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The nucleation and growth mechanism of Ni-Sn eutectic in a single crystal superalloy

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Abstract:

The microstructure of single crystal superalloy with and without tin layer on the surface of as-cast and heat-treatment state was investigated by Optical microscope (OM) and scanning electron microscopy (SEM). The composition of different region on the surface was tested by energy dispersive X-ray (EDS). The reaction intermetallic compound (IMC) formed in the heat treatment process was confirmed by X-ray diffraction (XRD). The orientations of different microstructure in samples of as heat treatment state were determined by electron back-scattering diffraction (EBSD) method. The porosity location in the interdendrite region was observed by X-ray computed tomography (XCT).

The experiment results showed that the remained Sn on the surface of the supealloy reacted with Ni, and then formed Ni_3Sn_4 in the as-cast state. Sn enriched by diffusion along the porosity located in the interdendrite region and γ+γ' (contain few of Sn) eutectic and Ni_3Sn_2 formed in single crystal supealloy during heat treatment, and the recalescence behaviors were found. Ni_3Sn_2 nucleated independently in the cooled liquid at the front of (γ+γ')(Sn) eutectic. The nucleation and growth mechanism of the eutectic and Ni_3Sn_2 IMC during heat treatment was discussed in the present paper.

Keywords: A1. Crystal structure A2; Growth from melt; A3.Solid phase epitaxy; B1. Alloys

1. Introduction

The single crystal superalloy turbine blade was widely used in the gas turbine industry. Generally, it is made by investment casting under directional solidification method. Directional solidification requires that heat is removed from the casting in one preferred direction, usually with a water-cooled chill plate [1]. Since high solidification rates at relatively high thermal gradients are desirable not only for economic consideration but also for improvement of mechanical properties and uniform structure, liquid metal cooling (LMC) method was