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Formation of spinels on ferritic stainless steels surface at high-temperature oxidation

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Abstract

Stainless steels are being widely used as structural materials for interconnects in solid oxide fuel cells (SOFC) and similar applications with aggressive environments operating at high temperatures. Several ferritic steels were oxidised at 800, 900 and 1000°C in air for 24-168 h. The surface state changes after oxidations have been observed by SEM and the differences in oxide layers between different alloys and conditions have been shown. Oxidation conditions for formation of the spinel have been determined.

Key words: *Oxidation, High-temperature corrosion, Ferritic stainless steel, Spinel, Solid oxide fuel cells*

1. Introduction

Stainless steels are often used in a variety of applications. One of the demanding areas is high-temperature components of power plants, advanced equipment and SOFC. The interconnect in a SOFC stack is simultaneously exposed to both an oxidizing environment on the cathode side and a reducing environment (fuel, such as hydrogen or natural gas) on the anode side for long period at 700-1000°C. Oxidation, hot corrosion and erosion affect the performance and lifetime of SOFC interconnects. A reasonable protection of steel can be reached by the formation of an oxide layer on the surface. The protective oxides may have low conductivity, and the growth of these oxides is limited because these oxides act as a diffusion barrier between the material and the atmosphere. For this reason, the use of certain alloys for high temperature applications depends basically on the oxide formed. Thus interconnect alloy should possess good surface stability (resistance to oxidation and corrosion) in both cathodic and anodic (fuel) atmospheres and at the same time have reasonable electric conductivity. The effect of various parameters on the oxidation behaviour of stainless steels for SOFC applications was studied (Schutze, 1997; Yang *et al.*, 2004; Abelan and Quadakkers, 2005; Yang *et al.*, 2003; Venskutonis *et al.*, 2005; Mekroud, 2007). The formation of spinel phase was considered as a good compromise between reasonable oxidation protection and requirements for lower electrical resistance.

A study carried out with ferritic alloy Crofer 22APU has indicated the formation of oxides consisting of a

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