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The effect of the deposition sequence of sol-gel SiO_2-Al_2O_3, CeO_2, Y_2O_3 coatings on the corrosion resistance of the FeCrAl alloy during cyclic high-temperature oxidation

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Abstract:

The surface of a ferritic FeCrAl alloy was covered with three-layer ceramic coatings by the sol-gel method. The SiO_2-Al_2O_3, Y_2O_3 and CeO_2 layers would be deposited in different sequences. The obtained material would be subjected to cyclic oxidation at a temperature of 900 °C. It was found that the sequence in which the layers are deposited affects the morphology and chemical composition of the scale. After 20 oxidation cycles (each lasting 12 h) the thickness of the building up oxide film amounted to 2.3-4.2 μm. Gravimetric analyses showed the parabolic character of the weight gain-oxidation time interdependence. The first layer deposited on the metallic surface determines the distribution of yttrium and cerium in the scale and in the alloy core. The scale building up on the samples in which yttrium oxide formed the first layer was found to have the most advantageous protective properties. After 20 oxidation cycles the FeCrAl alloy coated in turn with the layers: Y_2O_3, CeO_2 and SiO_2-Al_2O_3 showed the smallest relative change in weight. In comparison with the uncoated substrate the protection effectiveness of the deposited coatings amounts to 12-37%.

1. Introduction

The primary requirements which metallic materials intended for work in high temperature and aggressive atmosphere conditions must meet is good high-temperature creep resistance and high heat resistance. Chromium and aluminium present in ~~(proper concentrations) in~~ the material are responsible for FeCrAl alloys' resistance to high-temperature oxidation [1]. Scale composed of γ, δ, θ and α aluminium oxides builds up in the course of (isothermal or cyclic) oxidation [2]. The α-Al_2O_3 scale constitutes a barrier protecting the alloy against further degradation. The scale owes its good protective properties