

## Electrochemical Properties of Poly (ethyl acrylate-co-lithium methacrylate) Latex Film Solid Electrolyte

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**Abstract:** Poly (ethyl acrylate-co-lithium methacrylate) (PEM) latex film was synthesized by emulsion-free polymerization. The electrochemical window of plasticized PEM latex film is exceeding 5.0 V. LiCoO<sub>2</sub>/Li battery with PEM latex film as electrolyte exhibits excellent reversibility and when the discharge current density is 0.3 mA/cm<sup>2</sup>, the specific discharge capacity achieves 4.4 mAh/cm<sup>2</sup>.

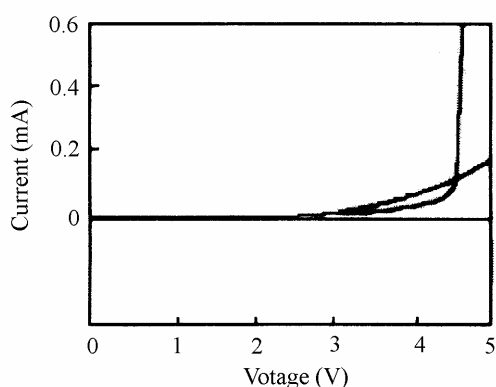
**Keywords:** Interface layer; polymer electrolyte; lithium battery.

Much attention has been paid to the development of new polymer electrolyte with special morphology, so as to improve their electrochemical properties to meet the needs of lithium (ion) battery. In this work, PEM latex was synthesized by emulsion-free polymerization. The microphoto of PEM latex film shows that it still retains the morphology of latex particles in the film. Our early work states that ion transport in interface layer between latex particles plays an important part in improving the ionic conductivity of polymer electrolyte<sup>1</sup>.

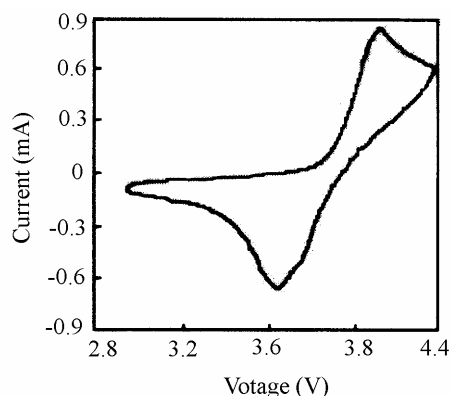
**Figure 1** shows the oxidation limit of plasticized PEM latex films and 1.0 mol/L LiClO<sub>4</sub>/EC-DEC electrolyte solution measured by cyclic voltammetry. Plasticized by whether EC-DEC plasticizer or 1.0 mol/L LiClO<sub>4</sub>/EC-DEC electrolyte solution, the electrochemical stability window of PEM latex film is over 5.0 V, which is higher than that (4.5 V) of the gel electrolyte with the same ionic conductivity as that of PEM latex film<sup>2</sup>. When the voltage is above 4.4 V, 1.0 mol/L LiClO<sub>4</sub>/EC-DEC electrolyte solution decomposes rapidly. The electrochemical window of PEM latex film swollen with 1.0 mol/L LiClO<sub>4</sub>/EC-DEC solution is broader than that of the corresponding electrolyte solution, which is attributed to the strong interaction between macromolecules and solvent molecules (EC and DEC) in the plasticized PEM film, and to the treacliness of polymer matrix making the diffusion potential barrier of the solvent molecules increasing. When the electrolyte solution decomposes on the interface of electrode/electrolyte, the decomposing products form passive films for the “fresh” solvent can not come to the interface in time. The passive films prevent the electrolyte solution in the polymer film from decomposing further, so the electrochemical stability of PEM electrolyte film is improved.

**Figure 2** shows the cyclic voltammogram of the  $\text{LiCoO}_2 / \text{Li}$  battery with PEM latex film, which is swollen by 1.0 mol/L  $\text{LiClO}_4 / \text{EC-DEC}$  electrolyte solution, as solid electrolyte. **Figure 2** shows one peak of oxidation at 4.14 V and one peak of reduction at 3.64 V when the electrode material is cycled between 2.9 and 4.4 V vs. Li, which states that PEM latex film exhibits good electrochemical stability and that cathode  $\text{LiCoO}_2$  and anode Li exhibit good electrochemical reversibility in lithium battery with PEM latex film as electrolyte. When the battery is discharged at the discharge density of  $0.3 \text{ mA/cm}^2$ , the stable voltage plateau appears at about 3.7-3.8 V and the specific discharge capacity is about  $4.4 \text{ mAh/cm}^2$ , which is much higher than that of some lithium batteries with gel electrolyte, and approaches that ( $4.5 \text{ mAh/cm}^2$ ) of lithium battery with electrolyte solution. The marked improvement of discharge rate and specific discharge capacity is possibly attributed to the ion transport in latex particles interface layer.

**Figure 1.** Potential scan graph of PEM latex containing (A) EC-DEC plasticizer and (B) 1.0 mol/L  $\text{LiClO}_4 / \text{EC-DEC}$  electrolyte solution and (C) 1.0 mol/L  $\text{LiClO}_4 / \text{EC-DEC}$  electrolyte solution. Electrode: Pt; scan rate: 10 mV/s; temprature: 25°C.



**Figure 2.** Cyclic voltammogram of the films  $\text{LiCoO}_2 / \text{Li}$  battery with PEM/1.0 mol/L  $\text{LiClO}_4 / \text{EC-DEC}$  as electrolyte. Scan rat: 0.2 mV/s at 25°C.



## Reference

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