INVITATION TO SPECIAL SEMINAR ON

Morphological Studies and Versatile Properties of Network-Forming Multiblock Ionomers

by

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ABSTRACT. Block copolymers continue to capture the attention of the academic and industrial worlds due largely to their fascinating ability to spontaneously self-assemble into a wide variety of "soft" nanostructures that are ideally suited for a broad range of diverse nanotechnologies. The development of thermoplastic elastomers (TPEs), such as triblock copolymers with glassy endblocks and a rubbery midblock, also endows these materials with elastic network-forming characteristics, and selective solvation of the rubbery midblock results in thermoplastic elastomer gels (TPEGs) with remarkable mechanical properties for dielectric elastomers, shape-memory systems, and flextronics. While most block copolymers are inherently nonpolar, targeted functionalization of block copolymers can permit these materials to be used in polar environments. Sulfonation of block copolymers, for example, yields materials that possess amphiphilic properties for new applications such as desalination membranes and fuel cells. Combination of TPEs with a sulfonated midblock produces a unique TPEG that is capable of forming a physical hydrogel. We have recently demonstrated that these materials are competitive candidates for electroactive media and photovoltaic devices, and these achievements will be presented. Unfortunately, the inherently high incompatibilities and glass transition temperatures of such block ionomers effectively prevent the use of thermal annealing, routinely employed to refine the morphologies of nonionic block copolymers. An alternative approach is therefore required to promote morphological equilibration in block ionomers. This presentation likewise explores the morphological characteristics of midblock-sulfonated pentablock ionomers (SBIs) differing in their degree of sulfonation (DOS) and cast from solvents differing in polarity, followed by solvent-vapor annealing (SVA). Transmission electron microscopy confirms that films deposited from different solvent systems form nonequilibrium morphologies due to solvent-templated self-assembly and drying. A series of SVA tests performed with solvents varying in polarity reveals that exposing cast films to the vapor of a polar solvent constitutes the most effective SVA protocol, yielding the anticipated equilibrium morphology. That is, three SBI grades subjected to SVA order into alternating lamellae wherein the increase in DOS is accompanied by an increase in lamellar periodicity, as measured by synchrotron small-angle X-ray scattering. I shall also demonstrate how discrete ion-rich microdomains undergo a phase transformation and become continuous in the presence of water.

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Dr. Richard J. Spontak is an Alumni Distinguished Professor of Chemical & Biomolecular Engineering and Materials Science & Engineering at North Carolina State University in Raleigh, NC. He received his B.S. degree in Chemical Engineering (with honors/high distinction) from the Pennsylvania State University in 1983 and was later awarded the Ph.D. degree in Chemical Engineering (under the supervision of Mike Williams) from the University of California at Berkeley in 1988. He then pursued post-doctoral research with Alan Windle in Materials Science & Metallurgy at the University of Cambridge (U.K.) and Tormod Riste in Condensed Matter Physics at the Institute for Energy Technology (Norway) before joining the Corporate Research Division of the Procter & Gamble Company in 1990. In 1992, he accepted a faculty position at North Carolina State University, where he supervises the Polymer Morphology Group. Since that time, Spontak has published over 275 research papers, and his work has been featured on 20 journal covers. Although active in a diverse range of disciplines, his primary research interests relate to the phase behavior and morphology/property development of nanostructured polymers, polymer nanocomposites, electron microscopy, and stimuli-responsive (electroactive and shape-memory) media. In recognition of his fundamental and applied research endeavors, he is the recipient of numerous honors and awards such as the *Sigma Xi* Outstanding Research Award, the Alcoa Foundation Engineering Achievement and Distinguished Engineering Research Awards, Alexander von Humboldt and Tewkesbury fellowships, the North Carolina State University Alumni Outstanding Research Award, the 2006 American Chemical Society (PMSE Division) Cooperative Research Award in Polymer Science & Engineering, the 2007 German Society for Electron Microscopy Ernst Ruska Prize, the 2008 American Chemical Society (Rubber Division) Chemistry of Thermoplastic Elastomers Award, the 2011 Institute of Materials, Minerals and Mining (IOM3) Colwyn Medal, the 2012 Norwegian University of Science & Technology Lars Onsager Medal, and the 2015 Society of Plastics Engineers International Award. An elected fellow of the American Physical Society, IOM3 and the Royal Society of Chemistry, he is or has been on the editorial advisory board of 21 international journals and holds editorial positions on 3 of them. He has been recognized as a 2007 Outstanding Scholar Alumnus and a 2012 Alumni Fellow by the Pennsylvania State University, and he is a member of the Norwegian Academy of Technological Sciences. Spontak is also a highly acclaimed educator and academic mentor. For his instructional effectiveness employing cooperative and active learning pedagogies in the classroom, he has been elected to the North Carolina State University Academy of Outstanding Teachers and selected for the UNC System Board of Governor's Award for Excellence in Teaching, the highest instructional honor bestowed by the University of North Carolina system. He has been active in promoting multidisciplinary undergraduate research and design, for which he received the 2006 International Network for Engineering Education & Research Recognition Award and the 2009 American Society for Engineering Education Southeast Region Outstanding Mid-Career Teaching Award. He resides in Raleigh with his wife Josie and his two children, Danielle and Joshua.