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Precise Microstructures in Functional Polymers Provide Morphology Control and Improved Transport

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Abstract: Polymer synthetic chemistry can now provide remarkable control over polymer microstructures, including the placement of associating functional groups in ionomers. We have studied various precise and nearly-precise polymer architectures focusing on connecting the microstructure to self-assembled morphologies and transport properties. This talk will highlight two sets of polymers. First, a set of segmented ionomers containing polar units with one neutralized sulfonate groups separated by a precise number (n = 10 - 48) of methylene groups (PESn-X) were synthesized in Prof. Stefan Mecking's group. These PESn-X ionomers exhibit exceptional long-range order and order-order transitions reminiscent of block copolymers and we have constructed phase diagrams for comparison with theoretical predictions of multiblock copolymers. The PES12-Li polymer exhibits a disordered morphology above 120 °C and we applied the RPA theory for multiblock copolymers to extract the chi parameter. With respect to ion conductivity, the most promising of the ordered structures is the double gyroid structure that exhibits higher ionic conductivity than the isotropic layered or hexagonal morphologies. Second, Prof. Justin Kennemur's group used ring opening polymerization to produce a linear polyethylene with a function group on every fifth carbon. When the functional group is a phenyl sulfonate and the polymer is hydrated, we found exceptional proton conductivity that is the result of percolated nanoscale water channels. Synthetic control over polymer microstructure undeniably promotes polymer physics understanding and consequently improves property control.

Biography: **Karen I. Winey** is the Harold Pender Professor of Engineering and Applied Science at the University of Pennsylvania. Karen received her B.S. in materials science from Cornell University and her Ph.D. in polymer science and engineering from the University of Massachusetts, Amherst. Karen's research focuses on the nanoscale structures in ionomers and associating polymers to improve mechanical and transport properties, and has recently reported new structures in several precise ionomers. Karen has expertise in the mechanic, thermal and electrical properties of polymer nanocomposites, as well as polymer dynamics and diffusion in the presence of nanoparticles and in nanoconfinement. Karen frequently couples experimental studies with simulation and theory via collaboration. In addition to numerous lectureships, fellowships and awards, Karen was recently awarded the 2020 Braskem Award by AIChE and the 2020 Herman F. Mark Senior Scholar Award.