ELECTROCHEMICAL AND STRUCTURAL INVESTIGATIONS OF HYBRID Mg-BASED MATERIALS FOR HYDROGEN STORAGE

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Abstract

Novel nanocomposite hydride materials proposed for anodes in hydride based rechargeable Ni-MH$_x$ batteries may successfully solve problem of energy storage. Mixed of minimum two different hydrogen storage phases like a A$_2$B – AB$_5$, A$_2$B – AB$_2$ or A$_2$B – AB$_2$ – AB$_5$ we called hybrid structure. We used the mechanical alloying process (MA) for mixed two components: a major component having good hydrogen storage properties and a minor component used as surface activator.

In this work, we have synthesized an amorphous hybrid Mg$_2$Ni-Ni$_x$-30%La ($x=50, 100\%$) nanocomposites. The starting material which was Mg$_2$Ni electrode, mechanically alloyed and annealed, displayed the maximum discharge capacity (100 mAh·g$^{-1}$) at the 1$^{st}$ cycle but degraded strongly with cycling. The poor cyclic behavior of Mg$_2$Ni electrodes is attributed to the formation of Mg(OH)$_2$ on the electrodes, which has been considered to arise from the charge-discharge cycles. To avoid the surface oxidation, we have examined the effect of nickel and/or lanthanum addition in Mg$_2$Ni-type material. This alloying greatly improved the discharge capacities. For example, Mg$_2$Ni-Ni$_x$-30%La ($x=50, 100\%$) alloys presents higher electrochemical capacities than Mg$_2$Ni or (MgH$_2$)$_2$Ni-Ni$_x$-30%La.

To improve the electrochemical behavior of Mg(MgH$_2$)$_2$Ni-Ni$_x$-30%La alloys additionally 50 and 100wt.% nickel was added. For example, amorphous Mg$_2$Ni-Ni$_x$-30%La ($x=50, 100\%$) alloys presents higher electrochemical discharge capacity than (MgH$_2$)$_2$Ni-Ni$_x$-30%La ($x=50,100\%$) on the average about 50%. Nickel addition improve discharge capacity from 46 (50%) to 116 (100%) mAhg$^{-1}$ (1$^{st}$ cycle) and form 40 to 76 mAhg$^{-1}$ (10$^{th}$ cycle) in Mg-alloys. For the MgH$_2$-alloys, discharge capacity increases from 58 (50%) to 71 (100%) mAhg$^{-1}$ (1$^{st}$ cycle) and from 22 to 38 mAhg$^{-1}$ (10$^{th}$ cycle). Extra 5% Palladium addition to Mg$_2$Ni-Ni100%-30%La improved discharge capacity of about 10%.

We also investigated structure of synthesized materials. For comparison we used magnesium and magnesium hydride as a starting material. The DSC examinations of MgH$_2$ – based materials, shows that total hydrogen liberated at two different temperatures, over 275°C and 550°C respectively.

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