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Interplay of Transport and Morphology in Nanostructured Ion-Containing Polymers

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The global energy crisis and an increase in environmental pollution in the recent years have drawn the attention of the scientific community to develop innovative ways to improve energy storage and find more efficient methods of transporting the energy. Polymers containing charged species that show high ionic conductivity and good mechanical integrity are the essential components of these energy storage and transport systems. In this talk, first, I will present a fundamental understanding of the thermodynamics and transport in ion-containing block copolymers with a focus on the structure-property relationships. Tailoring the intermolecular interactions between the polymer matrix and the embedded charges appeared to be vital for controlling the transport properties. Particularly, the achievement of well-defined self-assembled morphologies with three-dimensional symmetries has proven to facilitate fast ion transport by constructing less tortuous ion-conducting pathways. Examples of attained morphologies include disorder, lamellae, gyroid, Fddd, hexagonal cylinder, body-centered cubic, face-centered cubic, and A15 phases. Second, various strategies for accessing high cation transference number as well as improved ionic conductivity from ionic-containing polymers are enclosed; (1) the inclusion of terminal ionic units as a new means to control the nanoscale morphologies and the transport efficiency of block copolymer electrolytes and (2) the addition of zwitterions that offered a polar medium close to water, and accordingly increased the charge density and ionic conductivity. The obtained knowledge on polymer electrolytes could be used in a wide range of emerging nanotechnologies such as fuel cells, lithium batteries, and electro-active actuators.