UC San Diego
JACOBS SCHOOL OF ENGINEERING
NanoEngineering

UC SAN DIEGO NANOENGINEERING SEMINAR

Wednesday, February 14th, 2018 11:00am – 12:00pm
Faculty Recruitment Seminar Presentation
ASML Conference Center (SME 248)

"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. The theory is in excellent agreement with experimental measurements of hydrogel loop fractions 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 and simulation 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.

Biosketch: Dr. Rui Wang received his B.S. in Chemical Engineering from Zhejiang University, China. He received his Ph.D in Chemical Engineering from Caltech in 2014, advised by Prof. Zhen-Gang Wang. He is presently a postdoctoral researcher in the Department of Chemical Engineering at MIT and works with Prof. Bradley Olsen and Prof. Jeremiah Johnson. During his Ph.D and postdoctoral research, he developed a few molecular level predictive theories to study a variety of soft matter systems, including polymer solutions, liquid-crystal polymers, ion-containing materials and polymer networks. Particularly, he has developed a real elastic network theory (RENT) which provides quantitative prediction of the elastic modulus of gels from the molecular information. His current interests are in theoretical study of complex soft materials with multiple components and interactions. Research areas include complex electrostatics at interfaces, polyelectrolytes, ionic gels and liquid-crystal elastomers. He has won several academic awards such as the First Prize in Natural Science Award from Ministry of Education, China and Constantin G. Economou Prize from Caltech.