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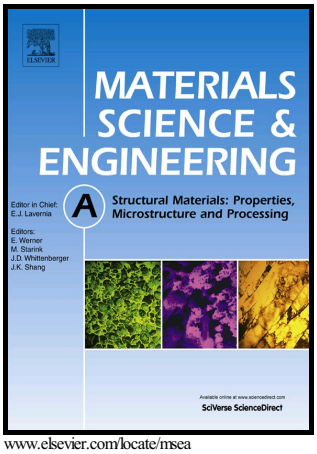

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Development of a trimodal microstructure with superior combined strength, ductility and creep-rupture properties in a near alpha titanium alloy

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Abstract

In the present study a new microstructure was introduced for a Ti-6242S alloy that has an appropriate combination of mechanical properties such as strength, ductility and creep-rupture. This trimodal microstructure was developed through thermomechanical processing consisted of a near beta rolling followed by solution annealing in alpha/beta region. In the following, the mechanical properties of this microstructure was investigated and compared to the conventional microstructures i.e., widmanstätten and bimodal microstructures to demonstrate its superiority. The results indicated that the yield strength, ductility and toughness in trimodal microstructure lies between those of the two other microstructures. However, the ductility and toughness of trimodal microstructure is significantly higher than that of the widmanstätten microstructure and almost close to the bimodal microstructure. The steady state creep rate in trimodal microstructure at 540°C and under an applied stress of 540 MPa approached closely to that of widmanstätten microstructure and was considerably lower than the value in bimodal microstructure. Furthermore, time to rupture for trimodal microstructure is 1.3 and 3.5 times higher than the widmanstätten and bimodal microstructures, respectively. These results clearly confirm a more optimized combination of mechanical properties in the trimodal microstructure compared to the widmanstätten and bimodal microstructures.

Keywords

Ti-6242S alloy, Trimodal microstructure, Strength, Ductility, Creep-rupture properties

1. Introduction

Ti-6242S alloy is a near alpha titanium alloy being widely utilized in aerospace and energy industries due to high strength to weight ratio, excellent fracture toughness, superior creep properties and corrosion resistance [1, 2]. Since this alloy is used in critical applications such as compressor blades, it must usually satisfy mechanical properties required for structural components exposed to high temperature [3, 4]. Mechanical properties of Ti-6242S alloy is considerably affected by microstructural features such as volume fraction and morphology of alpha and beta phases, grain size and distribution of the strengthening precipitates [5, 6]. The mentioned microstructural parameters depend mainly on chemical composition, processing history and heat treatment [7]. Widmanstätten and bimodal are two important types of microstructures in near alpha and alpha/beta titanium alloys [8]. To