Segmented Phosphonium Ionenes As Solid Polymer Electrolytes for Lithium Ion Batteries

K. Strong and A. Abdulahad

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All-solid-state lithium ion batteries replace the traditional liquid electrolyte with a conductive solid polymer electrolyte. Replacing the liquid electrolyte in batteries has the potential to improve safe use of batteries without the need for hermetic sealing, extending the operating temperature range, and extending the lifetime of the battery. However, solid polymer electrolytes often have non-competitive conductivity compared to liquid electrolytes. Improving the conductivity of solid polymer electrolytes based on an understanding of structure-property relationships is not yet well understood, but it is believed to depend heavily on the localized segmental motion of polymer chains. This work attempts to describe the role of polymer segmental motion on lithium ion transport through the synthesis and characterization of phosphonium ionenes that include poly(ethylene oxide) “soft” segments. Synthetically, these segmented polymers offer an opportunity to systematically control the segmental motion of polymer chains (i.e. glass transition temperature) through control of PEO incorporation. Prepared by step-growth polymerization, these segmented phosphonium ionenes achieve molecular weights up to 40,000 g/mol. Also, the degradation and glass transition temperatures are dependent on the percent incorporation of PEO as determined by thermogravimetric analysis and differential scanning calorimetry, respectively. The ability to influence the physical properties of this unique class of polyelectrolyte provides a unique opportunity to systematically probe the impact of glass transition temperature on the ion transport properties of solid polymer electrolytes in lithium ion batteries. Our initial results from electrochemical impedance as well as the charge/discharge performance of these novel solid polymer electrolytes in coin cell battery assemblies will also be presented.