Phase Behavior and Structure in Polymer / Lithium Salt Mixtures

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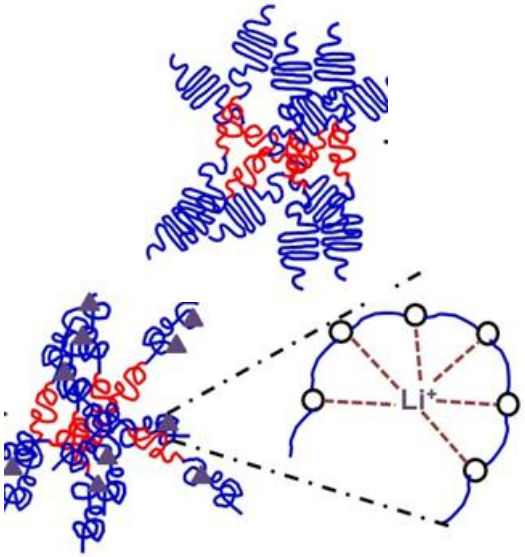
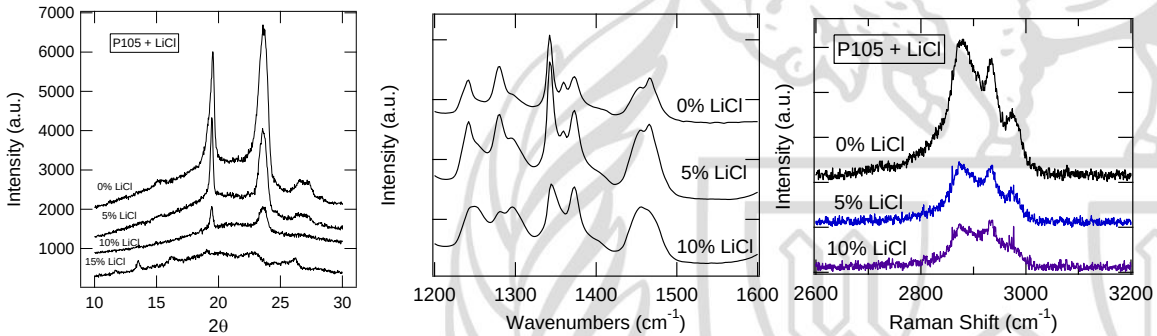
Rechargeable lithium batteries are attractive for energy storage because of their high specific energy and efficiency, but cannot meet scaled up demands. In particular, the liquid electrolytes commonly used impose serious safety concerns.

Solid electrolytes would improve safety, stability, and cost, but there are several issues to overcome. Block copolymer-based electrolytes offer multi-scale interactions and structure that can benefit the design of batteries. The structure of the nanoscale block copolymer domains where ions are located, and their mesoscale topology, are important to this end.

We research phase behavior and structure in multi-component systems containing block copolymers and lithium salts, with a focus on the interplay between block copolymer organization and Li+ location/mobility. We employ block copolymers consisting of poly(ethylene oxide) (PEO) that enable three levels of organization: crystalline PEO, liquid crystalline block copolymer assemblies, and long-range orientation of ordered domains. We also investigate additives such as colloidal silica and polyhedral oligomeric silsesquioxanes (POSS) that affect PEO chain conformation and ion mobility. This work contributes fundamental information that could inform the design of new/improved electrolytes and batteries for energy applications.





X-ray diffraction (left), FTIR (middle), and Raman data all show a decrease in the degree of crystallinity of poly(ethylene oxide)-poly(propylene oxide)-poly(ethylene oxide) block copolymer (Pluronic P105) following addition of LiCl.