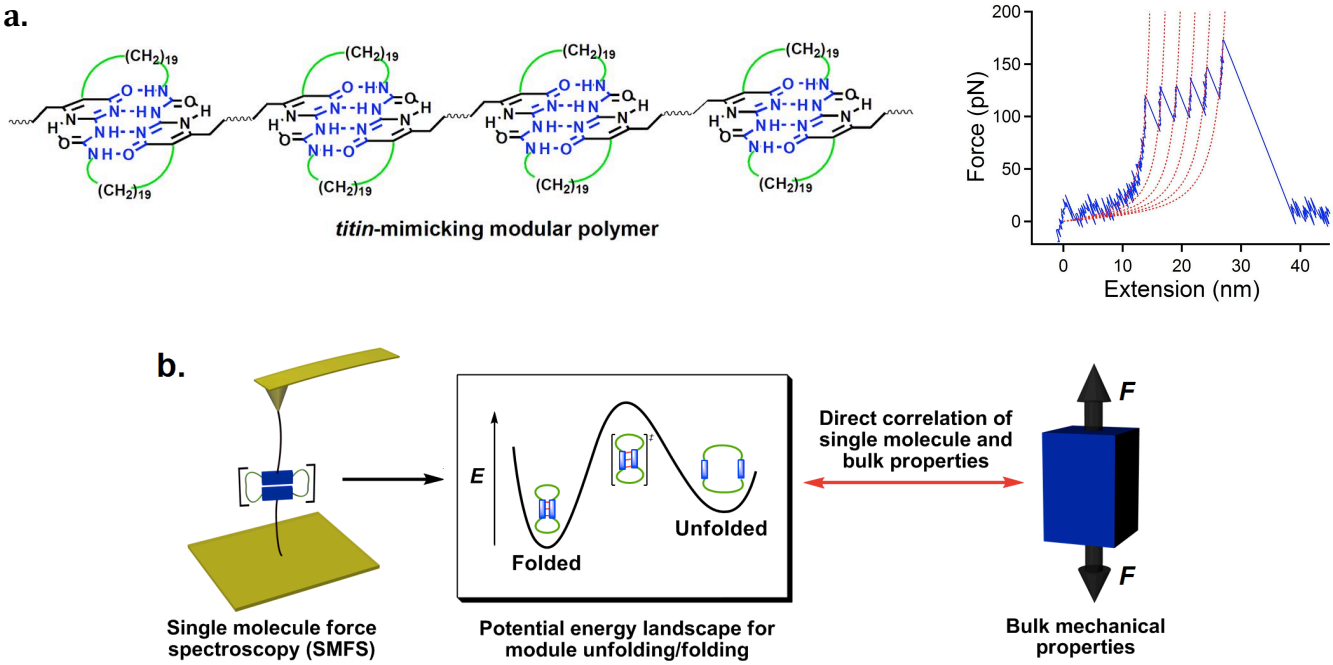
Be Strong, Tough, Adaptive and Self-healing: Life Lessons Applied to Soft Material Designs

Professor Zhibin Guan (zguan@uci.edu)
Department of Chemistry, University of California, Irvine, CA 92697-2025, USA

Abstract:

Many biopolymers not only have advanced mechanical properties such as high modulus, toughness, and elasticity, but more importantly, exhibit dynamic properties. Inspired by Nature, we have designed a series of biomimetic modular polymers with folded nano-domains as the repeat units. These new material manifest an exciting combination of key mechanical, as well as adaptive, properties that have until now proven difficult to achieve in man-made systems. Single molecule force was used to correlate the exceptional mechanical properties with their molecular structures. In another example of material design inspired by nature, we developed strong and spontaneous self-healing polymers. In contrast to previous designs, our system spontaneously self-heals as a single-component solid at ambient conditions without the need of any external stimulus, healing agent, plasticizer, or solvent. In addition, we developed several other strategies for self-healing materials including the use of dynamic metal-ligand interactions and dynamic covalent bond exchange. In this seminar, I will discuss the design, synthesis, and single molecule and macroscopic property studies of several dynamic adaptive polymers, as well as strong and autonomic self-healing systems.



References:

1. "Modular Design in Natural and Biomimetic Soft Materials" *Angew. Chem. Int. Ed.* **2011**, *50*, 9026.
2. "Multiphase Design of Stiff and Autonomic Self-Healing Polymers" *Nature Chem.* **2012**, *4*, 467.
3. "Direct correlation of single-molecule properties with bulk mechanical performance for the biomimetic design of polymers" *Nature Materials* **2014**, *13*, 1055.
4. "Self-Healing Multiphase Polymers via Dynamic Metal-Ligand Interactions" *J. Am. Chem. Soc.* **2014**, *136*, 16128.
5. "Malleable and Self-Healing Covalent Polymer Networks through Tunable Dynamic Boronic Ester Bonds" *J. Am. Chem. Soc.* **2015**, *137*, 6492.

Short Biography:

After finishing his undergraduate education at Peking University, Professor Guan received his Ph.D. degree in 1994 at the University of North Carolina, Chapel Hill. Following a postdoctoral stint at Caltech and a short career at DuPont, in 2000 he joined UC-Irvine as an assistant professor and was promoted to full professor in 2006. Professor Guan is recognized for his contributions to new polymerization chemistry, bioinspired materials design, single molecule force study of polymers, and functional biomaterials. His major research accomplishments include the development of new catalytic polymerization methods, the development of new biomimetic materials concepts, the design of strong and tough self-healing materials, and the invention of functional biomaterials for tissue engineering and gene delivery applications. His research work has been featured many times in scientific journals and popular newspapers such as C&EN News, Washington Post, Wall Street Journal, Los Angeles Times, CNN, Forbes, etc. He received numerous awards including the Japan Society for the Promotion of Science (JSPS) Fellowship, the Humboldt Bessel Research Award, the Camille Dreyfus Teacher-Scholar Award, the NSF CAREER Award, and the Beckman Young Investigator Award. In 2008, he was elected a Fellow of the American Association for the Advancement of Science. He was elected as the current Chair for the 2018 Bioinspired Materials Gordon Research Conference.