Building and Breaking Macromolecular Ladders to Develop Functional Materials

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Our interest in ladder-shaped polymers led to the development of unusual materials. We developed Catalytic Arene-Norbornene AnnuLation (CANAL) to synthesize ladder polymers consisting of fused conformationally restricted rings from readily available norbornenes and aryl bromides. Efficient CANAL polymerization produced rigid ladder polymers with ultrahigh molecular weights, contorted conformations, and various functionalities. These ladder polymers exhibited high microporosity, high thermal and chemical stability. Mechanically robust membranes from optimized polymers show unprecedented performance for gas separations.

We also developed several unique families of polymers with ladder repeat units that readily rearrange under mechanical force to form different conjugated polymers with variable optoelectronic properties and self-assembly behavior, dramatically changing all their intrinsic properties at once. The force-induced macromolecular transformation led to unprecedented materials that respond to stress in a multifaceted fashion in both solution and solid states, and revealed interesting dynamic effects with effective mechanotransduction along covalent bonds.

Prof. Yan Xia

Biography

Yan Xia received B.Sc. from Peking University ('02) and his Ph.D. in Chemistry from Caltech in 2010, working on cyclic and bottlebrush polymers under the guidance of Profs. Bob Grubbs and Julie Kornfield. Following his PhD, he worked as a senior chemist at Dow Chemical for one and a half years and then a postdoc associate at MIT. He joined the chemistry faculty at Stanford in the summer of 2013. His research interest lies in the design, synthesis, and manipulation of organic materials and polymers, driven by new synthetic capability, rational molecular design, and curiosity. He is a recipient of Terman Fellowship, Army Research Office Young Investigator Award, 3M Non-Tenured Faculty Award, NSF CAREER Award, Cottrell Scholar Award, and Sloan Research Fellowship.