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Electro-Chemical Study on Hydrogen Storage Characteristics of $LaNi_5$ Alloy

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Abstract We studied hydrogen storage property of $LaNi_5$ alloy by the electrochemical method. XRD and P-C-T curves of $LaNi_5$ alloy were measured under the different external conditions. The electrochemical measurements on hydrogen storage property of $LaNi_5$ alloy were proceeded in the electrochemical system consisting of the alloy electrode and nickel hydroxide electrode. The charging-discharging curve of $LaNi_5$ alloy electrode showed the alloy never absorbed oxygen and acted as functional hydrogen electrode which occludes only hydrogen and releases it again according to the external conditions. The hydrogen storage capacity of $LaNi_5$ alloy dropped with temperature raising. Results showed that hydrogen storage character of $LaNi_5$ alloy can be easily evaluated by the electrochemical method including P-C-T, XRD.
Key words $LaNi_5$, hydrogen storage alloy, electro-chemical method

Introduction

The great leader Comrade **Kim Il Sung** said as follows.

"**Now it is very important and extremely urgent to accelerate the development of our science and technology.**"("**KIM IL SUNG** WORKS" Vol. 34 P. 148)

Hydrogen obtained from water of which capacity is inexhaustible and does not bring about environmental pollution is the important energy source. In producing, storing, and using broadly such hydrogen, the developing of hydrogen storage alloy is of great significance.

The recent gradual tapering off and serious environmental pollution crisis of the petroleum and fossil fuel keenly need that one at the earliest date builds up hydrogen utility system.

Finding the hydrogen occlusion and release phenomena of $MmCo_5$ being magnetic substance (Mm the mixture of rare earth metals) brought about radical change in development of hydrogen storage alloys. Since then, various hydrogen storage alloys including Ca, Mg, Ti, Zr, rare earth metals were developed. And application field of hydrogen storage alloy being used in heat pump, hydrogenation catalyst, tritum and heavy hydrogen separation, electrode for alkaline battery and etc were opened up, and in its partial fields it is practically used [2, 3]. Recently, La alloys have been one of the most practical hydrogen storage materials [4－6]. But there is not detailed reports on the electrochemical method to measure the hydrogen storage property of $LaNi_5$ alloys.

We studied hydrogen storage property of $LaNi_5$ alloy by measuring the charge-discharge capacity of the electrochemical system with the alloy electrode.

Experimental Method

Alloy of $LaNi_5$ was melt in a vacuum arc furnace ("VA-1220") with the water-cooled cupric crucible.

XRD of the alloy was measured by the X-ray diffractometer ("D-3F") using CuKα-ray and hydrogen absorption-desorption properties by P-C-T measuring apparatus.

The electrochemical measurements on hydrogen storage property of $LaNi_5$ alloy were proceeded in the electrochemical system consisting of the $LaNi_5$ alloy electrode and nickel hydroxide electrode. Alloy electrode being test electrode was manufactured by mixing and treating alloy powder and graphite powder in Teflon suspension [1]. Contact shoe and electrode lattice are nickel drawing lattice and the squeezing-shaping pressure of the electrode was 400MPa. Capacity of nickel hydroxide electrode was more than 2 times of that of the alloy electrode. Electrolyte solution was 7mol/dm^3 KOH containing 15g/dm^3 LiOH and reference electrode was mercury oxide electrode.

Results and Discussion

Hydrogen occlusion and release curve(P-C-T) of $LaNi_5$ and XRD spectrum of $LaNi_5H_y$ are shown in Fig. 1, 2, where C_H is hydrogen concentration expressed as number(y) of hydrogen atoms occluded on $LaNi_5$ alloy.

As shown in Fig. 1, $LaNi_5$ occludes hydrogen and at the lower pressure and higher temperature it releases hydrogen occluded again.

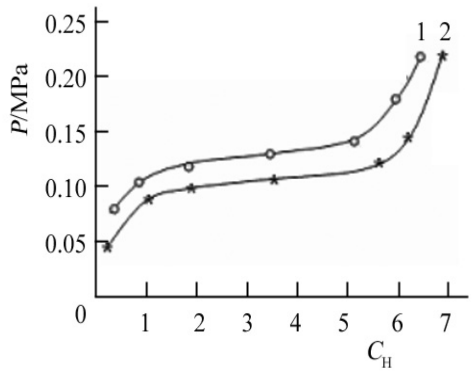

Fig. 1. P-C-T curve of $LaNi_5$ alloy(30℃)
1—hydrogen occlusion curve,
2—hydrogen release curve

