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EFFECT OF PREPARATION PROCEDURES AND HYDROLYSIS PARAMETERS ON THE HYDROLYSIS PERFORMANCE OF MgH_2 - $MgCl_2$ NANOCOMPOSITES

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Magnesium hydride is an attractive material for solid-state hydrogen storage and for hydrogen generation via hydrolysis due to its high capacity of hydrogen and low cost. However, the hydrolysis reaction of MgH_2 is rapidly blocked by the $Mg(OH)_2$ passivation layer, which can be destabilized by Cl^- ions. By taking into account this fact, we performed high-energy ball milling synthesis of MgH_2 with $MgCl_2$ additive, and evaluated the effect of preparation procedures and hydrolysis parameters on the hydrolysis performance of the prepared materials.

Keywords: *magnesium hydride, hydrolysis, hydrogen generation, nanocomposites, high-energy ball milling.*

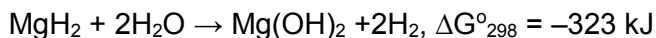
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Today, hydrogen is considered as one of the best options as a clean energy carrier when produced from renewable sources of energy. Hydrogen can offer a viable solution to many problems caused by climate change, air pollution, fluctuations in the green energy supply, etc., since it is renewable, eco-friendly and has a high energy density (120 MJ/kg). However, conventional hydrogen storage methods, i.e. high pressure gas cylinders and liquid hydrogen, cannot fully meet the

requirements for the application in fuel cell electric vehicles due to the issues associated with a low hydrogen storage capacity, safety and high cost. Solid-state hydrogen storage in hydrides is a promising method of storage for portable and automotive applications. Metal hydrides are chemical compounds of metals and hydrogen that can reversibly absorb/release large amounts of hydrogen in controlled temperature and pressure conditions. Compared to the reversible hydrogen storage materials, production of hydrogen via hydrolysis of hydrides provides a more efficient method for hydrogen generation because of the high hydrogen yield at low operation temperature.

In the search for advanced raw materials for hydrolysis, various hydrides (e.g., LiH, LiBH₄, NaBH₄, MgH₂) and Al-, Mg-based alloys have been tested. However, the last ones have poor hydrogen generation kinetics, while the hydrolysis of LiH or LiBH₄ is highly exothermic. NaBH₄ shows less exothermic reaction with water but the biggest disadvantages for its wide use are the necessity for catalysts as well as the reversibility and the cost issues.

Magnesium hydride (MgH₂) is considered to be one of the most attractive candidates due to its high hydrogen capacity (7.6 wt.% H₂ or 15.2 wt.% H₂, when hydrolyzed), relatively low cost, and environmentally friendly hydrolysis byproducts. Hydrogen is generated by MgH₂ hydrolysis via the following reaction:



Nevertheless, the main obstacle for practical application of MgH₂ is the formation of a passive Mg(OH)₂ layer on the MgH₂ surface. As the result, the hydrolysis reaction quickly slows down since Mg(OH)₂ has poor solubility in water as the pH increases. Various approaches were used to address this problem, which includes nanostructuring, the addition of salts, acids, alkali metals, inert additives at ambient conditions or when under heating, ultrasonic irradiation, stirring. As it was shown in our recent study [1], nanostructuring of MgH₂ with different additives (AlCl₃, EDTA, and TiC-2TiB₂) under

hydrogen atmosphere is an efficient way to improve the hydrolysis performance. Among the tested additives, the highest hydrolysis performance was obtained for materials with AlCl_3 additive. This was attributed to the destabilization of the $\text{Mg}(\text{OH})_2$ layer by Cl^- ions, which substitute the OH^- ones to form more soluble MgCl_2 than $\text{Mg}(\text{OH})_2$, while OH^- ions are consumed in the formation of $\text{Al}(\text{OH})_3$.

In order to further improve the hydrolysis reaction of MgH_2 , we studied the effect of preparation procedures and hydrolysis parameters on the hydrogen generation kinetics of MgH_2 – MgCl_2 composites prepared by reactive high-energy ball milling. The hydrogen generation performance in terms of conversion rate and hydrogen yield was determined volumetrically.

References:

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