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Mechanism of serrated flow in a cast nickel base superalloy

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ABSTRACT

Mechanism of serrated plastic flow in a cast nickel base superalloy was investigated in the temperature range of 25- 850°C by conducting tensile tests employing strain rates of 1×10^{-3} , 1×10^{-4} and $1 \times 10^{-5} \text{ s}^{-1}$ and subsequent TEM studies. Shearing of γ' precipitates by superpartials $a/2[110]$ bounded by anti- phase boundaries are found to be responsible for the serrated yielding.

Keywords: Superalloy; Serrated flow; Superpartial; Microstructure; Deformation and fracture; Inverse PLC effect

1. Introduction

Plastic deformation in a crystal involves interaction between existing and evolving defects such as dislocations and vacancies. Dislocation motion in its slip plane responsible for the monotonic plastic deformation often becomes discontinuous leading to inhomogeneous deformation and localized yielding. Such inhomogeneous plastic deformation manifest as serrations in tensile flow curves. The reasons for serrations in flow curve are attributed to dynamic strain ageing (DSA), deformation induced phase transformation, order-disorder transformation, etc. [1]. Dynamic strain aging (DSA) is commonly observed reason for serrated flow in structural alloys [2-4]. However, other causes of serrations in flow curve are less explored.

CM 247 EA LC is one of the advanced high strength cast alloys used for manufacturing rotating and stationary components of gas turbine engine [5]. These components experience a spectrum of temperatures during service. It is therefore important to understand the tensile behaviour of this alloy over the entire range of temperatures. Keeping this in view, a detailed study on tensile deformation behaviour of alloy CM 247 EA LC was carried out in the temperature range of 25- 850°C employing strain rates of 1×10^{-3} , 1×10^{-4} and $1 \times 10^{-5} \text{ s}^{-1}$. During tensile tests at low and intermediate temperatures, serrated flow and negative strain rate sensitivity, SRS, were observed. The present paper illustrates the cause of serrated flow in alloy CM 247 EA LC in the temperature range 300- 650°C at a strain rate of

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