Preparation and Electrochemical Characterization of Gel Polymer Electrolytes Based on Porous Polymer Membranes for Rechargeable Lithium Batteries

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Gel polymer electrolytes comprising a matrix polymer plasticized with solution of lithium salt in organic solvents are of practical interest for the rechargeable lithium batteries, because they usually exhibit ionic conductivity in excess of 10^{-3} S/cm. A variety of polymers, ranging from poly(ethyleneoxide)(PEO), poly acrylonitrile(PAN), poly(methyl methacrylate)(PMMA) to poly(vinylidene fluoride)(PVdF) has been used to prepare such gel polymer electrolytes. Gel polymer electrolyte films are usually prepared by casting a mixture of the electrolyte solution and a matrix polymer in a low boiling point solvent. However, this process requires a moisture-free environment because of the higher water sensitivity of the lithium salt. Besides their mechanical properties were often very poor, and the films had to be hardened by either chemical or physical curing. Bellcore's group successfully overcame these difficulties and developed a liquid extraction and activation method, to prepare the polymeric electrolyte materials for plastic lithium ion batteries [1]. The Bellcore's processes are the plasticization of a copolymer of vinylidene fluoride and hexafluoropropylene, subsequent removal of plasticizer, and the final reswelling in an electrolyte solution. This procedure requires critical moisture control only during the last activation step. The ability to absorb and retain the electrolyte solution is critical to their application for lithium batteries.

In our work, we tried to prepare the gel polymer electrolytes with the different porous polymer membranes. The porous membranes were prepared by a phase-inversion method, which has been known to be effective for producing a porous structure [2]. To enhance the electrolyte uptake and the ionic conductivity of polymer film, we prepared the highly porous polymer membranes by using many kinds of polymers, which have also high affinity for an electrolyte solution and dimensional stability after gelation with an electrolyte solution. The advantage of this method for preparing gel polymer electrolyte was that the conductivity and mechanical property could be controlled independently by designing the structure of the porous polymer membrane and by selecting an electrolyte solution properly. With these porous membranes, highly conductive gel polymer electrolytes were obtained by soaking them in an electrolyte solution. These porous membranes are observed to encapsulate high amounts of an electrolyte solution, without solvent leakage, while maintaining good mechanical properties. We investigated their electrochemical characteristics, and discussed the possibility of them as an electrolyte material for lithium-ion polymer batteries.

References

1. J.M.Tarascon, A.S.Goztz, C.Schmutz, F.Shokoohi, P.C.Warren, *Solid State Ionics*, **86-88**, 49 (1996).
2. Bottino, G.C-Roda, G.Capannelli, S. Munari, *J. Membrane Science*, **57**, 1 (1991).

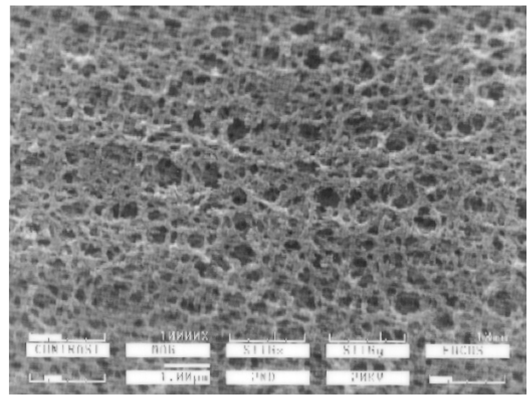

Fig. 1. Scanning electron micrograph of a porous PAN-based membrane

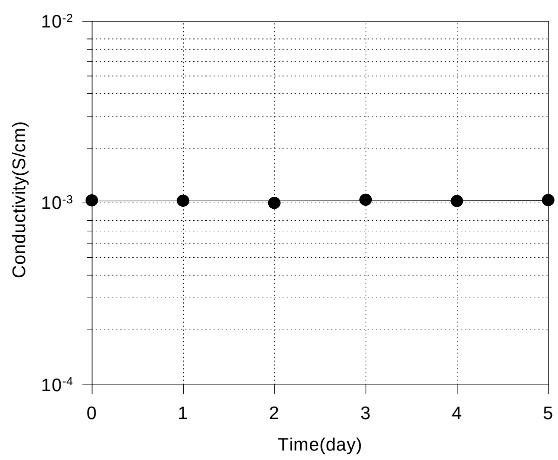

Fig. 2. Ionic conductivities of gel polymer electrolyte prepared with porous membrane as a function of storage time at 25 ^{o}C.

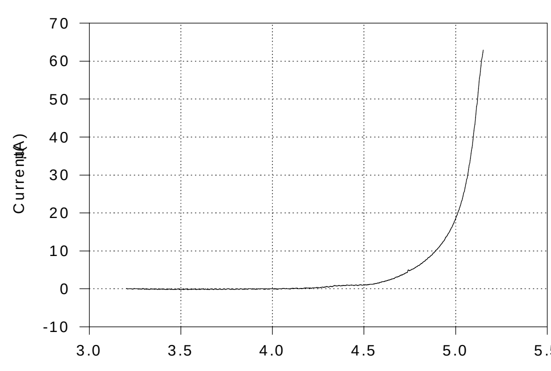

Fig. 3. Current-voltage curve of a Li/GPE/SS cell (scan rate : 1 mV/sec).