Materials Science and Engineering Department

Winter Seminar Series

Designing Advanced Macromolecules for Advanced Manufacturing: Balancing Reactivity, Rheology, and Resolution in Additive Manufacturing

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3-4PM
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This lecture will highlight recent advances in polymer design with a molecule to manufacturing perspective, and tailored crosslinking plays a major role in the design of elastomers for 3D stereolithographic printing, polyimides for vat photopolymerization, and novel polymer architectures for binder jetting of water-soluble adhesives. Star-shaped architectures of water- soluble poly(N-vinyl pyrrolidone) allow high concentrations for jetting solutions into powder beds for pharmaceutical manufacturing. The star-shaped polymers, which are prepared using RAFT polymerization, result in reduced entanglement concentrations, and higher c* concentrations that permit a higher maximum jetting concentration. Photo-reactive, fully aromatic polyimides that are decorated with acrylate substituents provide chemically crosslinked organogels that are amenable to thermal post-processing, and thermal decomposition of the network scaffold occurs without structural detriment to the polyimides. The lecture will describe a facile supramolecular salt approach for low viscosity solutions for vat photopolymerization with conversion to carbonaceous objects and nanoporous aerogels. 3D printing all-aromatic polyimides from water remains our research objective, and we will describe our strategies using sacrificial hydrophilic sites. Our latest efforts involve the preparation of semi-interpenetrating networks of latexes and crosslinked functional poly(ether) scaffolds using vat photopolymerization. Recent efforts have demonstrated three-dimensional elastomeric objects that approach the performance of conventional elastomers in the presence and absence of the scaffold network. Our latest advances have included vat photopolymerization of styrene-butadiene rubber latex, natural rubber latex, and most recently synthetic isoprene latexes. This lecture will illustrate various crosslinking strategies where the crosslinks are susceptible to reversibility using various external stimuli, ranging from heat and pH to photo-irradiation and ionic salts.

Prof. Timothy Long received his Ph.D. in Chemistry from Virginia Tech under the direction of Prof. James McGrath, and he subsequently joined both Eastman Kodak and Eastman Chemical companies for eight years upon graduation. He joined the faculty in the Department of Chemistry at Virginia Tech, where he also served as the Director of the Macromolecules Innovation Institute until 2019. In 2020, Prof. Long accepted an interdisciplinary faculty position across the School of Molecular Sciences (SMS) and the School for Engineering Matter, Transport, and Energy (SEMTE) at Arizona State University (ASU) where he launched and currently leads the Biodesign Center for Sustainable Macromolecular Materials and Manufacturing (SM3). In addition to over 400 peer-reviewed publications, his research awards include the 2022 Paul J. Flory Award, 2020 Virginia Outstanding Faculty Award, 2015 Virginia Scientist of the Year, 2010 Virginia Tech Alumni Research Award, ACS PMSE Collaborative Research Award, PSTC Carl Dahlquist Award, 2019 ACS Rubber Division Thermoplastic Elastomer Award, and the ACS POLY Mark Scholar Award. He has served as the Chair of the ACS Division of Polymer Chemistry, Chair of the Gordon Research Conference in Polymers, 2012 Chair of the IUPAC World Polymer Congress, and he currently serves as the Past-President of the Adhesion Society. He is a member of advisory boards for leading journals, and he was appointed as Editor-in-Chief of Wiley Polymer International. His most recent research efforts address the need for tailored advanced macromolecules for advanced manufacturing (3D printing), including vat photopolymerization, direct ink write, binder jetting, powder bed fusion, and melt extrusion. His interdisciplinary research establishes fundamental polymer structure-property-processing relationships with a lens of sustainability.

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