

THE INFLUENCE OF DOPING COMPONENTS ON THE ELECTROCHEMICAL HYDROGENATION OF THE $\text{GdFe}_{2-x}\text{M}_x$ PHASES

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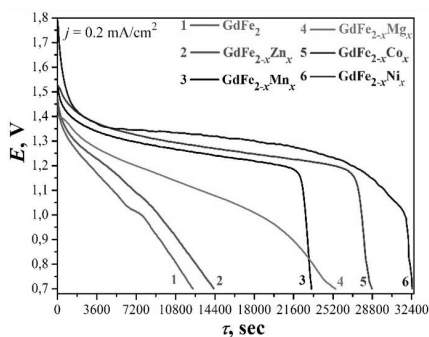
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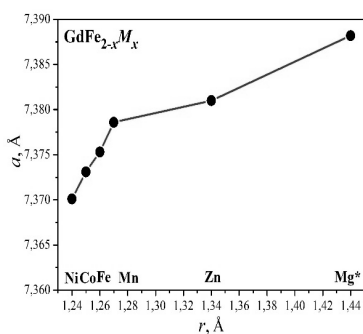
Intermetallics with cubic MgCu_2 -type structure are interesting for hydrogen storage purposes. Inclusion of hydrogen in the structure of these phases occurs in tetrahedral voids formed by transition elements. Application of these phases as electrode materials in nickel-metal hydride batteries depends on their corrosion stability in alkaline solutions which can be improved by adding of more resistant components to the alloys. In this work we studied the effectiveness of the electrochemical hydrogenation of the ternary intermetallics $\text{GdFe}_{2-x}\text{M}_x$, $x = 0.06$.

The synthesis of the alloys was carried out by arc melting of the pure metals Gd, Fe, Ni, Co, Mn, Zn and Mg (>99.9 wt. %) under an argon atmosphere with further annealing at 500 °C for two month in evacuated silica tubes and quenching in cold water. X-ray phase analysis of the samples was carried out using the data collected by powder diffractometer DRON-2.0M (Fe $K\alpha$ -radiation). The quantitative composition of the alloys was checked by X-ray fluorescent and energy dispersive X-ray analyses. The lattice parameters of the observed phases were refined by least squares method using the program Latcon. Electrochemical hydrogenation of the samples was carried out in 2-electrode "Swagelok-cell" prototype of Ni-MH batteries. The synthesized alloys served as anode materials, a mixture of powder $\text{Ni}(\text{OH})_2$ with graphite (9:1 wt. ratio) served as a cathode material. As electrolyte we used 6M solution of KOH. Hydrogenation (charge at 0.5 mA/cm^2) and dehydrogenation (discharge at 0.2 mA/cm^2) were carried out in galvanostatic mode.

Corrosion of the samples as by-reaction was observed in parallel with electrochemical insertion of hydrogen. The mutual influence of these processes was first observed in the binary phase. When we doped it by the components with the higher corrosion resistance we observed the bigger capacity and higher voltage of the battery that increased in the line $\text{Zn} < \text{Mn} < \text{Mg} < \text{Co} < \text{Ni}$ (see Fig. a). The alloys with magnesium, cobalt and nickel showed better cyclic stability and no evidences of significant oxidation of the electrodes. The lattice parameters of the phases (constantly 2 at.% of doping elements) (Fig. b) increased corresponding to the value of atomic (metallic) radii of the doping components. In the case of Mg which is the s-element we used the value of covalent radius unlike Mn, Co, Ni and Zn which are the typical 3d-transition elements.



a



b

Fig. Selected discharge curves at 10-th cycle for Ni-MH prototype batteries with electrodes on the basis of $\text{GdFe}_{2-x}\text{M}_x$ (a); dependence of unit cell parameter a versus atomic radii of doping elements (b)