Landau Monte Carlo worked for small simulation sizes but began to have significant slowdown as the simulation size increased.

Instead of solving for the density of states, we are making free energy landscape based on nematic and crystalline order parameters. With these landscapes, we can construct phase diagrams to understand polymer phase behavior.

Our simulations are performed at equilibrium to capture thermodynamic influences on crystallization. Advanced sampling techniques, such as metadynaimcs, are necessary to overcome significant free energy barriers at equilibrium. With these advanced methods, we can make phase diagrams for polymer chains of increasing molecular weight.

O.16: Paul Joshua Hurst (Brigham Young University)

Functional Self-Assembly and Targeted Delivery Systems

The solution-based self-assembly of amphiphilic polymers offers a promising route to targeted delivery systems for cargos ranging from biomacromolecules to small molecule therapeutics, addressing challenges in cellular uptake and stability. As a new research group, we aim synthesis new polymer systems and establish design rules for amphiphilic polymers that enable efficient delivery of difficult-to-transfect and structurally fragile biomolecules. Using ring-opening polymerization (ROP), we will develop a new class of random heteropolymers with segmented amphiphilicity for protein delivery. We will also systematically investigate how sequence, molar mass, and dispersity influence the assembly and function of amphiphilic copolymers. Ultimately, we will develop systems that preserve protein integrity outside of the cell while enabling efficient cellular transfection, towards the development protein-based therapeutics.

O.17: Jacob Lessard (University of Utah)

Pendant Effects in Frontal Polymerization

Frontal ring-opening metathesis polymerization (FROMP) enables rapid, energy-efficient access to high-performance thermosets and thermoplastics, but the range of accessible properties remains constrained by the rigidity of norbornene-type backbones. In this work introduce a side-chain plasticization strategy for FROMP, wherein norbornene esters bearing n-alkyl groups of varying length (n = 8, 12, 16) are copolymerized with dicyclopentadiene or hydrogenated DCPD. Systematic incorporation of these pendants tunes free volume, resulting in predictable reductions in glass transition temperature, decreased moduli, and a transition from rigid thermosets to elastomers. Free-volume analysis via dynamic mechanical analysis and solvent swelling ratios confirms pendant length and distribution as key parameters governing network porosity and mobility. Moreover, high-alkyl-content formulations exhibit nonlinear front propagation (spin modes) and strain-induced whitening—features that highlight opportunities for spatial patterning and cooperative molecular alignment under load. Collectively, these results establish side-chain engineering as a versatile design principle for expanding FROMP into elastomeric regimes, providing a scalable pathway to soft, tunable, and structurally programmable materials.

Poster Session Abstracts:

P.1: Seth Jackson (University of Utah)

Improving n-type organic electrochemical transistor performance by blending alkyl and oligoglycol functionalized polymers and modifying electrolyte pH

Compared to their p-type counterparts, n-type organic mixed ionic–electronic conductors (OMIECs) typically exhibit inferior stability, slower ion-injection kinetics, and reduced sensitivity when used as active layers in organic electrochemical transistors (OECTs). Enhancing the performance of n-type OMIECs is crucial for advancing next-generation technologies that rely on mixed conduction, including bioelectronics, neuromorphic computing, and energy storage. We find that blending NDI(biOE2)-T2 (branched oligoglycol side chains) with N2200 (branched alkyl side chains) at a 90:10 ratio doubles the electronic mobility–volumetric capacitance product (μC*) relative to neat NDI(biOE2)-T2, whereas higher N2200 fractions sharply reduce μC*. Nanoscale infrared imaging by photoinduced force microscopy (PiFM) reveals increased phase separation at higher N2200 content, consistent with the μC* decline. Furthermore, we find that the μC* enhancement at 90:10 arises from higher electronic mobility (μ), likely due to suppressed polymer swelling upon N2200 addition. Next, we investigate how adjusting the pH of electrolyte solutions impacts polaron formation and device performance using p(gNDI-T2). We also examine pH effects using p(gNDI-T2): at pH ≤ 3, doping induces pronounced spectral changes attributable to protonation of naphthalene diimide (NDI) units, confirmed by Raman spectroscopy and density functional theory. OECT performance also depends strongly on pH, as protonation of the NDI unit degrades OECT performance. Together, these results identify polymer blending and electrolyte pH optimization as practical levers to boost n-type OMIEC performance and offer mechanistic design rules for device engineering.

