MECHANICAL ALLOYING OF MG-CO-NI POWDER FOR HYDROGEN STORAGE

Hadi Suwarno[1)], Andon Insani[1)], Johny Wahyudi[2)], Eddy S. Siradj[2)], Bambang Herutomo[1)]

[1)]Center for Nuclear Fuel Technology, National Nuclear Energy Agency, Kawasan Puspiptek, Serpong, Tangerang 15310, Banten Indonesia
[2)]Dept. of Metallurgy and Materials, Faculty of Engineering, the University of Indonesia, Depok 16424, West Java, Indonesia
E-mail:

ABSTRACT

In order to develop the Mg-based materials for hydrogen storage purposes, Mg-Co-Ni alloy with the atomic ratio of the Mg: Co: Ni = 3:1:2 was prepared by mechanical alloying. The alloy was prepared from pure metal powder of magnesium, cobalt and nickel by using SPEX 8000 high energy milling (HEM) and conventional milling. Mass ratio ball to sample (B/S) were 1:1 and the milling time is varied at 5, 10, 15, 20 and 40 hours. Structure and crystallite sizes were observed by X-ray diffraction (XRD), morphology and particle size by scanning electron micrograph (SEM), and thermal properties of the sample by differential thermal analyzer (DTA).

The crystal sizes of the alloy were measured for Mg (101), Ni (200) and Co (101). Calculation results on the crystal size of the Mg exhibited that it is reduced significantly from 29 nm into 6 nm after milling for 40 hours, while Co and Ni are slightly reduced. From the diffraction pattern of the alloy it is also showed that the peaks intensity of Mg disappears gradually, due to the amorphisation of Mg particles. It could be happened during the continuous impact between the Mg particles and the balls. A significant change of volume fraction was observed in Mg, where it changed from 62.52 % into 26.04 % after 40 hours of milling. While Co and Ni increased from 7.63 % to 10.63 % and from 25.23 % to 30.02 % respectively. The SEM results showed that the particle sizes reduce after 5 hours milling. The initial particle size of Mg was $\leq$ 3.5 μm and the final milling was reduced into 0.5 μm. In addition, agglomeration of the powder was occurred after 10 hours milling. It is due to the increase in surface area of the powder that results in the easier contact of the powders to each other. The DTA differential thermal analyses on milling time of 0 and 10 hours identified that there is an endothermic peak. The peak at 400 °C is identified as phase transition of Co from hcp into fcc. Weak endothermic peak encountered at temperature of 150 °C for 20 hours of milling is indicated as evaporation due to the hygroscopic properties of material. In addition to 20 hours of milling, no endothermic peak is obtained since the structure of the specimen has changed as shown in the XRD examinations.

It is concluded that milling time of 40 hours using high energy ball milling at B/S ratio of 1 can be used to produce nano size of powder before hydriding. It is predicted that nano size of powder will increase the hydriding rate compared to the original one.

Note: Hydriding system is being constructed and estimated to be finished in December 2006. Abstract will be extended after hydriding experiment is conducted.