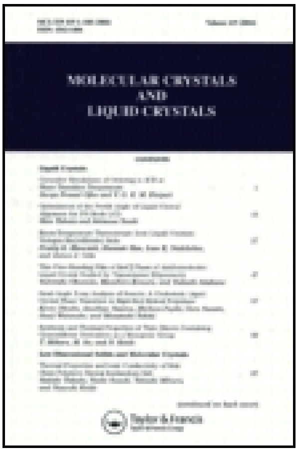

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The Effect of Semi-IPN Structure on Gel-type Polymer Electrolyte

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The Effect of Semi-IPN Structure on Gel-type Polymer Electrolyte

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Thermal stability of PVdF Gel polymer electrolyte (GPE) was enhanced by crosslinking with PEGDA. The resulting semi-IPN structure reduced the crystallization of PVdF and had better affinity with organic liquid electrolyte. When the cell composed of LiCoO2/GPE/Li foil was tested at 80 °C, interfacial impedance results indicated the higher thermal stability of GPE than PVdF.

Keywords Gel polymer electrolyte; semi-IPN; Lithium polymer battery; UV curing

INTRODUCTION

Currently, many gel polymer electrolytes based on PVdF have been investigated for rechargeable lithium batteries [1-2]. These systems showed good ionic conductivity (~ 10^{-3} S/cm), mechanical properties, and electrochemical stability but poor uptake ability and thermal stability due to disentanglement of polymer chains at high temperature. If PVdF forms a semi-IPN structure by a crosslinkable polymer, its entanglement will be preserved because of a high degree of interlocking. For this reason, we tried to improve the thermal stability by forming a semi-IPN structure of poly(vinylidene fluoride-hexafluoropropylene) (PVdF-HFP) copolymer with poly ethylene glycol diacrylate (PEGDA) as a crosslinkable polymer. Also the affinity with organic liquid electrolytes was studied.

EXPERIMENTAL

Liquid EGDA oligomer was mixed with PVdF in the presence of organic solvent composed of ethylene carbonate, dimethyl carbonate, ethylmethyl carbonate containing 1 M $LiPF_6$. The mixed solution was coated onto Mylar® film using doctor blade and then cured under UV irradiation. All process is carried out in a dry room. Polymer blend films were prepared by evaporation after casting film. The solvent was acetone without lithium salt.

RESULTS AND DISCUSSION

FIGURE 1 compares DSC thermogram of the crosslinked GPE with each thermogram of its component. As expected, the melting peak of PVdF decreased with increasing content of PEGDA, i.e., the degree of crystallinity of PVdF became significantly reduced by forming a semi-IPN structure.

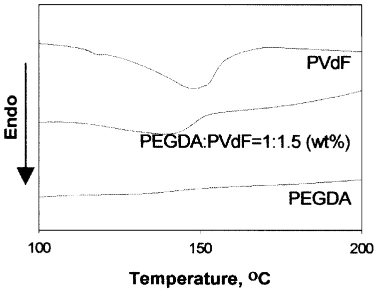

FIGURE 1 DSC thermograms of GPE

FIGURE 2 shows the weight change of GPE at room temperature upon exposure to lab atmosphere. The weight loss of GPE resulted from the evaporation of organic liquid electrolyte was smaller than that of PVdF itself. Hydrophilic nature of PEGDA helped to retain the organic liquids.

To study the thermal stability of membranes the cell was tested at 80 °C. FIGURE 3 shows the impedance spectra (Zahner IM6) of GPE. Test cell was formed by sandwiching GPE between $LiCoO_2$ and lithium foil. After 1 day, interfacial resistance of PVdF membranes increased

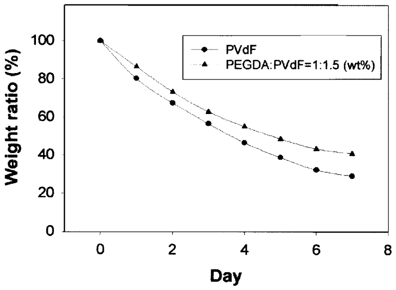

FIGURE 2 The weight ratio change of GPE

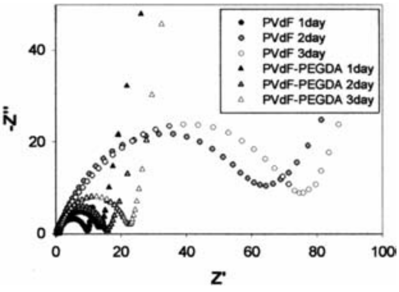

FIGURE 3 Impedance spectra of GPE

suddenly, however, that of GPE having a semi-IPN structure slightly changed. This may be due to the increased dimensional stability and improved affinity with organic electrolytes.

CONCLUSION

PVdF GPE was crosslinked with PEGDA by UV curing and the resulting membranes were expected to form a semi-IPN. The addition of PEGDA improved uptake of organic liquid electrolytes due to its hydrophilic nature and thermal stability at 80 °C due to dimensional stability.

Acknowledgment

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