POLYMER CONFORMATION AND DYNAMICS IN CROWDED ENVIRONMENTS: A COMBINED DIFFUSION NMR AND SMALL-ANGLE NEUTRON SCATTERING STUDY

Anand Yethiraj, Dept. of Physics and Physical Oceanography, Memorial University, St. John's, NL A1C2L2 Canada ayethiraj@mun.ca
Swomitra Palit, Memorial University, St. John's, NL A1C2L2 Canada
Arun Yethiraj, University of Wisconsin-Madison, Madison, WI, USA
Lilin He, William A. Hamilton, Oak Ridge National Laboratory, Oak Ridge, TN, USA

Key Words: pulsed-field-gradient NMR, macromolecular crowding, polymer dynamics, small-angle neutron scattering

The effect of particles on the behavior of polymers in solution is important in a number of important phenomena such as the effect of "crowding" proteins in cells, colloid-polymer mixtures, and nanoparticle "fillers" in polymer solutions and melts. In this talk, I will present a study of the effect of spherical inert nanoparticles (which we refer to as "crowders") on the diffusion coefficient and radius of gyration of polymers in solution using pulsed-field-gra- dient NMR and small-angle neutron scattering (SANS), respectively. In addition, the role of enthalpic crowder- crowder interactions on the crowding process is unknown: we can control this by varying charge on the crowder particle.

Below a characteristic polymer concentration, which we identify as the overlap threshold concentration $c^\star$, the diffusion coefficients exhibit a plateau. Above $c^\star$, in a crossover region between the dilute and semidilute regimes, the (long-time) self-diffusion coefficients are found, universally, to decrease exponentially with polymer concentration at all crowder packing fractions, consistent with a structural basis for the long-time dynamics. When the polymer radius of gyration and crowder size are comparable, the polymer size is very weakly affected by the presence of crowders, consistent with recent computer simulations. We find that crowder charge only weakly affects polymer size and dynamics in the crowding limit, but that local macromolecular mobility depends strongly on molecular flexibility.