Uncovering the impact of coordination chemistry on cation transport in polymer electrolytes

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Since the dawn of the research field of ion transport in polymer materials, there has been a heavy focus on materials based on polyether matrices and in particular poly(ethylene oxide) (PEO). While important lessons have been gained – such as the dependence on amorphous structures and chain dynamics for fast ion transport – the one-sided focus on PEO as the ion-solvating matrix has largely obscured the effects of the coordination structure on the movement of ions in polymeric materials. Instead, the prevailing models for ion transport emphasize the coupling of the cation movement to the segmental dynamics of the polymer host. This is indeed an important cornerstone of the phenomenon of ion transport in polymers, but recent research has uncovered additional aspects that are equally important to understand and control in order to optimize materials for fast ion transport. As one of these factors, the coordination structure and the strength of the ion–polymer interactions have a notable impact on ion transport, with a direct correlation between the coordination strength and the cation transference number, as measured both electrochemically and with electrophoretic NMR. [1] This improved understanding has been enabled both by the implementation of new materials with a wider range of coordinating motifs and differences in coordination strength, and by the development of methods that allow for determination of the coordination strength.
This presentation will account for our recent efforts into uncovering the effects of coordination chemistry on the transport properties of polymer electrolytes, how this brings us closer to painting a complete picture of the mechanism of ion transport in solvent-free polymers and how it can be applied to tailor materials for more efficient cation conduction. [2] While it is natural to start this discussion with Li^+ coordination and transport, it is also interesting to expand it further towards for example Na^+ and Mg^{2+}, [3, 4] which are interesting not only as next-generation battery systems, but also from the point of view of creating a more complete and fundamental understanding of the ion transport phenomena in these systems.

Keywords: polymer electrolytes, ion transport, coordination

References

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