Porous Polymer-Coated Separators for Lithium-Ion Polymer Cells

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Polymer electrolytes have been actively studied and developed for application in rechargeable lithium batteries, because the use of a polymer electrolyte makes the fabrication of safe batteries possible and permits the development of thin batteries with design flexibility. Attempts to obtain solid polymer electrolytes, consisting of a matrix polymer and a lithium salt, so far have been producing materials with limited ionic conductivity at ambient temperature. It was found that the addition of polar solvents could significantly increase the ionic conductivity of those materials [1]. Such gel polymer electrolytes exhibit high ionic conductivities in excess of 10^{-3} S/cm. However, their mechanical properties are often very poor, which is one of the most important deficiencies preventing them from being used in practical cells. In order to overcome this problem, the microporous polyolefin separators impregnated with gel polymer electrolytes have been developed as an electrolyte material for lithium-ion batteries. For example, a solution consisting of ethylene carbonate, propylene carbonate, tetraethylene glycol dimethyl ether, tetraethylene glycol diacrylate, $LiAsF_6$ and a small amount of a photopolymerization initiator was impregnated into the porous polyolefin membranes and polymerized to form a solid electrolyte [2]. Recently, a gel polymer electrolyte supported by microporous separator was also prepared and characterized by author [3], which was prepared by coating a gel polymer electrolyte onto a porous polyethylene membrane. Such membrane-supported polymer electrolytes show excellent mechanical strength for the fabrication of lithium-ion polymer batteries.

To develop highly conductive polymer electrolytes supported by a porous separator, we tried to coat physically gellable acrylonitrile-methyl methacrylate copolymer onto a microporous polyethylene(PE) separator. In the copolymer, methyl methacrylate is considered due to its ability to be easily swelled by the polar solvents used in lithium-ion battery. The porous polymer-coated separators were then gelled by soaking them in electrolyte solution. With these materials, we assembled lithium-ion polymer cells composed mesocarbon microbead(MCMB) anode and lithium-cobalt oxide cathode. The electrochemical performances of these lithium-ion polymer cells will be presented. Moreover, an effect of thickness of porous polymer coated on PE separator on battery performances was studied and the results will be also presented.

References

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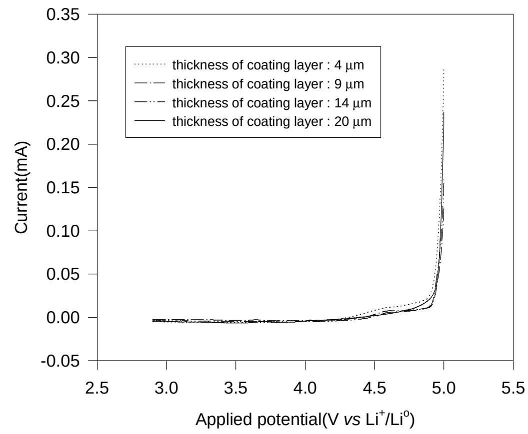

Fig. 1. Linear sweep of the cell prepared with the polymer-coated membrane containing $LiClO_4$-EC/DMC(scan rate = 1 mV/s).

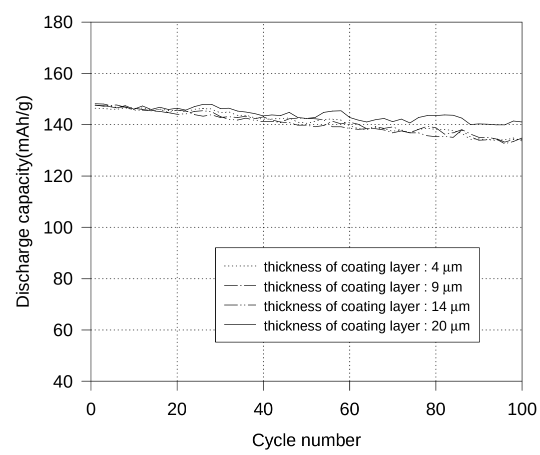

Fig. 2. Discharge capacity of lithium-ion polymer cell as a function of cycle number at C/5 rate.

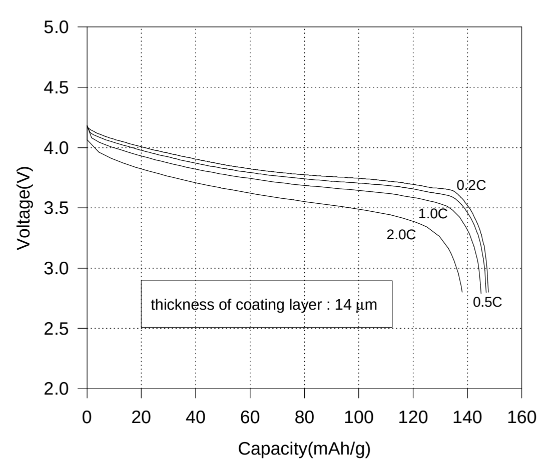

Fig. 3. Discharge profiles of a lithium-ion polymer cell as a function of C rate.(1C=2.2 mA/cm^2)