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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. NaBH4, 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 30-50 kg/m³. 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℃. To reach this temperature the exothermal chemical reaction of NaBH4 with water, which produces hydrogen as a welcome by-product, is used. To promote the reaction the HGMS (diameter approx. 20 μm) 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 TiO2 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.

Primary author(s) : Dr EISENMENGER-SITTNER, Christoph (Vienna University of Technology)

Co-author(s) : Dr DREXLER-SCHMID, Gerwin H. S. (Austrian Institute of Technology)

Presenter(s) : Dr EISENMENGER-SITTNER, Christoph (Vienna University of Technology)

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