BioPACIFIC MIP at UCSB & UCLA, DMR-1933487

Local project - 2024

Engineering Soft, Elastic, and Conductive Polymers for Stretchable Electronics Using Ionic Compatibilization

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What was achieved?:

In this paper the design of soft, elastic, and highly conductive polymer complexes through electrostatic interactions between an anionic conjugated polyelectrolyte (CPE) and a cationic bottlebrush polyelectrolyte (BPE) was demonstrated. Strong electrostatic attractions between oppositely charged side chains of the CPE and BPE suppressed phase separation and the polymers formed a nearly homogeneous charged complex despite marked differences in their chemistry and architecture. This straightforward approach eliminates the need for additional crosslinkers or complex processing optimization, to create a synergistic combination of elasticity from BPE and conductivity from CPE. This work underscores the potential of using ionic compatibilization to engineer multifunctional polymeric materials with implications for applications such as next-generation electronics and bio-interfacing.

Why is it important?:

The ability to overcome the challenge of combining softness, elasticity, and conductivity in polymers holds significant importance in material science. This achievement addresses a crucial obstacle, particularly evident in all-polymer systems, where the inherent stiffness of traditional conductive materials hampers effective mixing with elastomeric counterparts, resulting in inferior material properties. By utilizing electrostatic interactions to compatibilize polymers with contrasting properties, new avenues for designing advanced materials are opened. Such materials find critical applications in fields like soft robotics and wearable electronics, where the demand for tailored electrical conductivity coupled with mechanical flexibility is paramount. This breakthrough paves the way for the development of next-generation electronics and bio-interfacing technologies, offering solutions to pressing challenges and advancing the frontier of material science.

How is this achievement synergistic with BioPACIFIC MIP?

This study aligns with BioPACIFIC MIP's mission to understand structure-property relationships in materials. The scientists made use of the texture analyzer and SAXS for the characterization of the materials, which is crucial for understanding its properties.

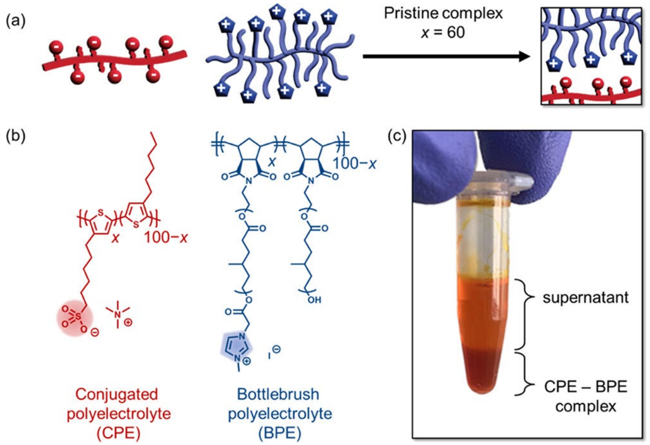

***Figure 1:** (a, b) Coacervation of a conjugated polyelectrolyte (CPE, red) and bottlebrush polyelectrolyte (BPE, blue), each with 60% charge fraction (x = 60), leads to an ionically crosslinked polymer complex. (c) Photograph of phase separation upon mixing CPE and BPE solutions, producing a concentrated coacervate (darker orange, bottom) in coexistence with polymer-deficient supernatant (lighter orange, top).*

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