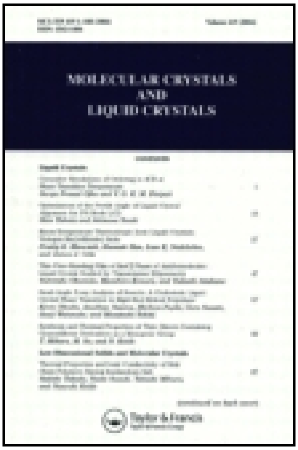

Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

UV-Cured PEGDA/PVdF/PMMA Blend Polymer Electroltye

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Version of record first published: 24 Sep 2006

To cite this article: Yong Tae Kim, Min Kyu Song, Byung Won Cho, Kyung Suk Yun & Hee-Woo Rhee (2001): UV-Cured PEGDA/PVdF/PMMA Blend Polymer Electroltye, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 370:1, 285-288

To link to this article: http://dx.doi.org/10.1080/10587250108030089

Mol. Cryst. and Liq. Cryst., 2001, Vol. 370, pp. 285-288

UV-Cured PEGDA/PVdF/PMMA Blend Polymer Electroltye

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We prepared a polymer electrolyte by blending PEGDA with PVdF and PMMA. PVdF was added to improve mechanical properties and PMMA was to impede the outflow of organic solvent by increasing an affinity for it. To study electrochemical properties of the blend polymer electrolyte, we investigated ionic conductivity, electrochemical stability window and battery performance as a function of blend ratio and amount of initiator. Also we studied the mechanical properties of the blend polymer electrolyte.

Keywords Polymer electrolyte; PEGDA/PVdF/PMMA; Lithium polymer battery; UV curing

INTRODUCTION

Lithium polymer batteries (LPB) have several distinct advantages such as safety, environmental compatibility and scaleability. However, there are still many critical challenges to be met. Polymer electrolytes based on PVdF, PVC, PAN, PMMA *etc*. have high melt viscosity and need long drying time, which is an obstacle for continuous processing. On the contrary, UV-curable polymer electrolytes, represented by ethyleneglycol diacrylate (EGDA) or ethyleneglycol dime-thylacrylate (EGDMA), can be directly cross-linked on cathode or anode laminates under UV irradiation within a few minutes. Conventional UV-cured polymer films suffered from poor mechanical strength and low electrochemical properties because of their glassy nature. To improve electrochemical and mechanical properties of UV-cured polymer electrolytes, we prepared a polymer electrolyte by blending PEGDA with PVdF and PMMA.

EXPERIMENTAL

Liquid EGDA oligomer was mixed with PVdF and PMMA in the presence of organic solvent composed of ethylene carbonate, dimethy 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.

RESULTS AND DISCUSSION

FIGURE 1 shows tensile elongation for pure PEGDA film and blend polymer electrolytes. The pure PEGDA film was very brittle while the elongation of ternary blend electrolytes was increased up to 300% at PEGDA/PVdF/PMMA = 2/1.5/1.5 (wt/wt). The better tensile property might be resulted from the high intrinsic viscosity of PMMA as a stiffener [1]. FIGURE 2 shows the ionic conductivity (σ) of blend electrolytes as a function of blend composition and temperature. Ionic conductivity of pure PEGDA electrolyte is lower than 0.1 mS/cm at room temperature, but that of blend electrolytes is *ca.* 5 mS/cm at ambient condition. Further, it is higher than 1 mS/cm even at 0 °C.

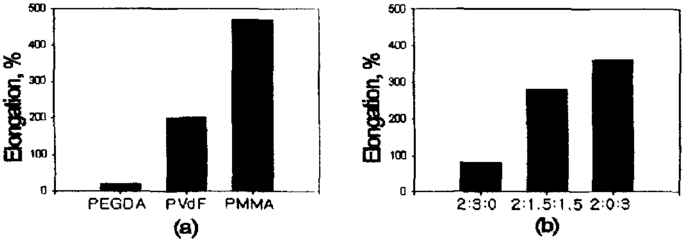

FIGURE 1 Elongation test of SPE: (a) by kinds of polymer (b) by blend ratio.(PEGDA:PVdF:PMMA)

It seems that PVdF or PMMA component forms a good conduction paths and possibly immobilizes liquid electrolyte. FIGURE 3 shows the electrochemical stability window for pure PEGDA and blend electrolytes. All electrolyte films are found to be electrochemically stable up to 4.5 V vs. Li/Li^+.

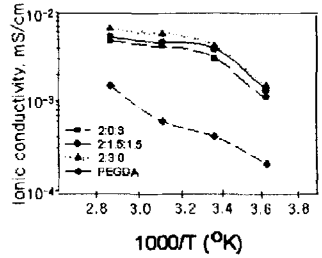

FIGURE 2 Ionic conductivity of SPE.

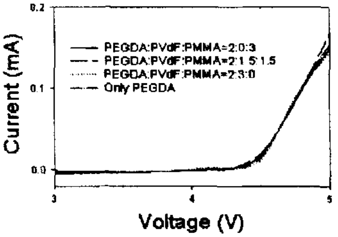

FIGURE 3 Stability window of SPE.

FIGURE 4 shows the effect of blend composition on the performance of $C/SPE/LiCoO_2$ cells. The discharge capacity of the polymer cell using PEGDA/PVdF/ PMMA film (2/1.5/1.5) was almost constant until 100th cycles.

However, the PEGDA/PMMA binary blend electrolyte showed fast capacity loss because PMMA has strong interaction with conduction medium [2].

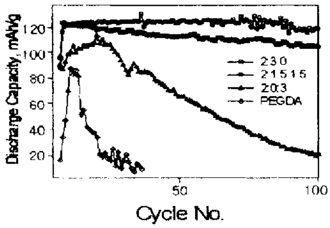

FIGURE 4 Battery performance as a function of blend ratio.

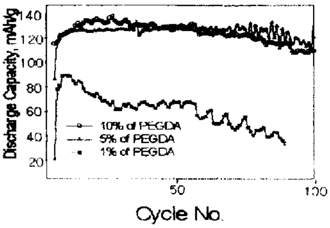

FIGURE 5 Battery performance as a function of initiator content.

FIGURE 5 shows the effect of initiator content on discharge capacity. The UV-cured blend film containing 1 wt% initiator showed lower initial capacity and fast capacity loss. It was reasoned that the amount of initiator was not enough to form a network structure of PEGDA. Thus uncured PEGDA oligomer may interrupt ion motion in polymer matrix.

Acknowledgment

This work was partially supported by ERC program.(grant. No. SP-45-00) from HOMRC.

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