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Al-Ti-W Metallic Glass Thin Films Deposited by Magnetron Sputtering Technology to Protect Steel Against Hydrogen Embrittlement

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Abstract : With the huge increase in world energy consumption, researchers are working to find other alternative sources of energy instead of fossil fuel one causing many environmental problems as the production of greenhouse effect gases. Hydrogen is considered a green energy source, which its combustion does not cause environmental pollution. The transport and the storage of the gas molecules or the other products containing this smallest chemical element in metallic structures (pipelines, tanks) are crucial issues. The dissolve and the permeation of hydrogen into the metal lattice lead to the formation of hydride phases and the embrittlement of structures. To protect the metallic structures, a surface treatment could be a good solution. Among the different techniques, magnetron sputtering is used to elaborate micrometric coatings capable of slowing down or stop hydrogen permeation. In the plasma environment, the deposition parameters of new thin-film metallic glasses Al-Ti-W were optimized and controlled in order to obtain, hydrogen barrier. Many characterizations were carried out (SEM, XRD and Nano-indentation…) to control the composition and understand the influence of film microstructure and chemical composition on the hydrogen permeation through the coatings. The coating performance was evaluated under two hydrogen production methods: chemical and electrochemical (cathodic protection) techniques. The hydrogen quantity absorbed was experimentally determined using the Thermal-Desorption Spectroscopy method (TDS)). An ideal ATW thin film was developed and showed excellent behavior against the diffusion of hydrogen.

Keywords : thin films, hydrogen, PVD, plasma technology, electrochemical properties
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