CHARACTERIZATION OF Mg – x wt. % FeTi COMPOSITES PREPARED BY HIGH ENERGY BALL MILLING

Lal C.*, **Dhunna R., Jain I.P.**
Centre for Non-Conventional Energy Resources, Jaipur, India
14 – Vigyan Bhawan, University of Rajasthan, Jaipur – 302015, India
**Fax: 0141-2711049 E-mail: clsaini52@hotmail.com*

Introduction

The current interest in hydrogen is primarily due to environmental concerns of the harmful emissions from the fossil fuels used presently. Also, a demand for more efficient power sources has increased the interest in different kinds of new technologies, such as fuel cells using hydrogen or hydrocarbons as fuel. It is widely believed that hydrogen will within a few years become the fuel that powers most vehicles and portable devices, i.e. hydrogen will become the means of storing and transporting energy. The reason is the depletion of oil and the relatively facile production of hydrogen from the various renewable sources of energy – hydroelectric, wind, solar, geothermal – with water being the only raw material needed. To release the energy, hydrogen can be burnt in an efficient and clean way in a fuel cell to form water again, or made to drive an electrochemical cell as in the commonly used nickel hydride battery.

Magnesium is an attractive material for hydrogen storage applications because of high storage capacity, low density, low cost and availability. The hydriding and dehydriding kinetics of pure Mg are slow. A group of Mg based hydrides stand as promising candidate for competitive hydrogen storage with reversible hydrogen capacity upto 7.6 wt% for on board applications. Efforts have been devoted to these materials to decrease their desorption temperature, enhance the kinetics and cycle life. The kinetics has been improved by adding an appropriate catalyst into the system as well as by ball milling that introduces defects with improved surface properties.

Composites based on Mg with intermetallic FeTi were prepared by ball milling for evaluation of their hydrogen storage characteristics. In order to have a better understanding of the nature and hydrogen desorption mechanism systematic studies have been undertaken. X-ray diffraction was performed to see the effect of absorption/desorption processes on the crystal structure. Crystallite size was evaluated by X-ray powder diffraction peak broadening. The electronic structure and bonding properties were observed by FTIR. The magnetic properties also observed by Vibrating Sample Magnetometer (VSM). Hydrogen storage characteristics, pressure-composition isotherms and kinetics were investigated under different parameters.

Results and discussion

The main objective of many current studies has been to reduce the high Mg-H binding energy by alloying additions, so as to reduce the sorption temperature. Numerous studies have been carried out in order to identify a suitable alloy that absorbs hydrogen close to room temperature and desorbs hydrogen at a temperature low enough to use the waste heat of exhaust gas. Both nanocrystallization and addition of 3d transition metal (such as Ni, Co, Mn, Cu, Ti, Fe, V, etc.), 3d non-transition metal (such as Nb, Ge, etc.) and intermetallic compounds (e.g. $LaNi_5$, FeTi, $ZrFe_{1.4}Cr_{0.6}$ etc.) catalysts demonstrated to improve the hydrogen sorption kinetics of Mg.

The most common techniques for measuring hydrogen uptake by a solid host are the Sieverts technique and gravimetry, with the focus of this work being on the former technique owing to its practicability and very widespread use. The Sieverts technique is cheap, robust, portable, simple and, when practised with reasonable care, universally accepted as accurate. In the Sieverts technique, a calibrated reference volume is filled with gas to a measured pressure and then opened to the sample chamber, the gas uptake by the sample being calculated from the change in the gas pressure in the system.

Magnesium and magnesium-based alloys are regarded as very attractive materials for hydrogen storage due to high hydrogen capacity, relatively low cost and abundance of the raw materials. However, the practical application of magnesium hydride has been limited so far due to the two main reasons: the reactions of hydrogenation/dehydrogenation are slow and the pressure of hydrogen gas in equilibrium with magnesium hydride is low (1bar at about 550K), therefore, a high temperature is required for hydrogen desorption.

Conclusions

Composites based on Mg with intermetallic FeTi were prepared by ball milling for evaluation of their hydrogen storage characteristics.

Observing the importance of Mg for hydrogen storage for practical applications, work in our laboratory is in progress in this field. Mg nanocomposites using various transition metal catalysts have been undertaken. We hope to contribute significantly to make Mg to some extent absorbing hydrogen at lower temperatures.

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