行政院原子能委員會
委託研究計畫研究報告

研究創新之 SOFC 材料結構設計

Innovative Structure and Material Design of Solid Oxide Fuel Cell

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中文摘要

固態氧化物燃料電池發展的重點之一是發展薄型穩態氧化鋯電解質，支撐在鎳-氧化鋯合成材料的陽極上。雖然藉著較低溫的運轉可以解決某些 SOFC 的問題，但這種設計在起始狀態可能遭遇某些問題。開始的第一步包括了陽極的鎳氧化物轉成鎳金屬，和增加三相邊界，這將會對之後的反應產生幫助。在這篇研究，我們將研究兩種不同的前處理法對 SOFC 性能的影響。前處理的條件將會影響 SOFC 的性能，包括將電池暴露於稀釋的 H_2/O_2，在開路或是閉路電壓下去研究它們的性能。藉著實行這些方法，發現在閉路電壓的情況下進行前處理，可以有效和高效率的得到較佳的性能表現。伴隨著 SEM 和元素分析，增加三相邊界被認為能增加陽極微結構的變化，導致陽極的活化。經由不同的前處理方法，陽極氧化鎳的機械性質將會轉成鎳金屬和多孔結構，和考慮到他們對於陽極微結構的影響。

關鍵字：前處理，陽極支撐，三相邊界，固態氧化物燃料電池，質子交換膜燃料電池，直接甲醇燃料電池，氧空缺

Abstract

An important objective in the development of solid oxide fuel cell (SOFC) is to produce thin stabilized zirconia electrolytes that are supported upon the nickel-zirconia composite anode. Although this will reduce some of the problems associated with SOFCs by permitting lower temperature operation, this design may encounter problems during start- up. The first step in a start-up involves the reduction of nickel oxide in the anode to metallic nickel and increase of three phase boundary will be beneficial for further reaction. In this study, two pretreatment methods are investigated for their effects on the performances of SOFC. Performances of the SOFCs are influenced by the pretreatment conditions which included exposure of the cells to dilute H_2/O_2 either under open circuit or closed circuit conditions prior to their performance studies. By carrying out the methods, the pretreatment using the closed circuit is found to attain much higher performances effectively and efficiently. Accompanying with SEM and element analysis, increase of three phase boundary is considered to give rise to changes in the anode microstructure, leading to activation of the anode. Mechanisms of NiO in anode reducing to Ni and porous structure via different pretreatments and their effects on the anode

microstructure are proposed.

Keywords: Pretreatment, Anode-supported, Triple phase boundary (TPB), Solid oxide fuel cell (SOFC), Proton Exchange Membrane Fuel Cell (PEMFC), Direct Methanol Fuel cell (DMFC), Oxygen Vacancy