Single-ion block copolymer electrolytes

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Today the environment is a major society concern and the polluting fossil energy consumption, more and more expensive, is a drag on our economy, thereby the development of alternative transportation such as electric or hybrid vehicles, has become a key need for a sustainable long term development[1]. The increase of energy density necessary to promote this future revolution imposes to develop "new" chemistries for both the active electrode materials and electrolyte[2,3]. However, for high scale applications a safety issue comes from the liquid electrolytes as they embedded organic solvents that can likely leak or generate flammable reactions. The use of a solid polymer electrolyte (SPE) could solve most of the safety issues encounter with liquid electrolyte. However, the development of SPE has been hampered by two hurdles i/ the inability to design a SPE that has both a high ionic conductivity and good mechanical properties[3] and ii/ the motions of lithium ions carry only a small fraction of the overall ionic current which leads during battery operation to the formation of strong concentration gradient with highly noxious effects like favored dendritic growth[4] and limited energy density, especially when power increases. In this context, we are developing nanostructured multifunctional block copolymer electrolytes (BCE), B-A-B comprising a central A block based on poly(ethylene oxide) (PEO) that brings ionic conductivity and a B block that brings other functionalities like mechanical properties, electrochemical stability, increase of transport number etc. We will present our approach in improving the performances of BCEs starting from neutral BCEs like PS-POE-PS[5,6] laden with a lithium salt to the single-ion BCEs (SIEL) comprising grafted lithium trifluoromethanesulfonylimide (TFSILi)[7]. Especially, we analyse the impact of the BCEs composition (ie proportion of PEO) and the effect of molecular weigh on the physical properties such as the morphology, the thermodynamic transitions, the mechanic stability and the ion transport. At last, for a complete analysis, the results obtained with several prototypes of batteries will be presented.

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