P.2: Neda Khatami (University of Utah)

3D-Printed Intravascular Scaffolds for Chemotherapy Drug Capture

P.3: Peter Wilhelm (University of Utah)

Modeling Carrier Transport in Organic Materials Using a Modified Inorganic p-n Junction Simulation

As organic photovoltaics (OPV) become an increasingly desirable alternative for inorganics, improving their efficiency is essential for their widespread implementation. A major roadblock for improved efficiency is that carrier transport is much less defined in organic materials than in inorganic materials. Using an inorganic p-n junction simulation, we modified factors such as carrier concentration, generation, and recombination such that they are calculated directly from the optical absorbance and density of states (DOS) of the material. Using this, we can simulate transport using materials with differing Urbach energies and DOS types. This allows us to simulate organic materials and grants us the ability to see how certain factors such as power conversion efficiency, current-voltage characteristics, and maximum power are linked to material properties and design choices in OPVs.

P.4: Jennafer Davis (Brigham Young University)

Carbazole-based Nitroxide Mediated Photopolymerization

Nitroxide-mediated photopolymerization (NMP2) offers a promising route toward controlled radical polymerization under mild, spatially and temporally regulated conditions. In this work, carbazole-based NMP2 photoinitiators were designed and the resulting photopolymerized systems were characterized. Photopolymerization kinetics are being examined under irradiation conditions relevant to visible-light activation, and the resulting polymers characterized to assess molecular weight development, dispersity, and overall control of the polymerization process. By correlating initiator structure with polymerization performance, this research aims to establish design principles for next generation photoinitiators capable of enabling efficient and tunable controlled radical polymerizations. The development of these carbazole-based systems expands the available toolbox for light-mediated polymer synthesis and provides new opportunities for tailoring polymer architecture and material properties in advanced photopolymer applications.

P.5: Darya Ivannikava (University of Utah)

Frontal Radical Polymerization of Linear Acrylates

Frontal radical polymerization (FRaP) has historically required crosslinkers, particulate additives, fillers, or applied pressure to sustain stable front propagation, each of which limits access to soluble linear polymers. Previous work on benzyl acrylate FRaP demonstrated that the low glass transition temperature of the resulting polymer leads to flow and front destabilization driven by Rayleigh–Taylor instabilities, preventing clean linear front propagation. Here we report that isobornyl acrylate (IBOA) overcomes this limitation owing to the high glass transition temperature of poly(IBOA), which drives vitrification of the polymer phase on a timescale that outcompetes convective destabilization at the propagating front. The system accommodates a range of radical initiators and monomer-to-initiator ratios, yielding soluble linear polymer at high monomer conversion. Molecular weight and dispersity are consistent with high instantaneous radical flux at the front, and polymer thermal properties are tunable through copolymerization with a low-Tg comonomer. These results establish high-Tg pendant-group acrylates as a monomer class for which FRaP can serve as a practical route to linear thermoplastic materials without auxiliary additives or processing aids.

P.6: Stephen Laishley (Brigham Young University)

Active Brownian Unicycle Framework for Coarse-Grained Modeling of Collective Motion with Decentralized Interactions

Active Brownian particles (ABPs) exhibit diverse emergent collective behaviors driven by local interactions and stochastic motion. Although many models describe specific physical mechanisms, a generalized dynamical framework is needed to represent different classes of collective behavior while remaining connected to underlying particle interactions. Inspired by decentralized multi-agent robotic systems, we introduce the Active Brownian Unicycle (ABU) model, which combines deterministic unicycle-style steering with stochastic Brownian motion characteristic of active particle systems.

We also evaluate whether decentralized interaction rules from unicycle-based robotic swarms remain effective in stochastic active-particle systems. Repulsion, alignment, and attraction rules are incorporated into the ABU torque balance and tested through numerical simulations. The results show that these rules generate persistent flocking and toroidal collective states despite thermal fluctuations. These findings suggest that robotic-style decentralized interaction strategies can be incorporated in active-particle systems, positioning the ABU framework as a bridge between decentralized control theory and physically realizable collective motion.

