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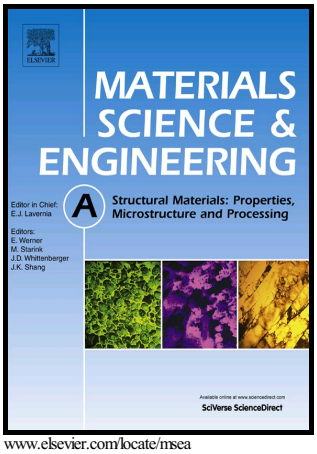

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PII: S0921-5093(17)30613-5
DOI: http://dx.doi.org/10.1016/j.msea.2017.05.018
Reference: MSA35034

To appear in: *Materials Science & Engineering A*

Received date: 13 February 2017
Revised date: 7 April 2017
Accepted date: 4 May 2017

Cite this article as: Z.Y. Yu, X.Z. Wang, Z.F. Yue and X.M. Wang, Investigatio on microstructure evolution and fracture morphology of single crystal nickel-bas superalloys under creep-fatigue interaction loading, *Materials Science & Engineering A,* http://dx.doi.org/10.1016/j.msea.2017.05.018

Investigation on microstructure evolution and fracture morphology of single crystal nickel-base superalloys under creep-fatigue interaction loading

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Abstract:

Creep-fatigue interaction behavior of a single crystal nickel-base superalloy was studied at 980 °C and the microstructure was quantitatively analyzed. A three-stepped plate specimen had been designed to simultaneously observe microstructure changed under three different stresses. It was found that the distribution of γ′ size was basically consistent with lognormal probability scale under all three loading conditions. The average size of γ′ precipitates increased with the increasing of stress at the same interrupted time. Four different layers including oxide layer, γ′-free layer, γ′-reduced layer and γ/γ′ layer can be observed on the cross-section of the specimens. The thickness of γ′-free layer also increased with the increasing of stress. Numerous dimples and square-shaped facets were observed at the fracture surface and furthermore propagation of cracks from micropores to the boundary of the facets could be found, which showed the fracture behaviours of both creep and fatigue damage.

Keywords: Nickel-base single crystal superalloy; Creep-fatigue interaction; Microstructure; Fracture morphology

1. Introduction

Single crystal nickel-base superalloys have been widely used in hot-section components in modern aircraft engines, such as gas turbine blades and vanes. They exhibit excellent high temperature mechanical strength, creep resistance and low cycle fatigue resistance. During the service, these critical components suffer fatigue damage caused by the repeating start-stop transient loading and the creep damage