NANOSTRUCTURED MgH_2 FOR HYDROGEN STORAGE APPLICATIONS

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Solid state -chemical- hydrogen storage forming reversible metal hydrides is of high interest since rise two major challenges for the civilization, that are the progressive decrease of fossil energies -oil and gas- and a dramatic temperature increase on earth due to the greenhouse gas effect. Both phenomena are closely related since massive CO_2 emissions result of the fossil energy combustion where coal takes a dominant position.
Clean and renewable energy systems are progressively operated, as based on solar energy conversion and more nuclear energy is planed, both solutions delivering electrical power. Electricity is of easy distribution, but no global scale solution exists for massive storage to adequate production and uses. Besides, for mobile applications using oil or gas, specific but clean storage must be developed, namely owing to the increasing fleet of vehicles.
Hydrogen, e.g. from alternative sources, appears as of the potential and large scale for both static and mobile applications. Dense H-storage can be realised under different forms hyperbaric, cryogenic or reversible metal hydride tanks, which fulfil (or not) many different criteria such as weight, volume, safety, energy of disposal, facility disposal etc. To date MgH_2 appears the most suitable solid storage (7.6 w% theor.), however the reaction kinetics is said very low and Mg reacts at ~ 300°C under normal pressure.
Here we describe and explain the fundamentals of nanostructuration of MgH_2 and so-called "catalyst" additives, both handled by energetic ball milling (BM), for fast and large hydrogen uptake, leading to reach some of the DOE's criteria. For this doing, the selected catalysts reactivity to hydrogen was optimised via specific melting route leading to deliver homogeneously fine and reactive composite microstructure.
Parallel, other Severe Plastic Deformation (SPD) techniques are under development, expecting faster and cheaper nanostructuration operations than from using BM.
Since hydrogenation of Mg is very exo(endo)thermic, heat transfers must be finely controlled, a point that was solved developing MgH_2-ENG composites. This allowed designing MgH_2 tanks working in adiabatic conditions thanks CPM units, for a total energy efficiency better than 95%.

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