P.7: Tara Buzinski (University of Utah)

Sulfoxide-Containing Polypeptide Materials Potently Inhibit Ice Recrystallization

Cryopreservation of biological materials is utilized daily in thousands of basic and translational research labs across the world, as frozen cells are more amenable to banking, preservation, and transportation. However, the freeze/thaw process – specifically the recrystallization of ice into larger, damaging crystals – induces osmotic and mechanical damage to cells, decreasing their post-thaw viability. Popular cryoprotective agents (CPAs) such as dimethyl sulfoxide (DMSO) and glycerol have toxic effects and are often present at unsafe concentrations during freezing protocols. Additionally, ice recrystallization is responsible for issues such as texture degradation in food and dairy products. To address this, we have developed scalable polypeptide materials that prevent ice crystals from recrystallizing into larger particles, promoting smaller, more benign crystals. These biopolymers are synthesized with inexpensive, commercially available starting materials through the well-established process of N-carboxyanhydride polymerization, enabling reproducible and streamlined manufacturing. The structure-function relationship between our polymers and their efficacy in inhibiting ice recrystallization was probed via a panel of polymers with different functional groups, lengths, and compositions. Ultimately, a high ratio of small, hydrophobic residues interspersed with sulfoxide-containing residues was found to be most efficacious. Through this work, we have identified potent materials with activity on the ug/mL scale. Thanks to their excellent cytocompatibility, we will apply these polymers as cryoprotective agents to aid in cellular cryopreservation or as a surface coating for food or agricultural uses.

P.8: Marti McKendrick (Brigham Young University)

Effect of Temperature, Run Length, and Box Size on Integrated Autocorrelation Time

Investigating effects of different variables in a monte carlo simulation saw that they had no effect on the autocorrelation time of the simulation.

P.9: Riley Nick (University of Utah)

Compositional Drift in Covalent Adaptable Networks

Covalent adaptable networks (CANs) are a class of crosslinked polymer material that combines the robustness of thermosets with the reprocessability of thermoplastics through dynamic covalent bond exchange. This bond exchange enables viscous flow under a stimulus while maintaining network integrity within the operational temperature range. Despite their industrial promise, it is necessary to improve our knowledge on the effect that basic polymer properties have on flow behavior within CANs. This work specifically assesses polymer composition, which describes the distribution of monomers within a copolymer. We hypothesize that copolymer composition strongly affects CANs viscoelasticity, leading to distinct network properties. This work aims to study the compositional drift of copolymers, firstly probing (2-acetoacetoxy)ethyl methacrylate (AAEMA) and butyl methacrylate (BMA) copolymer system. Three systems were created, one with 50:50 as the co-polymer composition, one with 75:25 and 25:75 compositions combined, and lastly one with 90:10 and 10:90 compositions combined. The overall net composition of all P(AAEMA-co-BMA) systems is 50:50, isolating compositional drift as the key variable. Dynamic Mechanical Analysis provides the glass transition temperature (Tg)of the systems, 50:50, 75:25 – 25:75 and 90:10 – 10:90 were 97, 102, and 97 °C, respectively, with 75:25 – 25:75 having a shoulder at 65 °C and 90:10 – 10:90 having a shoulder at 50 °C The 75:25 – 25:75 and 90:10 – 10:90 networks have increasing heterogeneity of the network composition compared to the controlled 50:50 composition as seen in the appearance of a low Tg shoulder. Rheological studies also show interesting differences between the networks, indicating that drift in the copolymer composition affects the overall network’s flow behavior.

P.10: Lars Nelson (Brigham Young University)

Field and Particle Simulations of Block Copolymer Microphase Separation

Polymerization-induced microphase separation (PIMS) is a promising method for manufacturing block copolymer monoliths with kinetically trapped bicontinuous morphologies, ideal for various applications such as isoporous membranes. However, PIMS processes currently suffer from a lack of predictive capability due to a sensitive interplay between chain dynamics, polymerization kinetics, and crosslinking reaction kinetics. In order to better predict and design these processes, we turn to modeling and simulation using both field- and particle-based methods. Self-consistent field theory (SCFT) allows us to determine the expected equilibrium state of block copolymer systems, while our reactive diffusive particle dynamics (RDPD) simulations allow us to determine how chain dynamics and reaction kinetics cause systems to depart from equilibrium.

