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Development of nanostructured solid oxide fuel cell electrodes

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Abstract

Nanostructured coatings have been fabricated for use as electrodes in solid oxide fuel cells (SOFC) by developing and applying innovative plasma spraying methods. Nanostructured cathode coatings of a variety of chemical composition were fabricated by thermal plasma chemical vapor deposition (TPCVD) using a RF plasma torch. Deposits of desired phase and microstructure were successfully produced. The cathode layers exhibited initially undesired secondary phases but this could be overcome by adjusting the chemical composition of the precursors. The microstructure of the deposited cathode was columnar-type with very high open porosity and specific surface area. The nanostructured NiO+YSZ anodes have been fabricated by three means: spraying of pre-synthesized agglomerates of nanoparticles, suspension dc plasma spraying and solution precursor dc plasma spraying. The nanostructured anode fabricated by pre-synthesized agglomerates of nanoparticles exhibited better gas permeability, comparable high temperature conductivity, and 43% lower polarization in SOFC operation at 800°C compared to conventional anodes. Moreover, by controlling the electrode structure, the anode nanostructure could be maintained for 1500 hours of operation. Further improvement in the microstructure of anodes is in progress using dc plasma suspension and solution precursor spraying.

Key words: *Solid oxide fuel cells, Nanostructured cathode, Nanostructured anode, Manufacture of electrodes, Suspension and solution precursor plasma spraying, Electrochemical performance*

1. Introduction

Solid oxide fuel cells (SOFC) considered as highly efficient and environmentally friendly energy converters, convert chemical energy from fuel and oxidizing gases directly into electrical energy and heat (Kendall and Singhal, 2003). The basic components of a SOFC cell consist of the porous electrodes - an anode for fuel supply and a cathode for air supply - which are separated by a gastight oxygen ion conductive electrolyte layer. The electrolyte usually consists of doped zirconia or ceria. A cermet of yttria-stabilized zirconia (YSZ) and nickel is mostly used for the anode and perovskite-type oxides such as doped lanthanum manganite (LSM), lanthanum cobaltite and ferrite (LSC, LSF, LSCF) are the common materials for the cathode (Minh and Takahashi, 1995). The electrodes have to provide the reaction sites for the

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