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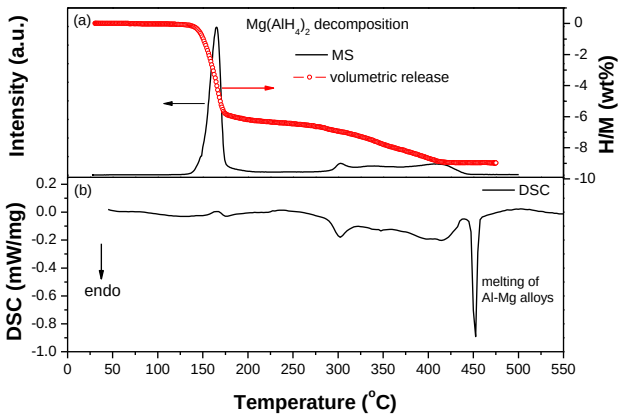
Synthesis and hydrogen storage properties of $Mg(AlH_4)_2$

Metal alanates are regarded as a very promising group of materials for high-density solid-state hydrogen storage. Therefore, the search for new alanates with high hydrogen content and sufficiently fast reaction kinetics of absorption and desorption at moderate temperatures is still a very active field.

In this work, we developed a modified synthesis method for $Mg(AlH_4)_2$ with high purity. By ball milling the mixture $NaAlH_4$ and $MgCl_2$ (molar ratio: 2:1) in Et_2O followed by Soxhlet extraction, $Mg(AlH_4)_2$ submicron rods were successfully obtained as the resultant product, and its purity was determined to be as high as 96.1%. Upon heating, ~ 9.0 wt% of hydrogen was released from the as-prepared $Mg(AlH_4)_2$ with a three-step reaction. This was measured by a combination of MS (m/z 2, **Hiden QIC-20**) and volumetric analyses. At 125-200°C, $Mg(AlH_4)_2$ decomposed first to liberate hydrogen and generate MgH_2 and Al (Figure 1 (a)). With increasing temperature to 320°C, the newly produced MgH_2 reacted with Al to form the $Al_{0.9}Mg_{0.1}$ solid solution along with hydrogen release. As the temperature was further elevated to 440°C, the reaction between the $Al_{0.9}Mg_{0.1}$ solid solution and the remaining MgH_2 occurred to evolve additional hydrogen and form Al_3Mg_2. DSC measurement showed that the first step dehydrogenation is exothermic while the last two steps are endothermic (Figure 1 (b)).



Analysis of the isothermal and non-isothermal behaviours revealed a diffusion-controlled kinetic mechanism for the first step dehydrogenation, and its apparent activation energy was calculated to be about 123.0 kJ/mol. However, only ~2.3 wt% of hydrogen could be recharged at 140-210 °C and 100 bar of hydrogen pressure. Therefore, further improvement on hydrogen storage reversibility of $Mg(AlH_4)_2$ should be performed to make it useable as a potential hydrogen storage material.

H_2-TPD, volumetric release (a) and DSC (b) curves of the as-prepared $Mg(AlH_4)_2$

Project Summary by:

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Hiden Product:

QGA Atmospheric Gas Analysis System (was QIC-20)