Charge-Discharge Characteristics of Nickel/Metal Hydride Battery with Polymer Hydrogel Electrolyte

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Alkaline secondary batteries such as nickel/metal hydride (Ni/MH) battery with a solid or gel electrolyte would be very attractive especially in terms of their reliability, safety and designing. In this work, an alkaline polymer hydrogel electrolyte was prepared from potassium salt of lightly cross-linked poly(acrylic acid) and a 7.3 M KOH aqueous solution and charge-discharge characteristics of the Ni/MH cell with the polymer hydrogel electrolyte were investigated.

The experimental Ni/MH cell was assembled using a sulfonated polypropylene separator impregnated with the polymer hydrogel electrolyte or a 7.3 M KOH aqueous solution, a sintered $Ni(OH)_2$ positive electrode and two $MmNi_{3.6}Mn_{0.4}Al_{0.3}Co_{0.7}$ alloy negative electrodes. The capacity of the cell was controlled by that of the positive electrode. The cell was charged at 145 mA $g[Ni(OH)_2]^{-1}$ for 2.4 h and discharged at 145 mA $g[Ni(OH)_2]^{-1}$ to 0.9 V of the cell voltage. After each charging, the circuit was opened for 10 min.

Figure 1 shows typical charge and discharge curves (10th cycle) for the experimental Ni/MH cells with the polymer hydrogel electrolyte and a 7.3 M KOH aqueous solution. Well-defined charge and discharge curves were obtained in either case. Discharge capacity of each cell was very similar to theoretical one of the positive electrode, 289 mAh $g[Ni(OH)_2]^{-1}$. As can be seen from Fig. 2, the cell with the polymer hydrogel electrolyte exhibited somewhat better charge-discharge cycle performance, compared with the cell with a KOH aqueous solution. Moreover, it was found that the cell with the polymer hydrogel electrolyte had excellent high-rate chargeability (Fig. 3) and dischargeability similar to those for the cell with a KOH aqueous solution. This may be mainly ascribed to the high ionic conductivity of the polymer hydrogel electrolyte.[1,2] It was also clarified that capacity retention characteristics of the cell with the polymer hydrogel electrolyte was better than that for the cell with a KOH aqueous solution. In addition, as a result of creepage tests, it was found that electrolyte creepage could be markedly suppressed by using the polymer hydrogel electrolyte instead of a KOH aqueous solution. These results indicate that the polymer hydrogel electrolyte is electrochemically stable and acts as an excellent electrolyte in Ni/MH battery.

Acknowledgements

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References

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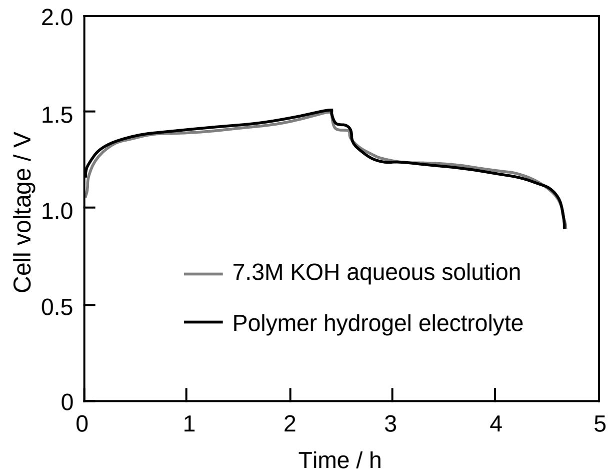

Fig. 1 Typical charge-discharge curves (10th cycle) of the Ni/MH cells with the polymer hydrogel electrolyte and a 7.3M KOH aqueous solution at 25°C.

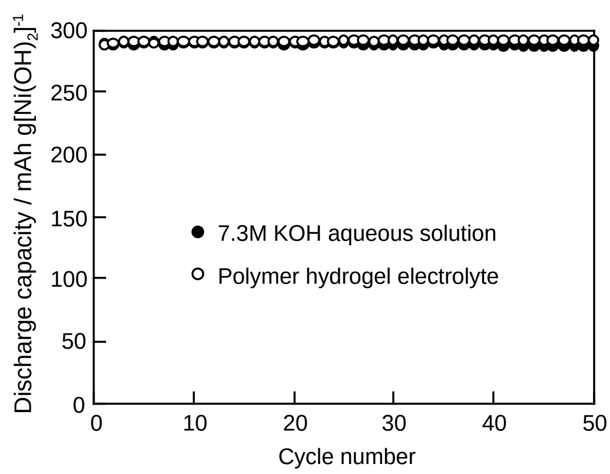

Fig. 2 Discharge capacities as a function of cycle number for the Ni/MH cells with the polymer hydrogel electrolyte and a 7.3M KOH aqueous solution at 25°C.

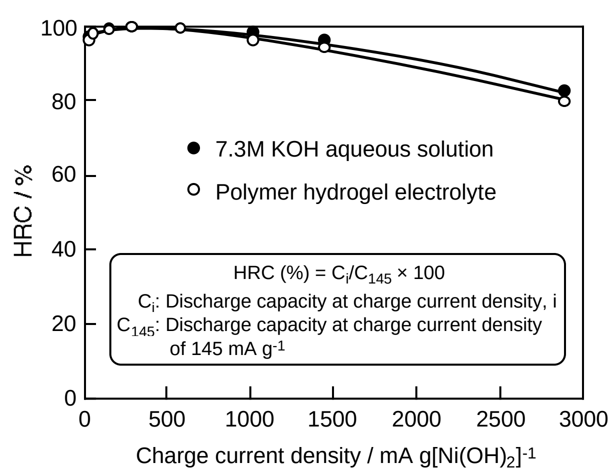

Fig. 3 High-rate chargeability (HRC) for the Ni/MH cells with the polymer hydrogel electrolyte and a 7.3M KOH aqueous solution at 25˚C.