Gel Polymer Electrolytes Based on Methacrylate End-Capped Poly(trimethylene) Carbonate Oligomers for Lithium Batteries

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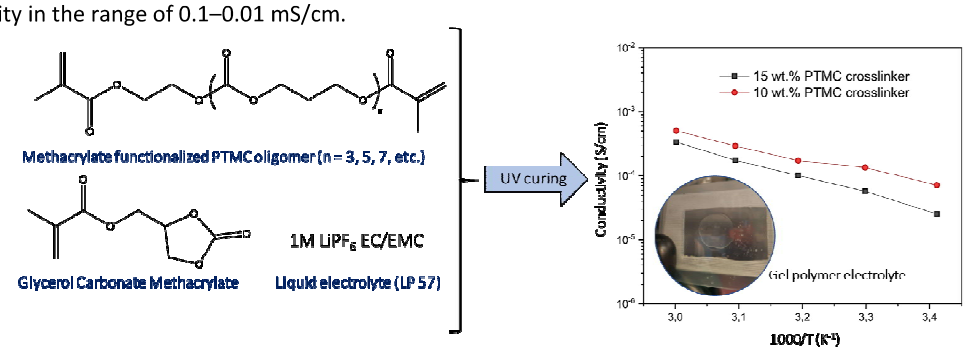
High molecular weight (> 10000 g/mol) linear poly(trimethylene carbonate) (PTMC) is a well-established polymer host used in solid-state polymer electrolytes for lithium battery application. Despite possessing several interesting electrochemical features as suitable electrolytes, the slow polymer chain dynamics of high molecular weight PTMC is often unfavorable for fast ion conduction.[1] Herein, we aim at designing and exploring the prospects of low molecular weight linear PTMC oligomers (< 2000 g/mol) as an alternative to the conventional high molecular weight linear PTMC polymers used in polymer electrolytes. The oligomeric PTMC expects to improve the polymer host's amorphous character, fastening the chain dynamics beneficial for enhanced ion transport in both solid-state and gel polymer electrolytes. However, the oligomeric PTMCs suffer from poor mechanical stability. They exist as viscous liquids at room temperature, unlike the solid/semi-solid high molecular weight PTMC counterparts, preventing the conventional solution/melt casting methods from processing them into self-standing polymer electrolyte membranes. In this regard, this work deals with tweaking the structure of low-molecular-weight linear PTMC oligomers by end-capping with methacrylate functionalities, making them prone to free-radical polymerization on ultraviolet (UV)-light irradiation (Scheme 1).[2] The functionalized PTMC crosslinker oligomers are viscous liquids easily soluble in carbonate-based organic liquid electrolytes. A precursor solution based on methacrylate-end-capped PTMC and another methacrylate monomer called glycerol carbonate methacrylate (GCMA) in the presence of LP57 liquid electrolyte (1M $LiPF_6$, EC/EMC) delivers gel polymer electrolytes with solid-like operability on UV-light-assisted free-radical crosslinking process. The preliminary results indicate the gel polymer electrolytes possess room temperature ionic conductivity in the range of 0.1–0.01 mS/cm.



Scheme 1: Structure of the linear and functionalized PTMC oligomers and the illustration of UV-light crosslinking for polymer electrolyte processing.

Keywords: Lithium-ion batteries, polymer electrolytes, ionic conductivity, electrochemical stability

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