Development of high-power Ni/MH battery for HEV using Mg-containing low-Co alloy

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Future spread of Hybrid Electric Vehicle (HEV) is mainly dependent on cost and power output of battery. In Nickel/Metal hydride (Ni/MH) battery, important issue for HEV application is reduction of Co content of $MmNi_5$-based alloy with keeping high power and long-term endurance.

In recent years, hydrogen storage and electrode properties have been investigated for R-Mg-Ni (R: rare earths) alloy systems. In AB_3 system, Kadir et al. found RMg_2Ni_9 alloys having stacked structure of RNi_5 and $MgNi_2$ subunits [1], and Kohno et al. reported $La_{0.7}Mg_{0.3}Ni_{2.8}Co_{0.5}$ alloy with as much as 410 mAh/g of discharge capacity [2]. In AB_5 system, we reported Mg addition improved cycle property for low-Co $MmNi_5$-based alloy (Mm:La-rich misch metal) [3]. This work is aimed at improve high rate capability and cycle property of this type of alloy for HEV application.

$Mm_{1-x}Mg_xNi_{4.5-y}Co_yMn_{0.4}Al_{0.3}$ (hereinafter denoted as CoxMgy) alloys were prepared by induction melting followed by heat treatment, and characterized by XRD, PCT, SEM-EPMA, and TEM. Negative electrodes containing these alloys were evaluated by using prismatic cell, AAA-sized cell, and SD-sized cell.

Figure 1 compares high rate capability and cycle life for low-Co alloys and commercial alloy. Here, cycle life was defined as cycle, in which discharge capacity reached 66% of initial value. Cycle life of the low-Co alloys was increased with increasing Mg content (x) from 0 to 0.05. On the other hand, effect of Mg content on high rate capacity in these alloys was relatively small. Co0.325 Mg0.05 alloy showed better electrode performance than commercial alloy, $MmNi_{4.0}Co_{0.65}Mn_{0.3}Al_{0.28}$ (Co0.65) in both of power output and cycle lifetime.

Effect of stoichiometric ratio of the alloys was then investigated. The alloy with B/A=5.2 had lower hydrogen storage capacity than alloy with stoichiometric composition (B/A=5.0), but showed superior discharge capacity at 10C rate (Figure 2). From TEM observation , Ni-enrichment on the surface was observed for this alloy, which would improve the high rate capability (Figure 3).

AAA-sized battery using the Mg-containing low-Co alloy enabled discharge at 25C rate and showed comparable high rate capability and cycle property to that using Co0.65 (Figure 4). In HEV cycle test at 45 ^{0} C, furthermore, SD-sized battery using the alloy attained cycle life corresponding to travel of 100,000km. It is suggested that this low-cost alloy is promising for high power applications such as HEV.

Acknowledgement
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References

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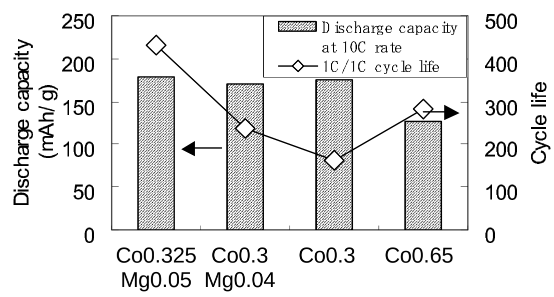

Figure 1 Comparison of discharge capacity and cvcle life.

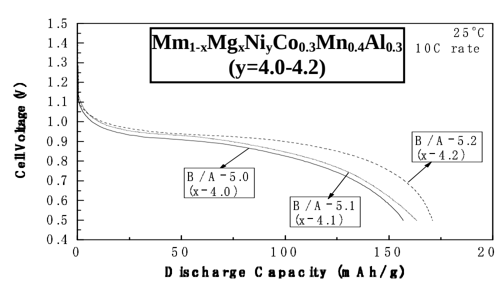

Figure 2 Discharge curves at 10C rate

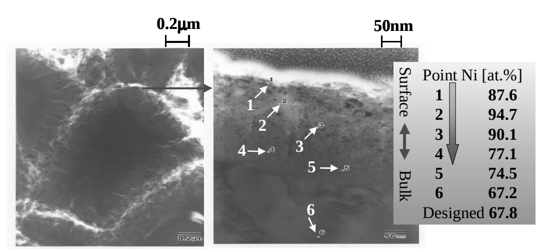

Figure 3 TEM images for $Mm_{0.96}Mg_{0.04}Ni_{4.2}Co_{0.3}Mn_{0.4}Al_{0.3}$ alloy with B/A=5.2

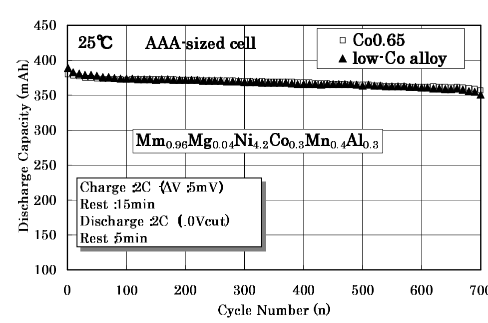

Figure 4 Comparison of cycle property in AAA-sized battery