Controlling Reactivity and Selectivity for the Discovery of Sustainable Thermoplastics

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Plastics are the largest synthetic consumer product in the world, with an annual production of over 360 million metric tons annually. Despite the structural diversity enabled by modern advances in polymer synthesis, greater than 60% of world plastic production remains dominated by polyolefins. These high-volume, low-cost engineering thermoplastics are made from a small sub-set of petroleum derived monomers and demonstrate diverse thermomechanical properties, attractive chemical resistance, and excellent processability. Creating sustainable materials that compete with the performance and value proposition of polyolefins is a grand challenge for the field of polymer science. The goal of research in the Leibfarth group is to control develop synthetic methods that transform readily available starting materials into functional and sustainable thermoplastics with molecular-level precision. This goal informs our two complementary approaches that seek to *1)* leverage chemo- and regioselective C–H functionalization of polyolefins to enhance the properties of these venerable materials and *2)* develop stereoselective polymerization methods that engender emergent polymer properties from simple chemical building blocks. These concepts have resulted in platform synthetic methods that enhance the thermomechanical, adhesion, and transport properties of polymeric materials while also uncovering mechanistic insights that broadly inform synthetic method development.