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A Hybrid Hydrogen Storage System Based on Hollow Glass Microspheres

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The theoretical and experimental aspects of a hybrid hydrogen storage system consisting of hydrogen pressurized hollow glass microspheres (HGMS) and a hydride, e.g. NaBH_4 , will be discussed. Volumetric and gravimetric storage densities are assessed. Thermal aspects and hydrogen diffusion through glass are discussed. It is shown that hydrogen pressurized HGMS in combination with a hydride bear the potential to achieve storage densities up to $30\text{-}50\text{ kg/m}^3$. Hydrogen is stored by heating and pressurizing the spheres at approx. 85 MPa, forcing the gas into the spheres. Hydrogen is released by heating again to approx. 250°C . To reach this temperature the exothermal chemical reaction of NaBH_4 with water, which produces hydrogen as a welcome by-product, is used. To promote the reaction the HGMS (diameter approx. $20\text{ }\mu\text{m}$) have to be coated with a catalyst. To produce the catalyst coating on the HGMS a special coating device based on non-reactive (for metals) and reactive (for non-metals) magnetron sputtering was designed. It provides continuous intermixing of the fragile spheres in a container by a combination of rotation and concussion. In the final design stage the coating mechanism can handle one liter of microspheres. The catalytic reaction is tested in a set-up which measures the released heat and amount of hydrogen. For Ru deposited on an adhesion promoting film of TiO_2 the theoretical maxima of released heat and hydrogen could be achieved, thus rendering even the hydride based part of the system alone an interesting option for hydrogen storage.

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