Chemical Engineering Doctoral Defense

Structure-property-function relationships for segmented ionenes

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Abstract

There are limited analyses of the properties of segmented ionenes on the influence of the type, structure, content of soft/hard segments, and type of counterions through direct comparisons, which are needed for a diverse set of applications. This dissertation research focuses on resolving the gaps in the structure-property-function relationship of segmented ionenes. First, the synthesis of novel segmented ionenes using step-growth polymerization via the Menshutkin reaction of ditertiary amines and alkyl dihalides was performed with PEG soft segment with three different content of soft/hard segments, 25, 50, and 75 wt%, and two different hard segments, linear aliphatic and heterocyclic aliphatic hard segments. The content of the soft segment influenced the degree of phase separation and ionic aggregation which affected the thermomechanical properties of segmented ionenes. In addition, the crystallization of the soft segment influenced the mechanical properties of the ionenes. Second, the effect of the type of the soft segment was investigated by analyzing the novel PTMO-based segmented ionenes possessing three different content of soft/hard segments, as well as two different hard segments. The heterocyclic aliphatic hard segment provided a better degree of phase separation compared to the linear aliphatic hard segment irrespective of the type of soft segment, PEG, or PTMO. Moreover, the type and content of hard segments not only affected the thermal and mechanical properties but also the morphology of the segmented ionenes significantly that even inducing an ordered morphology. Third, the counter-anion metathesis was performed with PEG- and PTMO-based segmented ionenes possessing two structurally different hard segments to investigate the effect of the type of counter-anions with a direct comparison of the type of soft and hard segments. The type of counterion significantly influenced the thermomechanical properties of the segmented ionenes, and the degree of phase separation of different types of counter-anions was dependent on the type of soft and hard segments. The results of this dissertation provide fundamental insights into the correlations between each factor that influences the properties of the segmented ionenes and enable the design of segmented ionenes for a diverse range of applications.

April 10, 2023; 10 AM; ECG G227;
Zoom Link: https://asu.zoom.us/j/9518789489