Deconstructing Macromolecules to Make Better Materials

Polymers are arguably the most important materials on Earth. Despite a century of study, however, much remains unknown about how the molecular-scale features of polymers translate to their bulk properties, preventing predictive design of next-generation materials with enhanced functions and circularity. This talk will highlight our efforts to leverage efficient synthetic methods and principles of physical organic chemistry to construct and deconstruct polymers using chemical and mechanical stimuli, thereby unveiling previously hidden features of macromolecular structure and enabling new polymeric material functions. Experimental tools for measuring previously hidden topological features of cross-linked polymer networks will be described.[1] Inspired by these results, new and simple strategies for enhancing the toughenss[2] and circularity[3,4,5] of polymer networks will be introduced.

[1] M. Zhong *et al.*, *Science* **2016**, *353*, 1264–1268.
[2] S. Wang *et al.*, *Science* **2023**, *380*, 1248–1252.
[3] P. Shieh *et al.*, *Nature* **2020**, *583,* 542–547.
[4] G. Kiel *et al.*, *J. Am. Chem. Soc.* **2022**, *144*, 12979–12988.
[5] K. Ko *et al.*, *J. Am. Chem. Soc.* **2024**, *146*, 9142–9154.