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### **Hierarchical Structures in Ion-Containing Polymers**

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Ion-containing polymers are currently used as tough thermoplastics primarily. To extend their applications to the electrolytes in batteries, electroactive polymers for actuation, and permselective membranes in fuel cells, the hierarchical structures of the complex polymers must be characterized and controlled. Over the last decade we have developed scanning transmission electron microscopy, X-ray scattering methods, and image simulations to quantify the nanoscale morphologies in these materials. This seminar will present our recent work, wherein we collaborate with various groups who are synthesizing new ion-containing polymers and correlating the morphologies to transport properties. The first example is a series of Li, Na, and Cs-neutralized sulfonated polyester ionomers with well-defined poly(ethylene glycol) spacer lengths. The state of ionic aggregation depends on the cation type, spacer length, and temperature. The second example is binary mixtures of a poly(styrene-*b*-methyl methacrylate) diblock copolymer and an ionic liquid, where the ordered morphologies profoundly impact the ionic conductivity. The third example is linear polyethylenes with precisely spaced acid groups and a layered hierarchical structure.