

Abstract for an Invited Paper
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Polymer Physics Prize Lecture: Polyelectrolyte complexes: New routes to useful soft materials

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Mixtures of oppositely charged polyelectrolytes may form precipitates (phase-separated solids) or coacervates (phase-separated fluids). Coacervates have been known for a long time to have interesting properties such as very low interfacial tension with water and a resultant ability to coat surfaces, engulf particles and invade porous media. Most prior work on coacervate complexes has been done with structurally complex (e.g., gum Arabic), biologically derived macromolecules (e.g., gelation). Our work is focusing on phase behavior and self-assembly in classes of structurally simpler polymers. Polypeptides are one such class, where we can produce anionic, cationic and neutral, water-soluble polymers all with the same backbone and varying in small side-group structures. We are able to demonstrate very general patterns in phase behavior over different members of this class of polymers. Coacervate formation is the rule rather than the exception in these materials, with such formation quite strongly peaked at balanced stoichiometry of the polyelectrolyte components. One molar salt is usually sufficient to dissolve the coacervate phases that form. Block copolymer mixtures containing oppositely charged blocks can form self-assembled structures: micelles with diblocks and hydrogels with triblocks. The structure and properties of these assemblies can be tuned based on knowledge of the bulk phase behavior response to molecular weight, stoichiometry and salt concentration. Examples of phase behavior and structure-property relationship will be discussed.