P.11: Andrei Lucadan (University of Utah)

Novel SLA-3D Printing Enables Ultra-High Volume-Fraction Filler Loading In Resin Matrix and Self-Supported Printing

The ability to implement high filler volume-fractions in photoreactive resin 3D printing is a key step in pushing polymer additive manufacturing from a prototyping tool to a practical means for building products with attractive properties. Most commercial photoreactive resins for traditional SLA are (meth)acrylate liquid resins, where adding filler materials is detrimental to printing due to increased viscosity and optical scattering. In this work, we develop a series of room temperature solid-state resins to be printed at their molten state. We successfully print 62vol% SiO_2 loaded resin— a value near the theoretical loading limit for random closed packed systems— while achieving <150 μm resolution and print unsupported 55° angled overhangs. We systematically investigated these solid resins with respect to traditional liquid resins using oscillatory rheology & dynamic mechanical analysis, thermogravimetric analysis, differential scanning calorimetry, and mechanical testing.

P.12: Muhammad Taha (Brigham Young University)

3D Printed Polymer-Based Thermoelectric Sensor for Small Scale Thermal Management

Peltier elements operate on thermoelectric principles and can function as compact heat flow or temperature difference sensors. They are useful for temperature monitoring and control in microfluidic systems, where precise thermal management is often required. However, conventional Peltier elements are typically bulky, require complex fabrication, and are difficult to integrate directly into microfluidic devices. Their size, fabrication complexity, and limited compatibility with small scale polymer systems often restrict their use to external attachment rather than true device level integration. This work introduces a miniaturized, polymer based thermoelectric device designed for integration with microfluidic systems. The device was fabricated using Digital Light Processing stereolithography (DLP-SLA) with polyethylene glycol diacrylate (PEGDA) as the structural framework. Conductive organic polymers were then deposited as a post-processing step to form the thermoelectric legs, using poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) for the p-type legs and poly(benzimidazobenzophenanthroline):poly(ethyleneimine) (BBL:PEI) for the n-type legs. These materials were selected for their thermoelectric properties and compatibility with solution based processing. The resulting miniaturized Peltier element measured 18 mm × 6 mm × 1 mm. Computational and experimental evaluations showed a perfectly linear voltage response with applied temperature difference, demonstrating its potential as a printed thermoelectric sensor for small scale systems. The proposed device provides a platform for integrated thermal sensing in microfluidic systems and may support applications requiring localized heat flow measurement or temperature monitoring, including biochemical assays, polymerase chain reaction systems, biosensing, and small scale thermal analysis of polymer systems.

P.13: Xu Ouyang (University of Utah)

Ultrasound-Triggered In Situ Crosslinking for Sound-Based Additive Manufacturing of Soft Functional Materials

Conventional additive manufacturing methods for soft materials often rely on direct nozzle deposition or light-based curing, which can limit fabrication in enclosed, opaque, or difficult-to-access environments. This work explores “sound printing,” a noncontact manufacturing strategy that uses focused ultrasound to trigger localized gelation and solidification within ultrasound-responsive polymer systems. By delivering acoustic energy into targeted regions, the platform generates localized heating capable of inducing controlled material transition without physical contact. Preliminary experiments demonstrate that MHz-range focused ultrasound can produce spatially confined crosslinking in soft polymer formulations under programmable exposure conditions. The results suggest that acoustic fields can serve as remotely controllable tools for patterning and manufacturing soft functional materials. This approach may enable future applications in biomedical engineering, embedded fabrication, and in situ bioprinting where conventional optical or extrusion-based methods face practical limitations.

