

Concentrated Poly(ethylene carbonate)/Poly(trimethylene carbonate) Blend Electrolytes for Lithium-Ion Batteries

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Solid Polymer Electrolytes (SPEs) have attracted much attention as electrolyte materials for next generation lithium-ion batteries, because they show promising advantages such as flexibility, shape diversity, light-weight, safety and so on. Recently, polycarbonate-based electrolytes have attracted much attentions as a host polymer for SPEs. Because, they show different ion-conductive behaviors from typical polyether-based electrolytes. In the case of poly(ethylene carbonate) (PEC)-based electrolytes, the ionic conductivity was increase with increasing in lithium salt concentration and they show high Li^+ transference number (t_{Li^+}). However, thermos-tolerance of PEC-based electrolytes were instability, and easy to decompose at high temperatures. In contrast, it has already reported that poly(trimethylene carbonate) (PTMC) has good electrochemical properties and thermal stability. Nevertheless, the conductivity and t_{Li^+} of PTMC-based electrolyte are lower than that of PEC-based electrolytes. The present study, proposes a simple PEC and PTMC blend-based electrolytes to fulfill their respective problems and used for all-solid-state lithium batteries.

As seen in Figure 1 PEC and PTMC have similar chemical structure and have the same carbonate unit (O-C(=O)-O) in the main chain. However, they were incompatible with each other. Interestingly, they become miscible with the addition of lithium salts and the ionic conductivity was also increased with the further addition of lithium salts. Figure 2 shows charge and discharge curves of PEC₆PTMC₄-LiFSI 150 mol% SPE in LiFeO₄ (LFP) cathode half-cell at 50 °C. The cycling behavior of the cell at the current rate of C/10 shows initial specific discharge capacity was keeping on around 150 mAh g⁻¹, which is almost 90 % of LFP cathode theoretical capacity (170 mAh g⁻¹). This result is better and stable than those of single PEC- and PTMC-based electrolytes. This is because of the dissolved ions play crosslinkers between two carbonate polymer phases, that not only can keep their original properties but also improve the electrochemical stabilities.

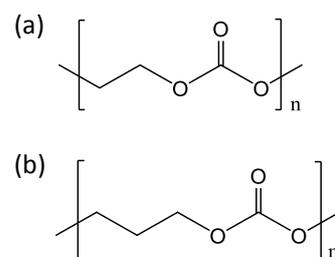


Fig. 1 Chemical structures of PEC (a) and PTMC (b).

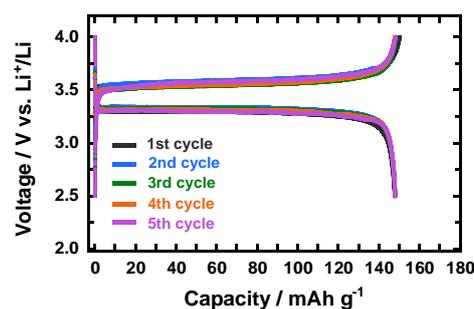


Fig. 2 Charge and discharge curves of LFP/ PEC₆PTMC₄-LiFSI 150 mol%/Li cells at C/10 current rate and 50 °C.

References:

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- [2] B. Sun, J. Mindemark, K. Edström, D. Brandell, SSI 262 (2014) 738-742.