SYNTHESIS, STRUCTURE AND ELECTROCHEMICAL PROPERTIES OF THE $NdY_2Ni_{9-x}Mn_x$ ALLOYS

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This paper presents the results of investigation of energy-efficient materials for Ni-MH batteries based on Ni substitution by Mn in the NdY_2Ni_9 alloys. Synthesized using arc melting and annealing, the alloys crystallize in a LaY_2Ni_9 type of structure. Electrochemical studies reveal nonlinear effects of Mn substitution on discharge capacity. The highest discharge capacity was found for the NdY_2Ni_8Mn alloy with 352 mAh/g, retaining 73% capacity after 50 charge/discharge cycles.

Keywords: Rare-earths alloys, Ni-MH batteries, electrochemical hydrogenation properties

The intensive development of portable electronic devices, electric vehicles, and the growing need for energy autonomy undoubtedly demonstrate the need of research and development new energy-efficient materials. This need is especially evident in materials for chemical power sources. One of the most promising areas is nickel-metal hydride batteries (Ni-MH). This type of batteries, due to their high capacity and environmental safety, are used as power sources in various fields, including the above-mentioned ones.

Recently, the attention of researchers has been devoted to Y-containing AB_3 intermetallic compounds, which demonstrate excellent electrochemical hydrogen sorption characteristics as electrode materials for Ni-MH batteries, as shown in [1–4]. Nowadays, there are still insufficient data on the effect of rare earth and transition metal substitutions in the above classes of compounds. This paper presents the results of a study of the effect of Ni substitution by Mn on the electrochemical properties of alloys based on the NdY_2Ni_9 compound.

The samples were prepared by arc melting in an argon atmosphere on a water-cooled copper base. After that, they were annealed at 600°C for three weeks in vacuumed quartz tubes. X-ray phase and structural analysis was performed using a DRON-3M diffractometer (Cu-*K*α radiation). Electrochemical properties were measured in a three-electrode system - metal hydride, auxiliary platinum, and silver chloride reference electrodes. The cyclic stability of the electrodes was studied galvanostatically at a current density of 50 mA/g at room temperature.

A series of alloys with the composition $NdY_2Ni_{9-x}Mn_x$ (x = 0…2 with a step of 0.5). The X-ray diffraction and X-ray diffraction analyses showed that the alloys were formed as single-phase with a LaY_2Ni_9 structure (R-3m space group). The change in the electrochemical characteristics of the synthesized samples is nonlinear. Electrochemical studies have shown a significant effect of manganese substitution on the discharge capacity of the alloys in a certain concentration range. Initially, the discharge capacity increases (up to $x = 1$) and then decreases. The highest discharge capacity was achieved by the NdY_2Ni_8Mn alloy, which reaches 352 mAh/g. At the same time, it retains 73% of its maximum capacity after 50 charge/discharge cycles at a current density of 50 mA/g.

More details on the electrochemical characteristics of the studied alloys can be found in Figure 1 and Table 1.

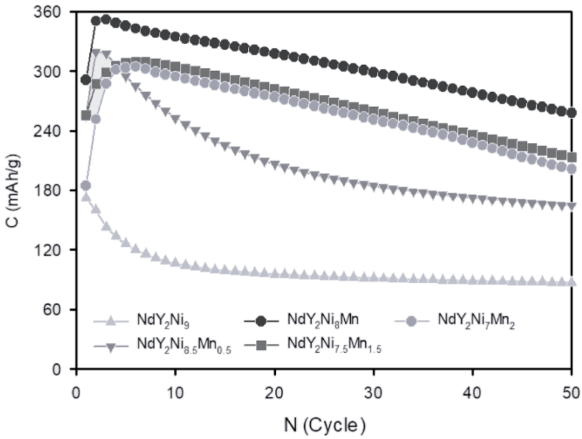

Fig. 1. Cyclic stability of the $NdY_2Ni_{9-x}Mn_x$ ($x = 0…2$) electrodes.

Table 1. Electrochemical characteristics of the $NdY_2Ni_{9-x}Mn_x$ ($x = 0 - 2$) electrodes.

№	Phase	C_{max} (mAh/g)	H/f.u.	C_{50} (mAh/g)	S_{50} (%)
1.	NdY_2Ni_9	173	5.5	87	50
2.	$NdY_2Ni_{8.5}Mn_{0.5}$	320	10.1	165	52
3.	NdY_2Ni_8Mn	352	11.1	258	73
4.	$NdY_2Ni_{7.5}Mn_{1.5}$	309	9.7	213	69
5.	$NdY_2Ni_7Mn_2$	305	9.6	201	66

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