

THE MATERIALS SCIENCE AND ENGINEERING DEPARTMENT
FALL COLLOQUIUM SERIES PRESENTS:

Professor Timothy Lodge

Professor of Department of Chemistry and
Department of Chemical Engineering & Materials Science



University of Minnesota

Equilibration of Block Copolymer Micelles: How Difficult Can It Be?

Block copolymers provide a remarkably versatile platform for achieving desired nanostructures by self-assembly, with dimensions ranging from a few nanometers up to microns. In particular, block copolymer micelles in selective solvents are of interest across a range of technologies, including drug delivery, imaging, catalysis, lubrication, and extraction. While block copolymers generally adopt the morphologies familiar in small molecule surfactants and lipids (*i.e.*, spherical micelles, worm-like micelles, and vesicles), one key difference is that polymeric micelles are typically *not* at equilibrium. The primary reason is the large number of repeat units in the insoluble block, N_{core} , which makes the thermodynamic penalty for extracting a single chain (“unimer exchange”) substantial. We use time-resolved small angle neutron scattering (TR-SANS) to obtain a detailed picture of the mechanisms and time scales for chain exchange, for systems at or near equilibrium. The dependence of the rate of exchange on the key variables – concentration, temperature, N_{core} , N_{corona} , and chain architecture (diblock versus triblock) – will be discussed. Interestingly, almost none of the observed features are captured by available theory. For concentrated triblock copolymers, it has also become possible to compare the stress relaxation time from rheology, directly with the end-block pull out time from TR-SANS. Then, when micelles are significantly larger or smaller than the equilibrium size, fragmentation and fusion mechanisms, respectively, can become operative. We will describe measurements using dynamic light scattering, small-angle X-ray scattering, and liquid-phase TEM to follow the fragmentation and fusion processes in unprecedented detail.

Tim Lodge graduated from Harvard B.A. *cum laude* in Applied Mathematics (1975). He completed his PhD in Chemistry at Wisconsin in 1980 with John Schrag, and then spent 20 months as a National Research Council Postdoctoral Fellow at NIST. Since 1982, he has been on the Chemistry faculty at Minnesota and, in 1995, he also became a Professor of Chemical Engineering & Materials Science. In 2013, he was named a Regents Professor, the University’s highest academic rank. He has been recognized with the American Physical Society (APS) Polymer Physics Prize (2004), the International Scientist Award from the Society of Polymer Science, Japan, (2009), the 2010 Prize in Polymer Chemistry from the American Chemical Society (ACS), and the Hermann Mark Award (2015) and the Paul Flory Education Award (2018) of the ACS Division of Polymer Chemistry. He has been elected to Fellowship in the American Association for the Advancement of Science, the APS, the ACS, and the Neutron Scattering Society of America. In 2016, he was elected to the American Academy of Arts and Sciences, and in 2024 to the National Academy of Engineering. From 2001–2017, he served as the Editor-in-Chief of the ACS journal *Macromolecules*. In 2011, he became the founding Editor for *ACS Macro Letters*. He has authored or co-authored over 520 papers in the field of polymer science, and advised or co-advised over 150 PhD students and postdoctoral fellows. His research interests center on the structure and dynamics of polymer liquids, including solutions, melts, blends, and block copolymers, with particular emphases on self-assembling systems using rheological, scattering and microscopy techniques.

Tuesday, October 15 • 4 pm CT • Tech L211

In person only; no Zoom

Questions? Contact allison.macknick@northwestern.edu