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Construction of interconnected micropores in poly(arylene ether) based single ion conducting blend polymer membranes via vapor-induced phase separation

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Abstract

We report the construction of interconnected micropores in a poly(arylene ether) based single ion conducting blend polymer electrolyte by tuning phase separation. Bis(4-fluorine benzene sulfonyl)imide is copolymerized with bis(4-hydroxy benzene sulfonyl)imide and bisphenol A separately to form two types of AB alternating block copolymers, i.e., lithiated poly(bis(benzene sulfonyl)imide)ether (LiPBIE) and lithiated poly(bisphenol A-*alt*-bis(4-fluorine benzene sulfonyl)imide)ether (LiPAFE). The former is immiscible with poly(vinylidene fluoride-*co*-hexafluoropropylene) (PVDF-HFP) and the latter is well entangled with the binder upon introducing the bisphenol group. The results reveal that the LiPBIE blend film exhibits an interconnected microporous structure while the LiPAFE blend film does not. Even if the ion exchange capacity (IEC) of the LiPAFE blend film is raised to the level of the LiPBIE blend film by reducing the proportion of PVDF-HFP, the film is porous only on the surface but remains dense in its bulk. The comparative experiments confirm that the disparity of polarity and solubility between the ionomers and the binder is largely responsible for the phase separation. The microporous single ion conducting gel polymer electrolyte offers an ionic conductivity of 0.52 mS cm^{-1} at 25 ^{o}C and its membrane displays the capability of dendrite suppression. A battery incorporating the electrolyte film exhibits excellent rate performance and electrochemical stability.

Key words: lithium ion battery, single ion conductor, phase separation, lithium dendrite