

Synthesis and Evaluation of Polymer Gel Electrolyte Membranes Using Solvated Ionic Liquid and Their Application to Lithium Ion Batteries

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Lithium-ion secondary batteries are used in cell phones and electric vehicles because of their high energy density and long life. However, they generally use organic liquid electrolytes, which present safety issues such as flammability and leakage. Therefore, in recent years, the development of lithium ion batteries using nonflammable and environmentally friendly solid or gel electrolytes has been attracting worldwide attention. However, conventional solid polymer electrolyte membranes have some problems, such as low ion conductivity, low lithium-ion transference number, and insufficient mechanical strength. To overcome them, solvated ionic liquid-containing gel polymer electrolytes have been studied [1]. In addition, we have developed cross-linked network polymer electrolyte membranes that are expected to show good retention ability of ionic liquids [2]. However, strong interaction between the solvated ionic liquid and polymer network decreases ion conductivity; in contrast, little interaction yields liquid leakage from the gel electrolyte membranes.

This study focused on the utilization of poly(dimethyl siloxane) units. We aim to develop polymer electrolyte membranes with high ionic conductivity and high safety by combining cross-linked network polymers consisting of multifunctional monomers with vinyl and thiol groups with solvated ionic liquid for lithium-ion batteries. (**Figure 1**). The siloxane units can interact with lithium ions moderately to prevent the conductivity drop and the liquid leakage from the membranes. In addition, the obtained membranes showed wide electrochemical stability (> 5.0 V vs. Li/Li^+) and superior electrochemical stability.

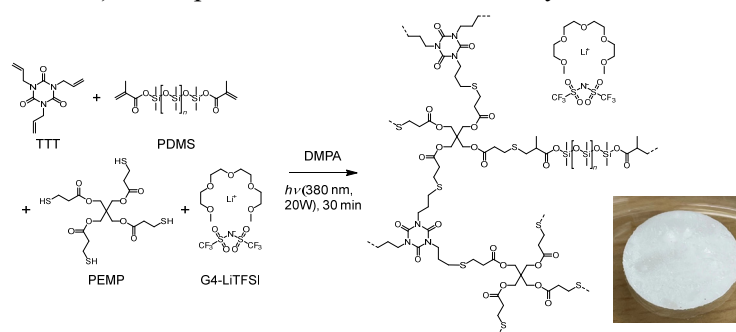


Figure 1. The synthetic procedure of the cross-linked network polymer electrolytes containing solvated ionic liquid, poly(TTT-PEMP-PDMS)/G4-Glyme.

Reference [1] M. Watanabe, *Bull. Chem. Soc. Jpn* **2021**, 94, 2739. [2] M. S. Grewal, M. Tanaka, H. Kawakami, *Polym. Int.* **2019**, 68, 684; *Electrochim. Acta* **2019**, 307, 148; *Polymer* **2020**, 186, 122045.