Lithium Ion Transport in Polymer Electrolyte Films for Solid State Batteries – An Overview on Concepts, Techniques and Results

Hans-Dieter Wiemhöfer

Institute of Inorganic and Analytical Chemistry, University of Münster, Corrensstr. 29-30, D-48149 Münster, Germany

Corresponding author: Hans-Dieter Wiemhöfer, E-Mail: hdw@wwu.de

Thin films of polymer based electrolytes are, first of all, an alternative to crystalline or glassy solid electrolytes. There are interesting advantages but also disadvantages if one compares lithium ion conducting polymer electrolytes with crystalline and glassy lithium ion conductors. Polymer electrolytes can offer a perfect flexibility and continuous adherence at electrode interfaces during charge-discharge cycling and thus deliver good interface kinetics. In addition, their chemical, thermal and electrochemical stability as well as the salt dissociation and ion mobility can be influenced in a wide range by chemical design and suitable additives.Thin polymer electrolyte films on electrodes can take the role of diffusion barriers, e.g. for cathode reaction products. Similarly, they may serve both as electrolyte and binder material in order to stabilize anode or cathode nanoparticle structures against large volume changes during lithium exchange. A further, rather appealing possibility is a multi-layer combination of crystalline or glassy solid electrolytes with thin polymer electrolyte films. Such properties make understandable the recent attention directed to polymer based electrolytes in the development of lithium/sulfur or lithium/air cells.
Many publications only characterize the total ionic conductivity of polymer electrolytes. Important arguments suggest that the partial lithium ion conductivities or alternatively the single ion diffusion coefficients are the most important properties to evaluate solid polymer based electrolytes for lithium batteries [1, 2]. This makes necessary a careful experimental determination of diffusion processes of ions, ion clusters and the relation to total and single ion conductivities. A particular importance for polymeric battery electrolytes concerns the knowledge and careful measurement of the transference number of lithium ions. In this presentation, the electrochemical properties of polymer electrolytes will be discussed with a special emphasis on the lithium ion transport mechanism and its implications [3 - 5].

References

[1] M.M. Hiller et al., *Electrochimica Acta* **114** (2013), 21-29
[2] S. Jankowsky, M.M. Hiller, H.-D. Wiemhöfer, *J. Power Sources*, **253** (2014), 256-262
[3] M. Grünebaum et al., (Review), *Progress Solid State Chem.* (2014), in Press, online under DOI: 10.1016/j.progsolidstchem.2014.04.004
[4] M. Burjanadze et al., (Review), *Z. Physikal. Chem. – Intern. J. Research in Phys. Chem. & Chem. Phys.*, **224** (2010), 1439-1473
[5] M. Kunze et al., *Macromolecules* **45** (2012), 8328-8335