PARTICLE DIMENSIONS AND METAL HYDRIDE ABSORPTION/DESORPTION PROPERTIES

Grinberga L.*, Rancans E., Kleperis J.
Institute of Solid State Physics of University of Latvia
Kengaraga str. 8, Riga, LV-1063, Latvia
**Fax: +371 67132778 E-mail: Liga.Grinberga@cfi.lu.lv.*

Introduction

Systems that function without pollutants and where the hydrogen is produced from renewable sources of energy are needed to convince the society for the need to transfer to a hydrogen economy. However, it will necessitate various technological advances, such as: fast working, long lasting, close to normal conditions operating and a reasonable operational cost.

Metal hydride thermodynamic reactions and kinetics are playing the most important role in selection of materials for reversible hydrogen storage. According to literature the use of nanoparticles can change the overall thermodynamic reaction and theses exhibits chemical and physical properties that differ from a macroscopic system grain [1, 2].

The chemical stability is mainly influenced by size dependent values of the surface tension and the molar volume. Therefore, the nanohydride system stability may be shifted to the hydrogenated or to the dehydrogenated side. Kim et al. [3] studied the temperature that is required for the hydride to generate a 1 bar H_2 pressure as a function of nanoparticles radius. In most cases, they discovered that the hydrogen release temperature increases slightly as the particle size is reduced.

In this work we investigated the relationship between metal hydride sorption properties and particle dimensions using gas sorption analysis.

Results and discussion

A Sievert type apparatus PCTPro-2000 is a very sophisticated instrument with excellent possibilities to perform precise and advanced set of measurements. It allows for the investigation of hydrogen in various storage materials.

For the initial experiments a $LaNi_5$ coarse grain (>50 microns) powder was used. After regular pre-treatment the hydrogen pressure of 20 bars was applied to the sample and hydrogen sorption kinetics was measured.

The Figure 1 represents the hydrogen concentration change as a function of time. During the performed measurement the $LaNi_5$ was not reaching the fully charged state at a satisfactory rate. A glitch on the data plot appears when the low pressure transducer switches to the high pressure transducer and a free volume is introduced.

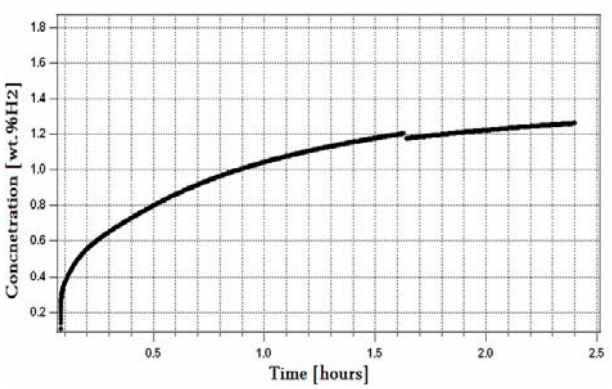

Fig.1. Hydrogen absorption kinetics.

In further measurements, we decreased the particle size by grinding a sample with a tungsten carbide ball mill. After grinding for 2 hours, the particle size decreased to ~2-10 microns. We applied the same measurement procedures to this reduced size particles.

The cycle life measurement plot (Fig. 2) of the new sample size is represented in three cycles. Here, the absorption pressure was set to 20 bars and held for 20 minutes. Desorption process is recorded for 20 minutes while the sample is exposed to a vacuum. In between these two atmospheric settings, the machine takes about 5 minutes to adjust and stabilize, in both directions.

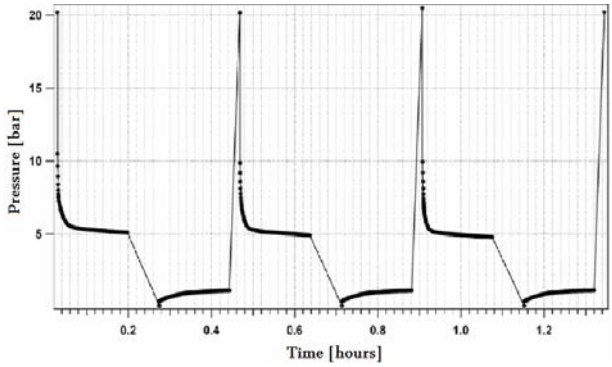

Fig. 2. Pressure changes as a function of time.

The results show, for smaller grain size, that the hydrogen absorption plateau is reached significantly faster. Although we observed an

increasing amount of absorbed and desorbed hydrogen after several cycles of measurements. The experiment was prolonged for 70 hours and after ~10 cycles the absorbed/desorbed amount of gas was not changing. This leads us to conclude that we must revise the treatment procedure and/or activation of the sample.

Conclusions

For these experiments, we used a new equipment PCTPro 2000 that determines the amount of hydrogen gas that is sorbed into material. It is doing so by measuring a pressure change inside a reservoir of known volume and temperature.

We gained a good experience and increased our competence. According to our measurements it is important to use just high or low pressure transducers for short measurements to avoid the faulty points (see Fig.1). It is crucial to properly activate the sample if one is to perform precise and repeatable measurements.

Preliminary results show a good agreement with the literature that reports about enhancement of kinetics of hydrogen absorption and desorption depending on particle size of hydride forming metals.

For further investigations we suggest to use smaller particle sizes of metal hydride and also exploit different support materials.

Acknowledgements

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