Preparation and Electrochemical Characterization of Polymer Hydrogel Electrolytes for Nickel-Metal Hydride Batteries

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Polymer hydrogel electrolytes containing various concentration of KOH have been prepared from so-called super-absorbent polymers (SAP) and KOH aqueous solution. Characteristics of the hydropgel electrolytes was examined to investigate the applicability of the hydrogel electrolyte to nickel /metal hydride(Ni/MH) battery.

The polymer hydrogel electrolyte prepared from potassium salt of crosslinked poly(acrylic acid) (PAAK) and 6 M KOH aqueous solution have found to have high ionic conductivity almost comparable to the KOH aqueous solution over the wide ranges of KOH concentration (~20M, 25°C). The transport number of OH^- ions of the hydrogel (6M KOH) was ca. 0.85 larger than the value ca. 0.73 in case of 6M KOH aqueous solution. Various redox reactions have found to proceed smoothly at the electrode/electrolyte interface from cyclic voltammetry and AC impedance spectroscopy. Therefore, the polymer hydrogel electrolyte had enough potential windows for charge and discharge reactions of the Ni/MH battery.

These facts could be attributed to that the hydrogel electrolyte had hjgh water-absorbing and water-holding capacity and high compatibility with electrode.

High rate of oxygen permeation through the electrolyte is very important for high-rate capability of Ni/MH battery. So, oxygen permeation rate through thin electrolyte layer was electrochemically determined by detecting oxygen reduction current by using the cell shown in Fig. 1. Oxygen evolved at an anode diffused away very rapidly in both polymer hydrogel electrolyte and KOH aqueous solution less than 2 mm in thickness as shown in Fig. 2.

Furthermore, the creepage rate of the alkaline electrolytes along negatively polarized metallic nickel surfaces was examined, because the creepage is the most serious problems to be solved for the safety and maintenance of the appliance to which the battery is supplying electric power. It was found from Fig. 3 that the creepage rate of polymer hydrogel electrolyte was much smaller than in case of a 6M KOH aqueous solution, due to high water-holding capacity of the polymer hydrogel electrolyte. The alkaline hydrogel of SAP is useful electrolyte material and is expected to have the wide applicability to alkaline secondary battery.

Acknowledgements

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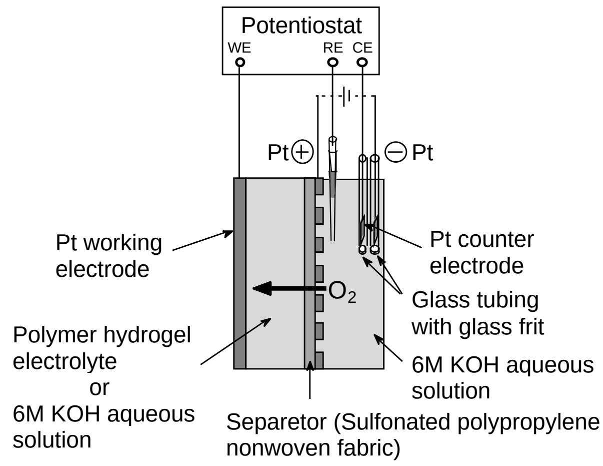

Fig. 1 Schematic representation of the cell for measuring oxygen transport time.

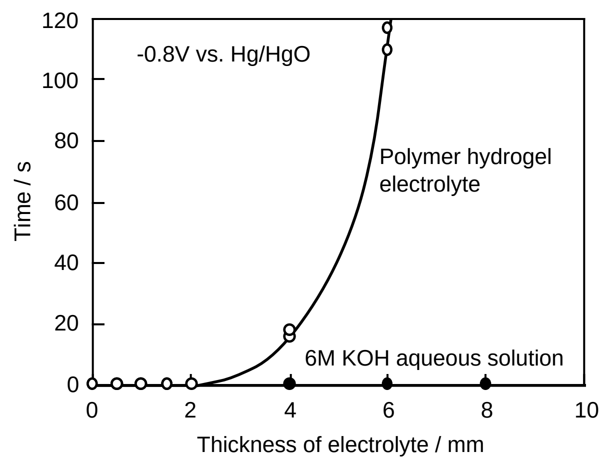

Fig. 2 Effect of a 6M KOH aqueous solution and the polymer hydrogel electrolyte on the oxygen transport time at 25°C.

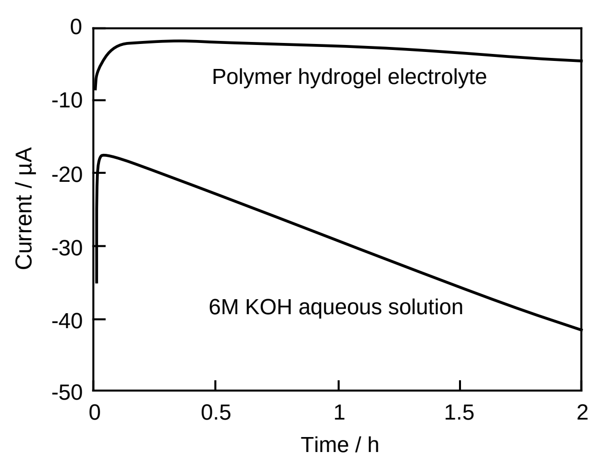

Fig. 3 Time course of current for oxygen reduction at -0.9V vs. Hg/HgO in a 6M KOH aqueous solution and the polymer hydrogel electrolyte under Ar rich atmosphere at 25˚C.