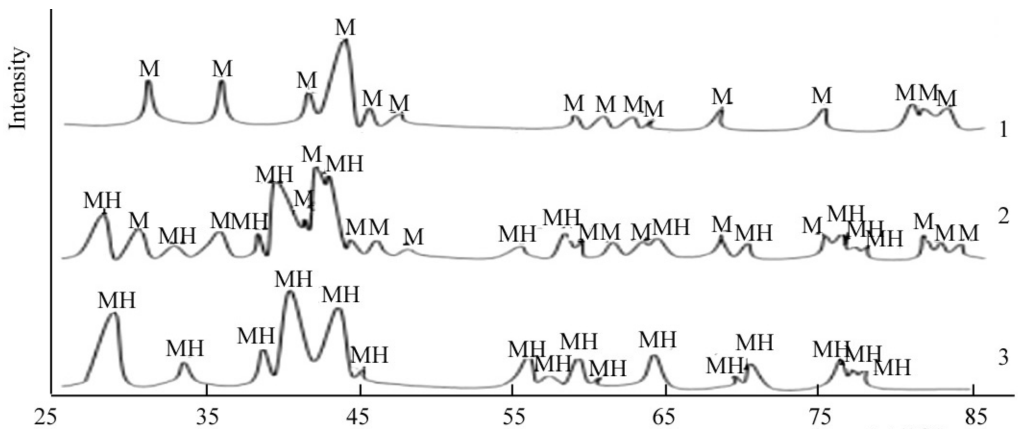

Fig. 2. XRD spectrum of $LaNi_5H_y$
1—y=0, 2—y=0～6.2, 3—y>6.2

Hydrogen occlusion and release characteristics of $LaNi_5$ alloy can be estimated with its electrochemical polarizing curve (Fig. 3).

As shown in Fig. 3, $LaNi_5$ alloy could be stable at the broad potential range of －900～＋700mV and at the potential more than ＋700mV oxygen was only precipitated in $LaNi_5$ alloy. But at that lower than －900mV it can not only precipitate hydrogen, but also occlude hydrogen itself. Namely, it acts as functional hydrogen electrode which occludes and releases only hydrogen.

The charging-discharging curve of $LaNi_5$ alloy electrode showed its hydrogen storage characteristics more detail (Fig. 4).

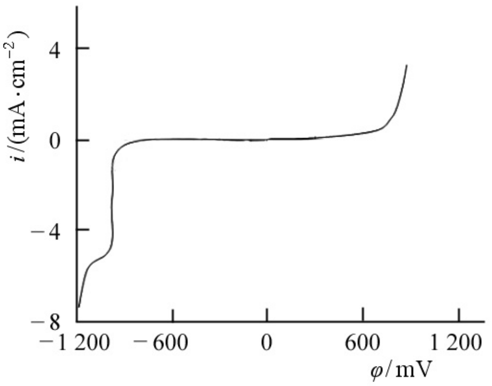

Fig. 3. Electrochemical polarizing curve of $LaNi_5$ alloy

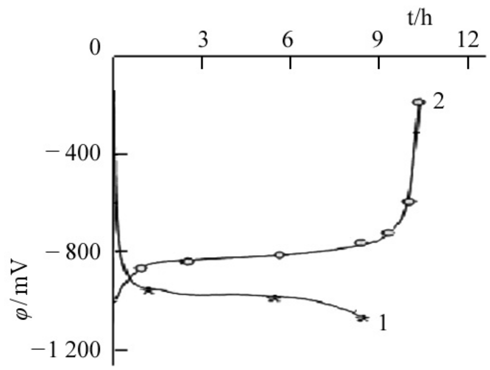

Fig. 4. Charging-discharging curve of $LaNi_5$ alloy electrode with time
1—charging, 2—discharging

As shown in Fig. 4, $LaNi_5$ alloy never absorbed oxygen and acted as functional hydrogen electrode which occludes only hydrogen and releases it again according to the external conditions.

To consider the hydrogen storage characteristics of $LaNi_5$ alloy with varing temperature, P-C-T curves of $LaNi_5$ alloy and discharge capacity of the battery are measured in some temperatures (Fig. 5, 6).

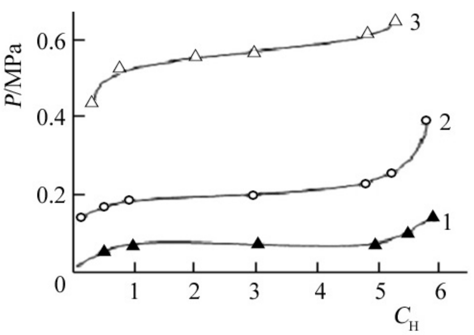

Fig. 5. P-C-T curve of $LaNi_5$ alloy
1—20℃, 2—40℃, 3—60℃

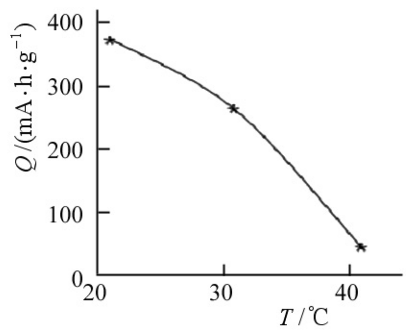

Fig. 6. Discharge capacity changes of $LaNi_5$ alloy electrode with temperature

As shown in Fig. 5, 6, the hydrogen storage capacity of $LaNi_5$ alloy dropped with temperature raising.

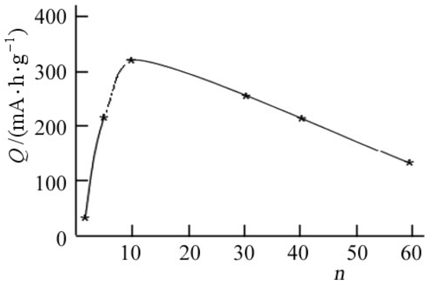

Fig. 7. Change of discharge capacity of $LaNi_5$ alloy electrode with charge-discharge number

The lifetime of $LaNi_5$ alloy as hydrogen storage material can be evaluated by measuring the change of its discharge capacity with charge-discharge number (Fig. 7).

Conclusion

Hydrogen storage characteristics of $LaNi_5$ alloy can be evaluated by the electrochemical method. $LaNi_5$ alloy can be used as the functional hydrogen storage material which absorbs and desorbs H_2 selectively.

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