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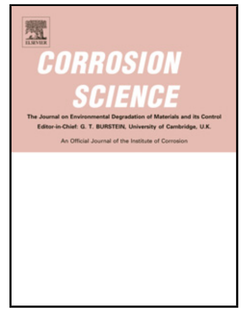

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Oxidation behavior of GTD111 Ni-based superalloy at 900°C in air

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Abstract
The oxidation behavior of GTD111 Ni-based superalloy was investigated at 900°C from 1h to 452h. The detailed oxide structure, from the top surface down to the base material, was clarified by modelling studies as Ni-Ti oxides, Cr-Ti oxides, Cr_2O_3 oxide band, Ni-W-Ta oxide and finally a blocky Al_2O_3 region. Internal oxide Al_2O_3 was discontinuous, Cr_2O_3 oxide dense band provided the most protection against further oxidation. Cracking and spalling of the outer oxides scale results in the nitrogen penetration into the inner oxides scale, and inner nitridation to form TiN occurs. Additionally, the oxidation mechanism was discussed by a model.

Highlights

- The general oxidized structures of GTD111 at 900°C are presented.
- An oxidation mechanism of the different oxides is discussed by a model.
- The first-oxidized element is Ti, followed by Al and Cr, and lastly by W and Ta.
- A Cr_2O_3 dense band provides the most protection against further oxidation at 900°C.
- Inner nitridation to form TiN due to the cracking and spalling of the outer oxides.

Keywords: A. Nickel; A. Superalloys; B. Modelling studies; B. SEM; C. Oxidation; C. Interface.

1. Introduction

Ni-based superalloys are widely used in the manufacture of aerofoil components such as blades and nozzle guide vanes that operate in the hot sections of advanced gas turbine engines [1-3], due to their good high temperature mechanical properties. These superalloys do not possess adequate oxidation resistance in their service environment, especially at damaged areas where the bare metal is exposed to the oxygen-containing atmosphere. Continual oxidation of the moving crack tip can accelerate the crack's propagation through the component, resulting in shorter service life, especially under thermal cycling conditions. Therefore high oxidation is a main cause, or at least a strong contributor, to the failure of hot-section turbine blades [4].
Characteristics of the oxide films formed on an alloy, including chemical composition, microstructure and thickness, et al, determine the protect ability of the oxide film and thus play a crucial role in the corrosion behavior [5]. Presently, the oxidation structure at high temperature of superalloys has been extensively studied [6-15], as shown in Table 1. The oxidation resistance of Ni-based superalloys at high temperature is achieved by additions of Al and Cr, which preferentially oxidize to form dense, protective oxide films and to slow down the overall oxidation process [8]. It has been found that NiO and Cr_2O_3 are the main

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