Metals and Materials International
https://doi.org/10.1007/s12540-019-00496-9

Electrochemical Studies on the Ca-Based Hydrogen Storage Alloy for Different Milling Times

Y. Dabaki[1] · C. Khaldi[1] · N. Fenineche[3] · O. ElKedim[4] · M. Tliha[1,2] · J. Lamloumi[1]

Received: 6 May 2019 / Accepted: 4 October 2019

Abstract
The $CaNi_{4.8}Mn_{0.2}$ powder was synthesized by mechanical alloying, under an atmosphere of argon at room temperature, at different milling times (2, 10, 20, 30, 40, 50 and 60 h) with ball to powder weight ratio of 8:1. The structural and morphological characterizations of the $CaNi_{4.8}Mn_{0.2}$ powder were carried, respectively, by scanning electron microscopy and X-ray diffraction. After 2 h, all the alloys had a biphasic structure, two major phases, Ni and Ca_2Ni_7, remained virtually unchanged when a small amount of Mn was added. After more than 40 h of milling, the same peaks of the Ni and Ca_2Ni_7 phases appeared, while the intensity of the peaks decreased, indicating an additional amorphization process. After 50 h of milling, this damping was followed by the crystallization amorphization. The electrochemical properties of $CaNi_{4.8}Mn_{0.2}$ electrodes were studied at different milling times (10, 20, 30, 40, 50 and 60 h) and in KOH electrolyte concentrations (1 M and 6 M) at ambient temperature, as anodes in the Ni–MH battery. Different techniques were used, such as galvanostatic polarization, potentiostatic polarization and potentiodynamic polarization.

Keywords $CaNi_5$ based alloys · Mechanical alloying · Structural and morphological techniques · Ni–MH batteries · Electrochemical techniques

1 Introduction

The nickel-metal hydride (Ni–MH) batteries are a source of electrochemical energy largely used to feed the portable devices and electric vehicles with electricity [1–3]. The Ni–MH batteries are significantly less dangerous than cadmium-nickel batteries and also much more cost-effective and safer than lithium-ion batteries [4]. The capacity, lifetime and charge/discharge property of a Ni–MH battery are measured in terms of its performance. These characteristics must be improved so that these batteries can be more widely used. The charging/discharging cycles of Ni–MH batteries are almost 1000 cycles while for Ni–Cd batteries they are 2000 cycles [4]. This charging and discharging property depends on the properties of the electrode and the method of fabrication. This is the main problem that needs to be ameliorated in these Ni–MH batteries [5–11]. The alloys of hydrogen storage can be classified in five families: Alloys of the type AB_5, AB_3, A_2B_7, AB_2 and AB. Moreover the storage capacity of hydrogen has to be studied for the applications in portable devices. Their thermodynamic and kinetic properties, their activation and the storage capacity are the essential parameters for the use as alloys of hydrogen storage [12]. The AB_5 family has the capacity to absorb high quantities of hydrogen at room temperature and pressure and has high potential as a hydrogen storage medium. The famous alloys of the AB_5family are $CaNi_5$, $LaNi_5$, YNi_5 and $ThNi_5$ [13].

The alloys of the AB_5 family have attractive properties, such as the formation of hydrides at pressure equilibrium of a few atm. up to 100 °C, the tolerance to gaseous impurities and in the first cycle, easy activation.

But almost all alloys belonging to the AB_5 family contain the element Ni, which increases the costs [14]. The $LaNi_5$ has received the highest attention in the AB_5 family and

✉ C. Khaldi
chokri.khaldi@esstt.rnu.tn

1 Université de Tunis, ENSIT, LR99ES05, 1008 Montfleury, Tunisia

2 Department of Physics, Umm-Alqura University, Al-Qunfudah, Saudi Arabia

3 ICB-PMDM/FR FCLAB, UTBM, UBFC, 90010 Belfort Cedex, France

4 FEMTO-ST, MN2S, UTBM, UBFC, 90010 Belfort Cedex, France

Published online: 21 October 2019