Hydrogen storage options

Because of hydrogen's low density??? State that?, its storage always requires relatively large volumes and is associated with either high pressures (thus requiring heavy vessels) or extremely low temperatures, and/or combination with other materials (much heavier than hydrogen itself).

Large underground hydrogen storage

Underground storage of hydrogen in caverns, aquifers, depleted petroleum and natural gas fields, and human-made caverns resulting from mining and other activities is likely to be technologically and economically feasible. Hydrogen storage systems of the same type and the same energy content will be more expensive by approximately a factor of three than natural gas storage systems, ??why ??due to hydrogen's lower volumetric heating value………what is meant??.

Above-ground pressurized gas storage systems.

Hydrogen can be stored in standard pressure cylinders look like gas storage.

Vehicular pressurized hydrogen tanks

Development of ultra-light but strong new composite materials has enabled storage of hydrogen in automobiles. Pressure vessels that allow hydrogen storage at pressures greater than 200 bars have been developed and used in automobiles.

A storage density higher than 0.05 kg of hydrogen per 1 kg of total weight is easily achievable. Storage as liquid H_2 imposes severe energy costs because up to 40% of its energy content can be lost to liquefaction. The storage containers lose energy due the boil-off of hydrogen that is caused by thermal conductivity. The boil-off losses vary from 0.06 % per day of large containers to 3 % per day of small vessels. The boil-off losses can be reduced through proper insulation.

Metal Hydrides

Metal hydrides are composed of metal atoms that constitute of a host lattice and hydrogen atoms that are trapped in interstitial sites, such as lattice defects such as vacancy. There are two possible ways of hydriding a metal, direct dissociative chemisorption and electrochemical splitting of water. These reactions are, respectively

M+ x/2 H2=MHx…….

$M+x/2H2O+x/2e=MHx+x/2\ OH^-$

Where M represents the metal. In electrochemical splitting there has to be a catalyst, such as palladium, to break down the water.

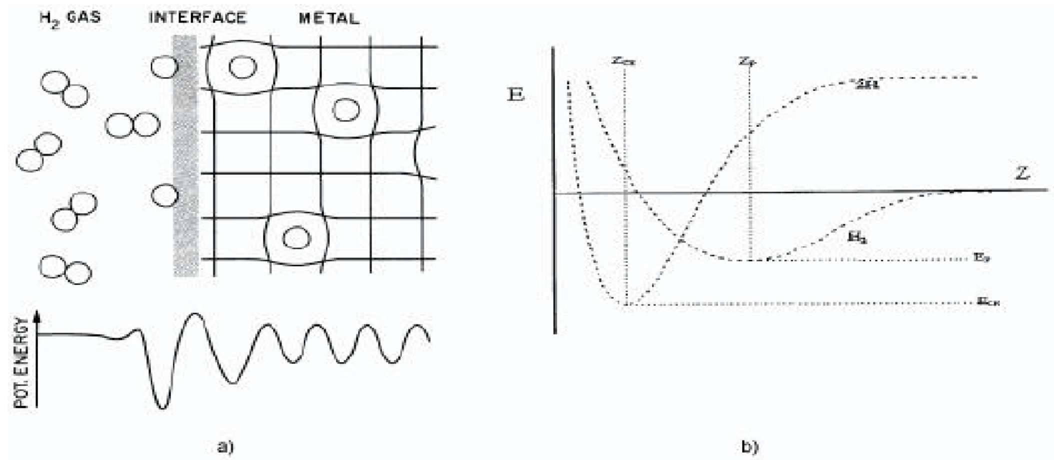

Figure* a states Schematic of hydrogen chemisorption on metal, b) Potential wells of molecular and atomic hydrogen sources

The essential requirements that should be satisfied by metal hydrides proposed for hydrogen storage at a commercial level. These are summarized below.

• High hydrogen content

• Facile reversibility of formation and decomposition reactions. The hydride should be decomposable at moderate temperatures that can be provided from locally available heat sources, like solar, automobile exhaust and waste heat • Adsorption-desorption kinetics should be compatible with the charge-discharge requirements of the system

• The equilibrium dissociation pressure of the hydride at peak desorption rate should be compatible with the safety requirements of the hydride containment system. The hydride itself should have a high safety factor

• The hydride should have a sufficient chemical and dimensional stability to permit its being unchanged over a large number of charge–discharge cycles

• Minimal hysteresis in adsorption–desorption isotherms

• The hydride should be reasonably resistant to deactivation by low concentrations of common (sometimes unavoidable) contaminants such as O_2,H_2O,CO_2, CO, and others

• The total cost of hydride (raw materials, processing and production) should be affordable for the intended application. The long term availability of raw materials (that is, the metal resources), must be ensured. The cost of the hydride system (which includes its containment) per unit of reversibly stored hydrogen should be as low as possible

• The storage vessel and ancillary equipment cost and the fabrication and installation costs should be moderate

• Operating and maintenance costs and purchased energy requirements (that is, energy other than waste energy and energy extracted from the ambient air) per storage cycle should be low.

Hydrogen in Carbon Structures

Hydrogen can be stored into the nanotubes by chemisorption or physisorption. The methods of trapping hydrogen are not known very accurately but density functional calculations have shown some insights into the mechanisms Calculations indicate that hydrogen can be adsorbed at the exterior of the tube wall by H-C bonds