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Polymeric Gel Electrolytes for Electric Double Layer Capacitors

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Electric double layer capacitors (EDLCs) have been used as auxiliary power sources in portable electronics. They are also considered to be promising energy storage devices that can assist power plants using natural energy resources such as solar and wind, as well as fuel cells for electric vehicles. The present EDLCs consist of polarizable electrodes made of carbonaceous materials with large surface area and aqueous or non-aqueous electrolytes. Recently, some types of capacitors with organic solid electrolytes have been developed. We have also reported several types of polymeric gel electrolytes for EDLCs, and compared their capacitor performances with those with liquid electrolytes [1]. In this paper, we describe proton-conducting polymeric gel electrolytes that have recently been developed [2].

Proton conducting polymeric gels were prepared by following two methods: 1) swelling a polymethacrylate-based polymer matrix in aqueous solutions of inorganic and organic acids, and 2) polymerizing complexes of anhydrous acids and prepolymers with organic plasticizer. We used in this work poly(ethylene oxide) monomethacrylate (PEM) and poly(ethylene oxide) dimethacrylate (PED) as the prepolymers, and poly(ethylene glycol) dimethylether (PEGDE) as the organic plasticizer.

The resulting polymeric gels were characterized by spectroscopic and electrochemical methods. The FT-IR spectra of the polymeric gels strongly suggest that the carbonyl groups in the polymer matrix interact with protons from the dopant acids. An ac impedance technique was employed for evaluation of the ionic conductivity. High ionic (proton) conductivity in the range of 6×10^{-4} ~ 4×10^{-2} Scm^{-1} was obtained at room temperature for the gels containing aqueous components. The non-aqueous polymer complexes

with the H3PO4 dopant showed rather low ionic conductivity, but it was about 10^{-3} Scm-1 at 70°C. The conductivity and its temperature dependence of both types of polymeric gels varied with the plasticizer content in the system. The mechanisms of ion (proton) conduction in the polymeric systems are discussed. Voltammetric responses of electro-active species proved that the present polymeric gel system works as an electrolyte of electrochemical devices.

References

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2. J. L. Qiao, *et al.*, *J. Power Sources*, 105, (2002); J. L. Qiao, *et al.*, *Electrochim. Acta*, 47, 3441 (2002).