Effects of Annealing Treatment on the Microstructures and Electrochemical Properties of $La_{0.7}Mg_{0.3}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$ Hydrogen Storage Alloy Electrode

MIAO He, LIN Yan, LI Rui, GAO Ming-xia, LEI Yong-quan, PAN Hong-ge
(Department of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, China)

Abstract: The effects of the dwelling time of annealing treatment on the microstructures and the electrochemical properties of the $La_{0.7}Mg_{0.3}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$ hydrogen storage alloy were studied systematically. The results of XRD showed that all of the alloys consisted mainly of two phases: the $(La, Mg)Ni_3$ phase and the $LaNi_5$ phase. Electrochemical studies showed that the maximum discharge capacity and the cyclic stability increased and the high rate dischargeability (HRD) of the alloy electrode decreased with increasing annealing time.

Key words: hydrogen storage alloys; annealing treatment; electrochemical properties
CLC number: TG146.22 Document code: A Article ID: 0529-6579 (2007) S1-0310-0

It is well known that the annealing treatment is a very effective way on the improvement of the overall electrochemical properties of the hydrogen storage alloys[1-3]. In this work, annealing treatment was applied to improve the properties of the La-Mg-Ni-Co type hydrogen storage alloys and the effects of dwelling time on the structure and electrochemical properties of the $La_{0.7}Mg_{0.3}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$ alloy were systemically studied.

1 Experimental

The $La_{0.7}Mg_{0.3}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$ alloy was prepared by induction levitation melting under argon atmosphere and remelted four times for homogeneity. All starting metals have a purity of higher than 99.9%. Annealing treatment was performed in vacuum, and dwelling times of 5 h, 8 h and 11 h at 1173 k were used. The other experimental details were same as[3].

2 Results and discussions

Fig. 1 (a) shows the XRD patterns of the as-cast and annealed $La_{0.3}Mg_{0.7}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$ hydrogen storage electrode alloys. As can be seen in the figure, the major phases of all of the alloys are the $(La, Mg)Ni_3$ phase and the $LaNi_5$ phase. No phase transformation occurred during the annealing treatment.

The curves of the discharge capacity versus cycle number of the as-cast and annealed $La_{0.7}Mg_{0.3}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$ alloy electrodes are shown in Fig. 1 (b). It is obvious from Fig. 1 (b) that annealing

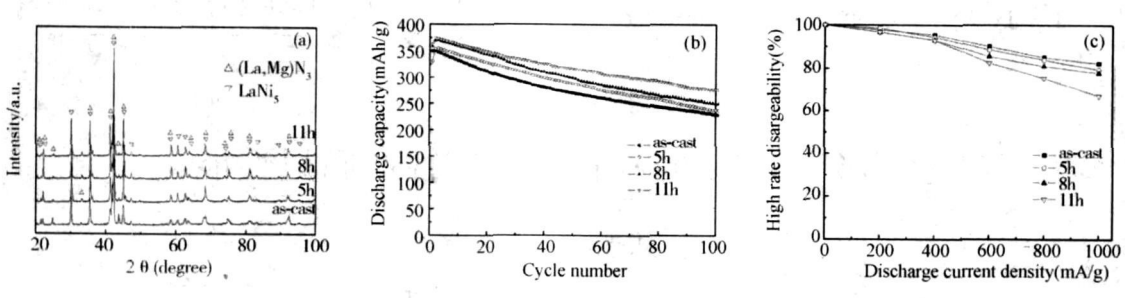

Fig. 1 XRD patterns and cyclic stability curves of the hydrogen storage electrode alloys
(a) XRD patterns; (b) Cyclic stability; (c) HRD

①收稿日期: 2007-01-10
基金项目: 国家自然科学基金资助项目 (50471040)
作者简介: 苗鹤 (1979年生), 男, 博士生; 通讯联系人: 潘洪革; E-mail: honggepan@zju.edu.cn

treatment increases the maximum discharge capacity of the alloy electrode, moreover, the maximum discharge capacity increases with increasing the dwelling time Ta. In addition, the cyclic stability of the alloy electrode also increases with increasing dwell time T_a.

Fig.1 (c) shows the high rate dischargeability (HRD) of the as-cast and annealed $La_{0.7}Mg_{0.3}Ni_{2.45}Mn_{0.1}Co_{0.75}Mn_{0.1}Al_{0.2}$ hydrogen storage alloy electrodes. It can be found that the HRD of the alloy electrode decreased after annealing treatment. Further, it decreases with the prolongation of the dwelling time T_a.

4　Conclusions

The effects of dwelling time on the phase structures and the electrochemical properties of the alloys were investigated systematically. The results of XRD analysis showed that all the alloys consisted of the (La, Mg)Ni_3 phase and the $LaNi_5$ phase. Electrochemical studies showed that the maximum discharge capacity and the cyclic stability increased and the HRD of the alloy electrode decreased with increasing annealing time.

References:

[1] NAKAMURA Y, NAKAMURA H, FUJITANI S, et al. Homogenizing behaviour in a hydrogen-absorbing $La-Ni_{4.55}Al_{0.45}$ alloy through annealing and rapid quenching [J]. J Alloys Compd, 1994, 210: 299-303.

[2] LIU Y F, JIN Q W, GAO M X, et al. Effects of heat treatment on electrochemical properties of $La_{0.7}Mg_{0.3}Ni_{2.8}Co_{0.5}$ hydrogen storage alloy [J]. Rare Metal Materials and Engineering, 2003, 32: 942-945.

[3] PAN H G, JIN Q W, GAO M X, et al. An electrochemical study of $La_{0.4}Ce_{0.3}Mg_{0.3}Ni_{2.975-x}Mn_xCo_{0.525}$ ($x=0.1$-0.4) hydrogen storage alloys [J]. J Alloys Compd, 2004, 376(1-2): 196-204.

[4] PAN Hongge, CHEN Ni, GAO Mingxia, et al. Effects of annealing temperature on the structure and the electrochemical properties of $La_{0.7}Mg_{0.3}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$ hydrogen storaage alloy [J]. J Alloys Compd, 2005, 397: 306—312.

热处理对贮氢电极合金 $La_{0.7}Mg_{0.3}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$ 的微结构与电化学性能的影响

苗　鹤，林　燕，李　锐，高明霞，雷永泉，潘洪革

(浙江大学材料科学与工程系，浙江 杭州 310027)

摘　要：研究了热处理时间对贮氢电极合金 $La_{0.7}Mg_{0.3}Ni_{2.45}Co_{0.75}Mn_{0.1}Al_{0.2}$的微结构与电化学性能的影响。XRD分析结果表明，所有合金均由 (La, Mg)Ni_3与 $LaNi_5$两相构成，热处理并没有使该贮氢合金发生相变。电化学研究结果表明，随着热处理时间的延长，合金电极的最大放电容量与循环稳定性能均得到明显改善，而高倍率放电性能却逐渐恶化。

关键词：贮氢合金；热处理；电化学性能

中图分类号：TG146.22