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New Electric Double Layer Capacitor with Polymer Hydrogel Electrolyte

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Introduction

In electric double layer capacitors (EDLCs), an aqueous or organic solution is usually used for the electrolyte. Replacement of the liquid electrolyte by the solid or gel electrolyte would lead to better reliability, flexibility and so on. Hence, in this work, the polymer hydrogel electrolyte that showed good characteristics in Ni/MH batteries was applied to EDLC, and the electrochemical characteristics were investigated compared with those of EDLC using KOH aqueous solution.

Experimental

The polymer hydrogel electrolyte was prepared from crosslinked potassium poly(acrylate) (PAAK) and a KOH aqueous solution. As shown in Fig. 1, an experimental EDLC cell was assembled using the polymer hydrogel electrolyte and two activated carbon cloths (specific surface area : ca. 2000 m^2 g^{-1}) as electrode material. Electrochemical characteristics were investigated by cyclic voltammetry, charge-discharge cycle test and measurement of leak current, compared to those of the cell using a KOH aqueous solition as electrolyte.

Results and Discussion

Figure 2 shows cyclic voltammograms for the EDLCs with the polymer hydrogel electrolyte and a 10 M KOH aqueous solution. The voltammogram close to the ideal rectangular shape was observed for each electrolyte, and there were no visible peaks due to redox reactions. From the voltammograms, capacitances of the electrodes in the polymer hydrogel electrolyte and the KOH aqueous solution were evaluated to be 108 and 104 F g^{-1}, respectively.

The charge-discharge curves for EDLC cells with the polymer hydrogel electrolyte and a 10 M KOH aqueous solution were shown in Fig. 3. Typical liner curves were obtained for both electrolytes. The discharge capacitance of EDLC with the polymer hydrogel electrolyte was higher than that with KOH aqueous solution. This result is in good agreement with that obtained by the cyclic voltammetry. It is suggested from AC impedance spectra that difference in the capacitance may be ascribed to the pseudo-capacitance.

The leak currents of the EDLCs with polymer hydrogel electrolyte and 10M KOH aqueous solution are shown in Fig. 4. It is clear that the leak current was remarkably improved by using the polymer hydrogel electrolyte. Moreover, the leak currents decreased with increasing the polymer content in the polymer hydrogel electrolyte.

Acknowledgements

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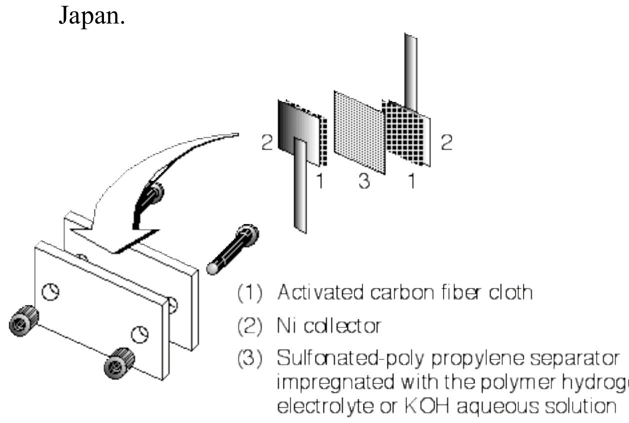

Fig. 1 Schematic representation of the experimental cell assembly.

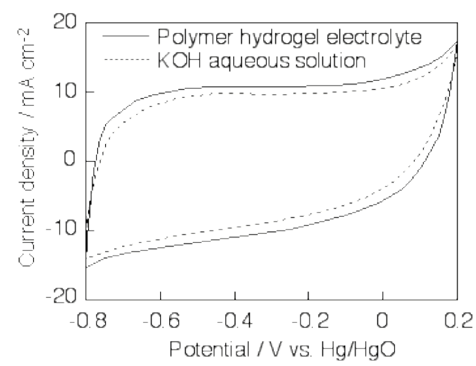

Fig. 2 Cyclic voltammograms at 10 mV s^{-1} for EDLC cells.

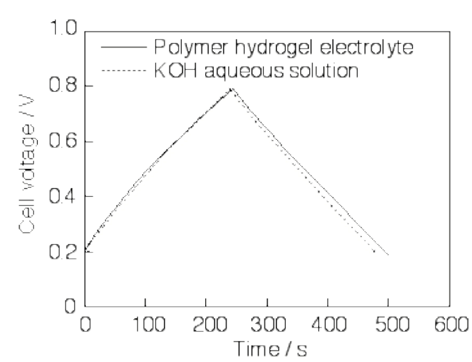

Fig. 3 Charge-discharge curves at 10th cycle for the EDLC cells .

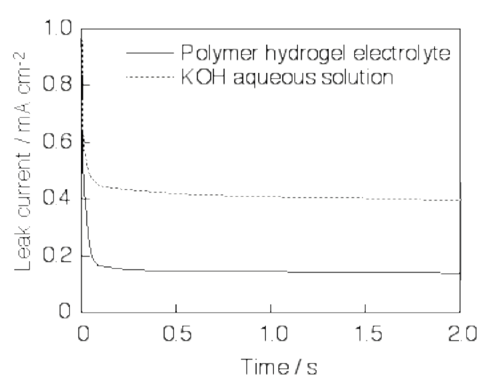

Fig. 4 Leak current of the EDLC cells at the cell voltage of 0.8 V.