World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:10, No:01, 2016

On the Effect of Carbon on the Efficiency of Titanium as a Hydrogen Storage Material

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Abstract : Among the metal that forms hydride´s, Mg and Ti are known as the most lightweight materials; however, they are covered with a passive layer of oxides and hydroxides and require activation treatment under high temperature (> 300 C) and hydrogen pressure (> 3 MPa) before being used for storage and transport applications. It is well known that small graphite addition to Ti or Mg, lead to a dramatic change in the kinetics of mechanically induced hydrogen sorption (uptake) and significantly stimulate the Ti-Hydrogen interaction. Many explanations were given by different authors to explain the effect of graphite addition on the performance of Ti as material for hydrogen storage. Not only graphite but also the addition of a polycyclic aromatic compound will also improve the hydrogen absorption kinetics. It will be shown that the function of carbon addition is two-fold. First carbon acts as a vacuum cleaner, which scavenges out all the interstitial oxygen that can poison or slow down hydrogen absorption. It is also important to note that oxygen favors the chemisorption of hydrogen, which is not desirable for hydrogen storage. Second, during scavenging of the interstitial oxygen, the carbon reacts with oxygen in the nano and microchannel through a highly exothermic reaction to produce carbon dioxide and monoxide which provide the necessary heat for activation and thus in the presence of carbon lower heat of activation for hydrogen absorption which is observed experimentally. Furthermore, the product of the reaction of hydrogen with the carbon oxide will produce water which due to ball milling hydrolyze to produce the linear H5O2 + this will reconstruct the primary structure of the nanocarbon to form secondary structure, where the primary structure (a sheet of carbon) are connected through hydrogen bonding. It is the space between these sheets where physisorption or defect mediated sorption occurs.

Keywords : metal forming hydrides, polar molecule impurities, titanium, phase diagram, hydrogen absorption
Conference Title : ICHS 2016 : International Conference on Hydrogen Safety
Conference Location : London, United Kingdom
Conference Dates : January 18-19, 2016