Polymer Electrolyte for Rechargeable Lithium-Sulfur Battery

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The lithium-sulfur battery system is one of the promising candidates of next generation of high performance lithium battery system because of the high theoretical capacity of sulfur and lithium, which corresponds to 1,675 and 3,860 mAh/g, respectively. The lithium-sulfur battery can be cost-effective due to the abundant resources, the low cost and environmental friendly of elemental sulfur. In addition, the operating voltage of the lithium-sulfur battery, 2.1 V, is suitable for low voltage electronic devices [1~3].

In this work, we synthesized the novel polymer, terpolymer of 2,2,2-trifluoroethyl acrylate-poly(ethylene glycol) methyl ether methacrylate-acrylonitrile(TAMP) and investigated not only the electrochemical properties of polymer electrolyte but also the discharge characteristics of the lithium-sulfur battery.

The novel polymer has low crystallinity with a good mechanical property, thermal and chemical stability, without impeding movement of lithium ions. Since the novel polymer contains an ethylene oxide unit in the poly(ethylene glycol) methyl ether methacrylate promotes movement of dissociated lithium ions, thereby enhancing ionic conductivity. An alkyl group including fluorine in the terminal of 2,2,2-trifluoroethyl acrylate improves mechanical properties of the polymer, thereby enabling manufacture of a thin film. The ionic conductivity of the polymer electrolyte is about 2×10^{-4} S/cm at room temperature and electrochemically stable up to 4 V.

Fig. 2 shows discharge capacity *vs.* cycle number obtained from sulfur dispersed carbon electrode with and without polymer electrolyte. The polymer electrolyte coated on the separator improves the discharge capacity as well as battery cycle life. From the experimental results, increased capacity and cycle life of lithium-sulfur battery was discussed in terms of diffusion limit of sulfide anion from cathode to anode in the presence of the polymer electrolyte coated on the separator. Additionally, it is supposed that the polymer electrolyte hinders the dendritic growth of lithium during cell operation.

References

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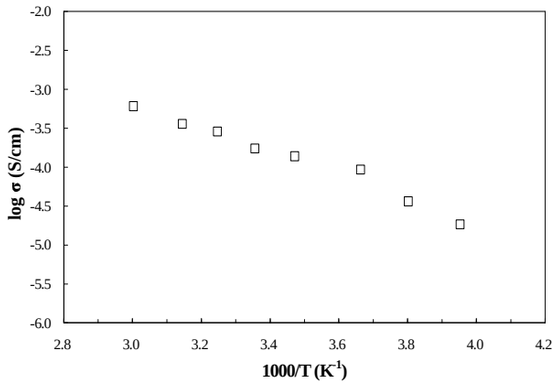

Fig. 1 Temperature dependence of ionic conductivity for the polymer electrolyte.

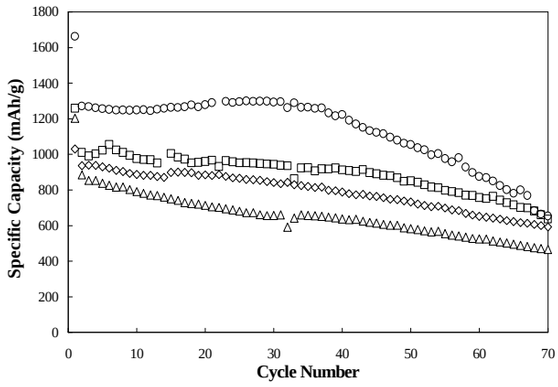

Fig. 2 Cycle performance of the lithium-sulfur cell employing the polymer electrolyte and without polymer electrolyte. (O) L/L=0.50 mA/cm2, polymer electrolyte, ( ) L/L=0.70 mA/cm2, polymer electrolyte, (◊)L/L=0.75 mA/cm2, polymer electrolyte, and (Δ) L/L=0.75 mA/cm2, without polymer electrolyte.