université de technologie Troyes

PhD thesis offer

Development of hydrogen barrier coatings to protect metallic structures used in energy sector.

Keywords: Thin films, hydrogen barriers, PVD, surface treatment, functional materials, physico-chemical analysis, mechanical testing.

Context

Hydrogen energy as a one of clean and economical future resources has enormous potential for the society and environment. In the literature, hydrogen barrier coatings are deposited by different techniques: sol-gel, electrodeposition, PVD (Physical Vapor Deposition), ion beam assisted deposition, MOCVD ... etc. We note that different materials have been studied: oxides, nitrides and metal alloys. The corrosion behavior and the hydrogen permeability of coatings are mainly evaluated. Despite the research works performed these last years, in the literature little data could be found on the architectural multilayer coatings deposited by PVD investigated in real conditions of service under hydrogen. In this way, developing of hydrogen barrier coatings confirms high potential and great motivation for the industry. Metallic and ceramic coatings will be chosen as promising candidates.

Objectives

Hydrogen as an energy source could be an alternative to fossil fuels. Its development, however, faces major scientific, technological and economic challenges. In particular, since hydrogen is small, it penetrates into the crystalline sites of metallic materials and shortens their lifetimes. The objective of this project is to develop coatings of few micrometres thick to protect metallic structures damaged by hydrogen embrittlement (HE) used in different industrial sectors, particularly in the energy field. These structures correspond to the hydrogen production, transport and storage systems. The development of advanced coatings by combining barrier properties that are resistant to environmental conditions, hydrogen barriers and corrosion resistant, presents immense scientific and economic potential in the energy sector.

Methodology

The experimental study will be carried out using reference and coated samples. The deposition parameters that could influence the resistance of coatings to the penetration of hydrogen will be investigated. The project revolves around several tasks:

1- Deposition of coatings: thin layers will be deposited by different technologies especially by magnetron sputtering.

2- Quantify the hydrogen amount adsorbed/absorbed in the reference and coated samples. Both electrochemical and chemical hydrogen charging methods could be used.

3- Characterizations of coatings: crystallographic analysis, morphological, physico-chemical and mechanical characterizations.

4- Study the effect of static and dynamic loading under hydrogen on the behavior of the material and its lifetime.

During this project, many partners can participate. The future PhD student will work with different teams specialist in coatings, science of materials and mechanical testing.

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