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以電漿濺鍍技術製備鈀-銀合金薄膜於氫氣分離之研究

Study of Palladium-Silver Alloy Thin Film for Hydrogen Separation by Plasma Sputtering Technology

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Abstract

Currently, there are five types of fuel cells technologies which are Alkaline Fuel Cells (AFC), Phosphoric Acid Fuel Cells (PAFC), Proton Exchange Membrane Fuel Cells (PEMFC), Molten Carbonate Fuel Cells (MCFC) and Solid Oxide Fuel Cells (SOFC). Owing to the low temperature operation, high electrical density and free of corrosive electrolysis releasing, it is suitable for the transportation vehicles and batteries. In a number of projects, when it is used to develop fuel cell processors to provide a hydrogen-rich fuel, the PEMFC system for transportation applications becomes preferred. However, the presence of carbon monoxide tends to poison the platinum electrocatalyst under the low temperature operation conditions. CO preferentially adheres onto the catalyst surface and thus prevents the hydrogen adsorption necessary for the electrochemical reaction. Therefore, it is necessary to include a another stage of gas purifier prior to entering the fuel cell so as to reduce the carbon monoxide concentration to an acceptable level for the reformer .

In this research the palladium silver alloy inorganic thin film was experimentally investigated to attest its ability to separate the hydrogen from the steam reformer. Owing to the high hydrogen permeability, the use of Pd-Ag alloy membrane at the exit of the processor can be used to produce 99.9% ultra pure hydrogen for the fuel cell. The membrane of Pd-Ag alloy allows the hydrogen to diffuse through its metallic crystal structure whilst impermeable to the remaining gases produced by the reformation process. Although currently, the technology is expensive due to materials cost and high operating pressure. Research is presently underway to focus on developing much thinner 77% Pd-23%Ag alloy membranes (5-10 microns) supported on porous ceramics or stainless steel by plasma sputtering technology. Reductions in cost and operating pressures are experimentally investigated without compromising the membrane strength. This supported membrane not only will be used to separate or purify the hydrogen but also to get separate hydrogen-rich gas from methanol-steam reforming system without the thermodynamic equilibrium limitation.

Key words: Fuel cells, Palladium silver thin film, Hydrogen permeation, Plasma sputtering

摘 要

目前主要的燃料電池技術包括鹼性型（AFC），磷酸型（PAFC），質子交換模型（PEMFC），熔融碳酸鹽型（MCFC）及固態氧化物型等五種，由於車輛及小型攜帶型電池需於較低溫下操作，以及高電流密度再加上無腐蝕性液體溢出等需求。PEMFC 除合乎上述條件且可提供高濃度氫氣燃料故目前較適合國內發展，但此種低溫條件導致電極中的白金觸媒產生嚴重一氧化碳毒害，因一氧化碳傾向附著於觸媒表面而阻止氫氣之吸附，故燃料氣在進入燃料電池前必須有進一步氣體純化以使一氧化碳濃度降低至水蒸氣重組器可接受之範圍。

本文主要以實驗方法來研究鈀銀合金無機薄膜於水蒸氣重組中之氫氣分離，由於鈀銀合金薄膜對氫氣有良好選擇性，故可產生 99.9%高純度氫氣，此薄膜僅允許氫氣擴散通過其金屬結構而不允許其它氣體滲透。雖然此技術目前面臨較貴的材料成本與高操作滲透壓力，本研究爲降低成本與提昇氫氣在鈀銀合金膜的滲透量，以電漿濺鍍技術將鈀銀合金鍍在多孔質陶瓷或不鏽鋼載體上形成支撐式 77%鈀-23%銀合金膜組成，並減少膜之厚度至 5-10 μm，可在不影響薄膜強度之下來減低成本。