Classical Challenges in the Physical Chemistry of Polymer Networks: Topology, Elasticity and Percolation

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ABSTRACT

Polymer networks is a very important category of materials. Despite the ubiquity of applications, the way that chemistry and processing interact to yield the final structure and material properties of polymer networks is not fully understood, which leads to a number of classical challenges in the physical chemistry of gels. Much of our fundamental knowledge about polymer networks is based on an assumption of ideal tree-like structure. However, real polymer networks inevitably possess topological defects: loops of different orders. Quantifying the number of loops and their impacts on the gel properties remains a long-standing problem. Recently, we have developed a kinetic graph theory to provide a quantitative prediction of loop densities, which is in excellent agreement with experimental measurements without any fitting parameters. We have also developed a real elastic network theory (RENT) that systematically accounts for the loop impacts on the elastic modulus of polymer networks. Furthermore, we have developed a kinetic Monte Carlo simulation to quantify the gel point suppression for real polymer networks. These theoretical tools provide for the first time the quantitative prediction of gel properties based on molecular information of polymer networks, serving as a key step toward predictably designing new materials.

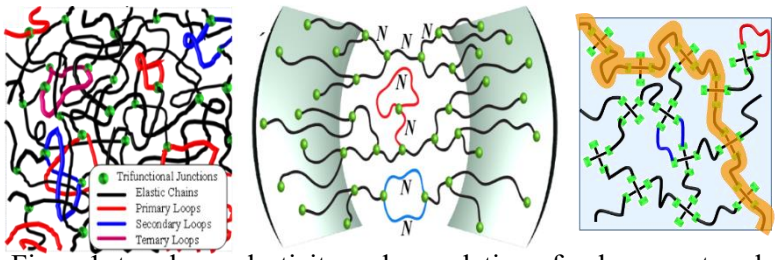
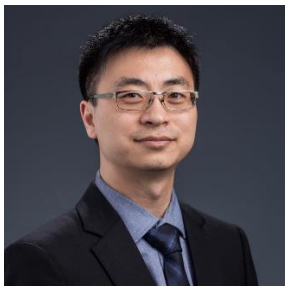


Figure1, topology, elasticity and percolation of polymer networks

Biography



Rui Wang received his B.S. in Chemical Engineering from Zhejiang University. He received his Ph.D. in Chemical Engineering from Caltech in 2014, advised by Prof. Zhen-Gang Wang. He was a postdoctoral researcher in the Department of Chemical Engineering at MIT by working with Prof. Bradley Olsen and Prof. Jeremiah Johnson from 2015 to 2018. He will join the Department of Chemical and Biomolecular Engineering at UC Berkeley from Jan. 1, 2019 as an Assistant Professor.

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