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# Characterization of deformation in primary $\alpha$ phase and crack initiation and propagation of TC21 alloy using in-situ SEM experiments

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## Abstract:

In present work, the localized deformation, crack initiation and propagation behavior of Ti-6Al-2Sn-2Zr-3Mo-1Cr-2Nb-0.1Si (TC21) titanium alloy was investigated through the in-situ scanning electron microscope (SEM) test and electron backscatter diffraction (EBSD). The results indicate that deformation in  $\alpha$  phase is mostly accommodated by the prismatic slip. The localized deformation is concentrated at the interface of primary  $\alpha$  lath. Some parallel slip bands with prismatic and pyramidal slip are prevalent in primary  $\alpha$  lath, while the multiple slip bands with prismatic slip are dominant in equiaxed primary  $\alpha$  phase. Higher ability to coordinate local plastic strain (nearly to 79.5%) is induced in equiaxed  $\alpha$  than the primary  $\alpha$  lath (7.9%). Most of the cracks easily initiate at the shear bands in primary  $\alpha$  lath, which is a fatal site for the tensile deformation. The main crack propagates quickly along the shear bands or interfaces of  $\alpha$  lath and then penetrates into the  $\beta_{\text{trans}}$  matrix and also transfers across the equiaxed  $\alpha$  phase along the slip bands. The results indicate that the high compatibility of deformation in equiaxed primary  $\alpha$  phase delays the initial crack nucleation. Whereas, it does not show satisfied resistance against crack propagation in front of the main crack tip due to the abundant slip bands.

**Keywords:** TC21 titanium alloy; Localized deformation; In-situ SEM test; Crack initiation; Crack propagation

## 1. Introduction

Due to the low density, high strength and high corrosion resistance, titanium alloys have been applied widely to aircraft structures and engines [1,2,3]. It has been

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