IMPROVEMENT OF ELECTROCHEMICAL PROPERTIES OF A MH ELECTRODE FOR ADVANCED NI/MH BATTERIES

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Nickel/Metal Hydride (Ni/MH) rechargeable batteries have been attracting considerable attention because of their inherent advantages such as high energy density and non-polluting nature [1-2]. The performance of a Ni/MH battery closely depends on the characteristics of the negative MH electrode. Discharge capacity, discharge potential and high-rate dischargeability of a MH electrode are very important properties, especially when Ni/MH batteries are applied to electric vehicles (EVs) because these three properties determine the driving mileage and acceleration performance on uphill grade of EVs. Self-dischargeability is another important property for the unloaded condition of the batteries.

Significant improvements in discharge capacity, discharge potential, high-rate dischargeability and self-dischargeability of a MH electrode have been observed for a 9.0 wt.% copper coated $LaNi_{4.7}Al_{0.3}$ MH electrode. High-rate dischargeability was determined from the ratio of high (200 mA g^{-1}) to low (20 mA g^{-1}) rate discharge capacity. Fig. 1 shows both high and low rate discharge curves for both the $LaNi_{4.7}Al_{0.3}$ electrode and 9.0 wt.% Cu-coated $LaNi_{4.7}Al_{0.3}$ electrode, respectively. The discharge capacity at 200 mAh g^{-1} discharge current density for the anode with un-coated alloy powder was 274 mAh g^{-1} and 320 mAh g^{-1} for the anode with Cu-coated alloy powder. The high-rate dischargeabilities were determined to be 88.4% for the $LaNi_{4.7}Al_{0.3}$ electrode and 99.4% for Cu-coated $LaNi_{4.7}Al_{0.3}$ electrode. It can also be seen from Fig. 1 that the discharge potential for the Cu-coated $LaNi_{4.7}Al_{0.3}$ electrode is lower (i.e. more negative) than that for the $LaNi_{4.7}Al_{0.3}$ electrode, especially at a large discharge current density (i.e. 200 mA g^{-1}). The discharge potentials of the Cu-coated $LaNi_{4.7}Al_{0.3}$ electrode are almost the same value (i.e. -0.930 V vs. Hg/HgO) at both 20 mA g^{-1} and 200 mA g^{-1} discharge current densities. This indicates that Cu-coating ensures both large energy and power density of a Ni/MH battery.

The factors that affect the self-discharge characteristics of MH anode are investigated which include state of discharge (SOD), temperature, storage time and microencapsulation of the alloy with a thin copper layer. The comparison of self-discharge performance of Ni/MH batteries with and without copper-coated anode powders is made and it is found that the microencapsulation of alloy powders improves the self-discharge performance of a MH anode.

It is believed that microencapsulation by copper provides complete coverage of the intermetallic alloy powder surface that helps prevent corrosion or oxidation of both the active material ($LaNi_{4.7}Al_{0.3}$ alloy) and the catalyst (Ni cluster), thus the self-dischargeability property of a MH anode is improved. Also, because of copper's superior electrical and thermal conductivity, the presence of copper grains enhances the effectiveness of the current collection processes, and further improves the charge transfer process on the alloy powder and electrolyte interface. Therefore, discharge capacity, discharge potential and high-rate dischargeability of a MH anode for the Ni/MH batteries are improved.

References:
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2. T. Sakai, T. Hazama, H. Miyamura, N. Kuriyama, A. Kato and H. Ishikawa, J. Less-Common Met., **172-174** (1991) 1175.

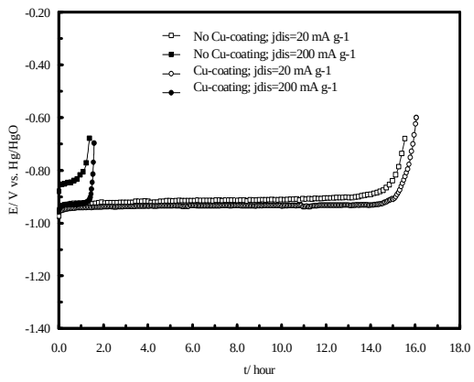

Figure 1 Discharge curves of both $LaNi_{4.7}Al_{0.3}$ alloys electrodes with and without 9.0 wt. % Cu-coating.