Single-Molecule Fluorescence Studies of Block Copolymer Microdomains

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In recent years, single-molecule fluorescence methods including single-molecule tracking (SMT) have been employed to study molecular mass transport in self-assembled one-dimensional nanostructures. These methods offer quantitative information on the diffusion of single molecules and also on nanostructure morphologies. In this presentation, I would like to introduce our recent SMT studies of nanoscale block copolymer microdomains. We record the diffusional behavior of individual sulforhodamine B (SRB) molecules incorporated into the one-dimensional (1D) microdomains of cylinder-forming polystyrene-poly(ethylene oxide) (PS-*b*-PEO) diblock copolymer films. The resulting single-molecule trajectories permit us to determine the diffusion coefficients and diffusion directions of individual SRB molecules that reflect the permeability and orientation of the SRB-loaded PEO microdomains, in addition to the radii of the microdomains. These parameters enable a detailed comparison of microdomain morphologies in PS-*b*-PEO films prepared via two different approaches (horizontal solvent vapor penetration and substrate-defined shear flow), and also the investigation of a relationship between the radius and permeability of solvent-swollen microdomains. In addition, fluorescence recovery after photobleaching (FRAP) and SMT measurements are explored at identical areas to directly compare ensemble and single-molecule diffusion (ergodicity) with minimum influence of material heterogeneity. These fluorescence methods provide unique means to measure the morphology and permeability of polymer nanostructures under ambient conditions, and thus will afford fundamental information required to design better polymer nanostructures for chemical separations and sensing.

Short Bio:

Takashi Ito is a professor of chemistry at Kansas State University. He received his B.S. (1993), M.S. (1995), and Ph.D. (1998) degrees in chemistry from the University of Tokyo (Mentor: Prof. Yoshio Umezawa). He worked as a research associate at Tokyo University of Science (1998-2001; Mentor: Prof. Yuko Hasegawa) and then as a postdoctoral research associate at Texas A&M University (2001-2004; Mentor: Prof. Richard M. Crooks) before starting his independent career as an assistant professor at Kansas State University. His current research projects involve investigation of mass and charge transport within self-organized nanostructures using microscopic and electrochemical techniques for future development of efficient separation and sensing methods/materials. He currently serves as an editorial board member for *The Chemical Record* (The Chemical Society of Japan and Wiley).