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UV-cross-linked poly(ethylene oxide carbonate) as free standing solid polymer electrolyte for lithium batteries

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Abstract

Aliphatic polycarbonates have emerged as promising polymer electrolytes due to their combination of moderate ionic conductivity and high lithium transference numbers. However, the mechanical properties of the aliphatic polycarbonates polymer electrolytes are usually weak due to the low molecular weight achieved and plasticization effect of the added lithium salt. In this article, we present a copolymer having poly(ethylene oxide) segments linked by carbonate groups with cross-linkable methacrylic pendant groups. Once the polymer and the lithium salt were mixed, the poly(ethylene oxide carbonate) was cross-linked by UV light producing a free standing solid polymer electrolyte (SPE). Different SPE formulations were designed by varying the LiTFSI concentration within the polymer matrix showing the highest ionic conductivity of $1.3 \cdot 10^{-3}$ S cm^{-1} and a lithium transference number of 0.59 at 70 °C. ^{7}Li solid-state NMR experiments were used to correlate the lithium cation environment and dynamics with ionic conductivity. At the same temperature the electrochemical stability window was analyzed, and a reasonable value of 4.9 V was achieved. The study was complemented by mechanical and thermal stability measurements. Finally, the optimized UV-cross-linked poly(ethylene oxide carbonate) was tested as electrolyte in lithium metal symmetric cell at 70 °C, showing low over-potential values and a stable solid electrolyte interphase layer.