Nanocomposites of ionic liquid confined in fumed silica gel electrolytes for lithium batteries
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Ionic liquid-nanoparticle hybrid electrolytes have attracted considerable attention because of their high thermal stability, nonflammability, and the ability to suppress the formation of lithium dendrites [1, 2]. In this work, ionic liquid-gel electrolytes were prepared by dispersing 2-5wt% fumed silica nanoparticles (Aerosil A200) in an ionic liquid based electrolyte, N-methyl-(n-butyl)pyrrolidinium bis(trifluoromethanesulfonyl)imide (PYR14-TFSI) and lithium bis(trifluoromethanesulfonyl)imide (LiTFSI). We have investigated the gelation of the electrolyte as well as the conductivity, and the electrochemical performance. Stable gels are formed with the addition of ≥4wt% nanoparticles, as shown in Figure 1. Gel electrolytes formed with up to 3wt% SiO2 show an improvement in the ionic conductivity compared to the neat ionic liquid based electrolyte, in particular at low temperatures where the crystallization of the liquid component is suppressed in the hybrid electrolyte. However, a further addition of SiO2 decreases the ionic conductivity. Raman spectra show that the interaction between the Li+ cation and the TFSI- anion is not affect by the dispersion of silica nanoparticles in the ionic liquid. The cycling behavior in symmetric cells shows that the addition of silica to the ionic liquid electrolyte decreases the overpotential and maintains it at a stable level over the whole period of cycling. Impedance measurements reveal that the solid electrolyte interphase (SEI) film formed with the gel electrolyte is as stable as in the neat ionic liquid electrolyte. These results indicate that the gel electrolyte is compatible with the lithium electrode and improves the performance. Thanks to the combination of the mechanical and the electrochemical properties presented here this gel electrolyte can be considered as a potential quasisolid electrolyte for lithium batteries.

Fig 1 Photographs of gel electrolytes after inversion for 60min. Content of SiO2, from left: 2wt%, 3wt%, 4wt%, 5wt%, 6wt%

Fig 2 Ionic conductivity of gel electrolytes as a function of temperature

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References