行政院原子能委員會

委託研究計畫研究報告

研究平板式 SOFC 微米級厚度雙極板流道之最佳化設計與理論分析

Optimization of Flow Channel Design and Analysis in Thin Interconnects for Planar SOFC

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中文摘要

本計畫利用實驗以及數值模擬的方法，分析平板式固態氧化物燃料電池(SOFC)之流場特性。研究內容有兩大重點，一為測試不同雙極板設計之流場均勻度，含陰極流道設計與陽極鎳網；二為定量量測流體與多孔性介質接觸界面之氣態流場資訊，並輔以數值分析探討多孔介質內部之速度分佈，探討 SOFC 電極表面之流場行為。所獲得的重要成果如下：(1)已於 2006 國際燃料電池會議發表論文一篇，李堅雄組長為共同作者；(2)已於國內第 30 屆力學學術研討會發表論文一篇；(3)舉辦定期性 DPIV 教學課程，所內參與人員為李佳蔭小姐與黃昱先先生；(4)完成測試核研所為提升加工效率而修改設計之雙極板流場，發現此修改後之設計在 *Re*=130 條件下，流場均勻度仍高於改良前之設計，改善約 5%(改良前均勻度約為 81%，改良後約 86%)；(5)完成測試鎳網內部之流場特性，發現可使流場均勻分佈之鎳網最佳尺寸為長 8.5 cm，寬 9 cm，厚度 0.2 cm；(6)發現鎳網速度分佈曲線與鎳網劣化趨勢類似，未來將利用單電池測試與數值模擬做更深入之探討；(7)發現流體與多孔介質之接觸界面存在一滑移速度，且當材料孔隙度為 43%時，距多孔介質材料界面最近垂直間距為 0.2 mm 處所量得之速度為固體界面(孔隙率為 0)的 2.73 倍，材料之孔隙特性乃對流場特性有重要影響；(8)建立折射率契合技術，以更深入量測分析多孔介質內部之流場特性；(9)彙整上述成果，已投稿一篇會議論文至第 10 屆國際 SOFC 會議。

關鍵字：平板式固態氧化物燃料電池、雙極板、鎳網、多孔性介質、流場均勻度、滑移速度

Abstract

This project applies both experimental and numerical methods to simulate the flow behavior in planar solid oxide fuel cells. There are two key focuses. (1) To evaluate the degree of flow uniformity for various different modules of interconnects. On both cathode and anode sides, including different designs of rectangular flow channels using ribs and nickel mesh. (2) To investigate flow boundary conditions across the surface of electrode for SOFC using quantitative measurements and numerical simulations. Several achievements and findings are as follows. (1) We have presented the results of this project in 2006 Fuel Cell Seminar, Hawaii, Honolulu, Nov. 13-18. (2) A paper to be presented at 30^{th} conference on Theoretical and Applied Mechanics, Da-Yeh University, Changhua, Dec. 15-16, 2006. (3) Regular DPIV training courses opening for INER's co-workers. (4) Several recent designs of simplified interconnects have been tested in the hydraulic platform. We found that the new simplified interconnects have better flow uniformity than previous designs, about 5% better. (5) The flow field on the anode side using Ni mesh has been investigated. An optimal Ni mesh size of 8.5×9.0 cm^2 with 0.2 cm thick is found for the purchased commercial single cell. (6) Similarity between the velocity profile and the degradation profile of Ni mesh is observed. In the future, we shall further investigate this similarity using numerical simulations of a full single cell. (7) We found that there is a significant slip velocity on the surface of porous medium, indicating the importance of porosity on the flow boundary conditions. (8) Using the refractive index matching technique, we shall be able to measure quantitatively flow boundary conditions on the porous surface in the near future. (9) We will write up

these results and submit a paper to 10th International Symposium on SOFC to be held in Japan, June 3-8, 2007.

Key words: Planar SOFC, interconnects, Ni mesh, porous medium, flow uniformity, slip velocity