P.14: Parnian Govahi (University of Utah)

Ultra-Stretchable, Anti-Drying, and Adhesive Hydrogels Based on Gelatin Methacryloyl (GelMA) for Skin Wound Dressing

Gelatin methacryloyl (GelMA) has served as a bioactive scaffold for dressing chronic and acute wound types. These hydrogels however, lack tissue adhesion and stretchability, thereby fail to comply with tissue deformation. In situ dopamine polymerization has previously been explored as a means to improve the stretchability, toughness, and adhesion of GelMA hydrogels to a limited extent. Here, we leverage glycerol additives to boost these properties, tailoring hydrogel physical properties for applications as wound dressings. To this, GelMA precursor solutions containing dopamine, NaOH, Irgacure, as the photoinitiator, and varying glycerol concentrations were prepared and photocrosslinked under UV light. After crosslinking, the hydrogels were dehydrated under controlled conditions. The physical, mechanical, and adhesive properties of the hydrogels were then evaluated using adhesion testing, UV–vis spectroscopy, swelling analysis, anti-drying experiment, tensile testing, and rheological characterization. The results showed that glycerol played an important role in improving the flexibility and integrity of the dehydrated hydrogels. Hydrogels containing glycerol exhibited reduced brittleness and less cracking after dehydration compared to samples without glycerol. In addition, glycerol improved both the adhesion and stretchability of the hydrogels, with higher glycerol concentrations showing greater flexibility and compliance. This work demonstrates that glycerol can be used as an effective additive to tune the mechanical stability, stretchability, adhesion, and dehydration resistance of GelMA-based adhesive hydrogels. The developed dehydrated hydrogels show potential for applications such as wound dressings and wearable biomedical devices.

P.15: Mohammadmajid Sepantafar (University of Utah)

Stretchable and Adhesive Conductive Polymer Electrodes for Flexible Electronics

Conductive biomaterials have attracted growing interest for applications in bioelectronics and biomedical engineering. Among others, poly(3,4-ethylenedioxythiophene (PEDOT):polystyrene sulfonate (PSS) is widely regarded as the gold standard conductive polymer due to its redox activity and high conductivity. However, its poor adhesion, brittleness, and limited stretchability restrict its use in flexible electronics and interfacing with soft tissues. Here, we aim to develop a biocompatible conductive biomaterial with enhanced coating cohesion, adhesion, and stretchability. To this end, we engineer PEDOT's doping chemistry using a comprehensive library of sulfonated natural biomacromolecules, based on agarose, alginate, albumin, extracellular matrix, dextran, gelatin, keratin, silk fibroin, and zein backbones. Conductive films with high cohesion and adhesion to stretchable silicone-based elastomers were attained via an optimized composition of glycerol and (3-glycidyloxypropyl)triethoxysilane (GPTS) additives, respectively. Sulfonated gelatin (Gel-S) dopants resulted in a two-fold increase in conductivity compared with PEDOT:PSS formulations. As opposed to PEDOT:PSS, which was susceptible to cracking and brittleness, and flaking off, PEDOT:Gel-S resulted in uniform, flexible, water-stable and adhesive electroconductive films. Together, these results identify PEDOT:Gel-S as a promising stretchable, adhesive, and conductive biopolymer for next-generation wearable and implantable bioelectronic applications.

P.16: Darren Fillmore (Brigham Young University)

The Effects of Monomer and Solution Concentration on the Electrochemical Impedance of Hydrogel Coatings in Cochlear Implantsore

Cochlear implants are devices which have been used to improve hearing outcomes in patients affected by heavy sensorineural hearing loss (SNHL). Individuals strongly affected with SNHL, which commonly results from damaged inner ear hair cells, often report limited success in using hearing aids. Cochlear implants function through bypassing the damaged inner hair cells altogether, taking external audio, converting it into electrical impulses, and using those impulses to directly stimulate the auditory nerve through an implanted electrode array.

The application of photopolymerized zwitterionic hydrogels shows promise to increase ease of cochlear implant insertion as well as decrease the strength of the foreign body response. Lubricious hydrogels can decrease the friction between the electrode array and the cochlea, leading to fuller (deeper) insertion and less insertion trauma, as well as a lower risk of electrode array folding or twisting. These can improve overall the functionality of the cochlear implant. Reduction in the strength of the foreign body response has also been seen as zwitterionic hydrogels tightly bind water molecules, making protein adsorption difficult. The lack of protein adsorption, particularly fibrinogen, decreases the number of cells attracted to the implant area, decreasing inflammation and scar tissue formation.

The current research focuses on two key avenues. The first is attempting to create an experimental system that successfully mimics the in vivo environment of the cochlea with cochlear implant. The second is the modeling and deconvolution of EIS data in order to determine information about the in vivo environment purely based on changes in collected EIS data.