Mechanochemistry of topological molecules

Min Zhang

East China Normal University

In the 1930s, Staudinger discovered that mastication of polystyrene reduced its molecular weight, marking the inception of polymer mechanochemistry. Over the past two decades, the field has advanced rapidly with the introduction of mechanophores—force-sensitive molecular motifs. To date, hundreds of diverse mechanophores have been designed. These motifs not only exhibit unique mechanochemical mechanisms but also enable the construction of force-responsive materials for applications including controlled release, sensing via color change, catalysis, self-strengthening, and so on. However, current research predominantly focuses on covalent systems, where activation necessitates covalent bond scission followed by reconstruction—a process typically requiring high force thresholds. In contrast, supramolecular systems rely on non-covalent interactions, but are less studied in mechanochemistry. Our research aims to investigate the mechanochemical behavior of supramolecular systems, particularly topological molecules (including mechanical bonds), and to develop functional force-responsive materials based on these architectures. In this presentation, I will highlight our recent work in this area, including force-driven molecular machines, the mechanical behavior of knots, and our attempts toward constructing novel mechanophores.

Mini-bio:

Dr. Min Zhang obtained his Ph.D. degree from Tongji University (Shanghai) in 2015 under the supervision of Prof. Xiaoming Zhao, working on organic methodologies and chiral sulfoxide ligands. He subsequently conducted postdoctoral research with Prof. Jun-Li Hou at Fudan University, designing and synthesizing artificial transmembrane channels. From January 2018 to January 2020, he investigated polymer mechanochemistry as a Newton International Fellow in Prof. Guillaume De Bo's group at the University of Manchester. He continued his research on polymer mechanochemistry and molecular nanotopology with Prof. David A. Leigh at the same institution from February 2020 to March 2023. Currently, he is a Zijiang Outstanding Young Professor in the School of Chemistry and Molecular Engineering, East China Normal University, Shanghai. His research interests focus on the intersection of molecular nanotopology and polymer mechanochemistry.