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Effect of Scandium on the Structure and Electrochemical Properties of $La_{1-x}Sc_xNi_{3.5}$ Alloy Electrodes

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La-Sc-Ni based A_2B_7-type hydrogen storage alloys $La_{1-x}Sc_xNi_{3.5}$ (x = 0.0~1.0) is prepared by an arc furnace method and maintained for a week in a sealed stainless steel tube at 1173 K. XRD and SEM-EDS results show that the alloys are mainly consisted of $LaNi_5$, La_2Ni_7 and minor LaNi phases. Under appropriate amount of Sc addition (x = 0.3~0.5), the $(La, Sc)_2Ni_7$ phase increases whereas the $LaNi_5$ and LaNi phases decreases. Moreover, the further increase of Sc content results in appearance of Sc_2Ni_7 phase. The thermodynamic analyses show that the enthalpy change of $La_{0.7}Sc_{0.3}Ni_{3.5}$-H_2 is more close to -7.5 kcal mol^{-1} for the La-Mg-Ni-H_2 system while the equilibrium absorption/desorption hydrogen pressure plateau of that is still higher than La-Mg-Ni systems, which indicate that the phase rule of Sc-containing alloy is different from Mg-containing alloy. Compared to pure La_2Ni_7 alloy, the maximum discharge capacity increases and the cycle stability improves by adding the right amount of Sc content (x = 0.3~0.5). Especially when x = 0.5, the cycle stability (S_{100}) is up to 92.6% which is obviously superior to A_2B_7-type and AB_5 type hydrogen storage alloys. We hope that our experimental results can develop the novel La-Sc-Ni-based hydrogen storage alloys by tuning their superlattice structures.

Keywords: La-Sc-Ni-based hydrogen storage alloy, Sc element substitution, Microstructure, Enthalpy change, Electrochemical properties

FULL TEXT