DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Fall Seminar Series

Direct Measurement of the Local Glass Transition in Diblock Copolymers

Rodney D. Priestley, PhD
Professor, Chemical and Biological Engineering
Princeton University

Wednesday, December 4, 2:00 p.m.
PISB 104

Block copolymers, which self-assemble into nanodomain structures due to the incompatibility of chemically dissimilar monomer segments, have generated intense scientific interest and are used in a myriad of important technologies. In such systems, a large fraction of the polymer segments can lie within a few nanometers of an internal interface, within a region where the dynamics and mechanical properties can be strongly modified from their bulk values. The molecular dynamics at these soft internal interfaces can modulate the performance characteristics of copolymers and enable them to escape traditional material property tradeoffs—such as those between stiffness and toughness—that set limits on the performance of homogeneous polymers. The ability to characterize the dynamics near the internal interfaces within block copolymers could enable the rational design of polymers with prescribed interfacial properties for next-generation applications. In addition, these same insights would advance our fundamental understanding of the complex ways in which interfaces and nanoscale confinement can influence the dynamics of polymers in technologically important macroscopic materials, i.e., block copolymers. In this talk, we will present an experimental methodology to allow for the first direct measurement of the local glass transition temperature (Tg) in block copolymers. This iss achieved by incorporating fluorescence-bearing monomers at specific locations along the polymer chain, allowing the labeled monomers local environment to be interrogated via fluorescence. As an example, in lamellar forming poly(butyl methacrylate-b -methyl methacrylate) diblock copolymers, a strong gradient in glass transition temperature, Tg, of the higher-Tg block, 42 K over 4 nm, was mapped with nanometer resolution. These measurements also revealed a strongly asymmetric influence of the domain interface on Tg, with a much smaller dynamic gradient being observed for the lower-Tg block. We also find that chain connectivity plays an important role in setting the glassy dynamics in diblock copolymers.

Rodney D. Priestley is the Vice Dean of Innovation at Princeton University. He is a Professor in the Department of Chemical and Biological Engineering and the Associate Director of the Princeton Center for Complex Materials. He obtained his Ph.D. in Chemical Engineering from Northwestern University in 2008. He completed a NSF/Chateaubriand postdoctoral fellowship at Ecole Superieure de Physique et Chimie Industrielles de la Ville de Paris. His research interests include polymer glasses, nanoconfined polymer dynamics, polymer thin film and nanoparticle formation, MAPLE and responsive polymers. He is the recipient of numerous awards including the Quadrant Award, ACS New Investigator Grant, 3M Non-Tenured Faculty Grant, NSF CAREER Award, AFOSR YIP, Presidential Early Career Award for Scientist and Engineers, Alfred P. Sloan Fellowship and Camille Dreyfus Teacher-Scholar Award, AICHE MSED Owens Corning Early Career Award; and was named to the Root 100 list of most influential African Americans and World Economic Forum Young Global Scientist.