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Title: Magnesium Hydride: Modifications and enhancements for hydrogen storage.

Short Abstract:

Despite poor kinetics and the intrinsic high enthalpy, magnesium continues to be investigated as a potential hydrogen storage material. Ways in which these drawbacks can be overcome or reduced through modifications such as the introduction of defects and alloying with other metals are discussed as well as enhancements through small amounts of additives.

Abstract

Magnesium is a light-weight metal, which, because of a moderate hydrogen capacity of 7.6 wt% as MgH_2 and its abundance in the earth's crust and oceans and the relatively cheap extraction from carbonates, hydroxides and naturally occurring salts is still considered a potential hydrogen storage material. This is despite problems caused by the ever-present oxidation layer, relatively poor kinetics and the high enthalpy of formation of the hydride which in turn requires high temperatures (ca 300 °C) for desorption to occur.

There are a number of methods which have been shown to improve the kinetics of the Mg-H reaction and the decomposition to release the hydrogen. Substantial enhancements have been made by introducing defects into the material by ball-milling, severe plastic deformation and rapid solidification techniques. While some of the benefits are subsequently lost after cycling hydrogen absorption and desorption at temperature, additives can help to prevent the sintering of the material. Additives are also shown to improve the kinetics, although the mechanisms by which this occurs are poorly understood. A brief review of additives with the role of the most effective additive to date, Nb_2O_5 as well as a new additive, is given and the possible mechanisms are discussed.

To lower the temperature required for desorption, the thermodynamics must be changed and there is little evidence that additives alone can accomplish this. Alloying with another metal or metals is a means to reduce the enthalpy and various alloys are discussed together with the effect on the thermodynamics. The enthalpy may also be changed by reducing the particle size to less than 10 nm as well as nano-confinement in porous materials or thin films.

The current state of the methods to improve the kinetics and the thermodynamics is presented and the underlying mechanisms are discussed together with a summary of possible future avenues for improving magnesium hydride as a hydrogen storage material.