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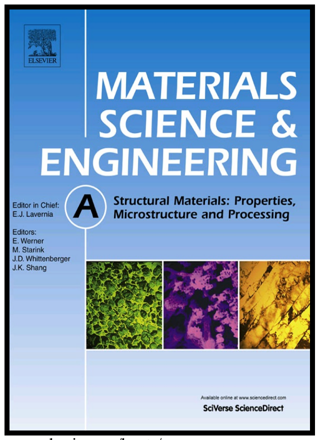

www.elsevier.com/locate/msea

PII: S0921-5093(18)31279-6
DOI: https://doi.org/10.1016/j.msea.2018.09.073
Reference: MSA36954

To appear in: *Materials Science & Engineering A*

Received date: 29 June 2018
Revised date: 19 September 2018
Accepted date: 20 September 2018

Cite this article as: M. Hassanipour, S. Watanabe, K. Hirayama, H. Toda, K. Uesugi and A. Takeuchi, Short Crack Growth Behavior and its Transitional Interaction with 3D Microstructure in Ti-6Al-4V, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.09.073

Short Crack Growth Behavior and its Transitional Interaction with 3D Microstructure in Ti-6Al-4V

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Currently, short crack growth behavior and rate variations are not well understood in the literature. This is due to lack of studies regarding the interaction between 3D short crack and microstructure and its effect on crack growth. In order to study this interaction, in situ computed tomography was performed to measure crack growth at sub-grain level (every 5μm) during a fatigue test in a bimodal Ti-6Al-4V alloy for two crack front regions. This was followed by serial sectioning coupled with electron backscattering diffraction (EBSD) to identify the short crack growth in the microstructure, i.e. α, α+β phases and interface. Results show that crack growth has the highest rate in α phase as compared to the α+β phase and the interface in both regions. The crack grows preferably into α phase when compared to the average microstructural fraction in the first region, but it decreases below this fraction in the second region. The crack grows mainly close to crystallographic planes in α grains with the maximum shear stress (favorable planes) in the first region. As the short crack grows into the second region, there is an increase in number of grains enclosed in the plastic zone size. As a result, there is a decrease in the mismatch angle between neighboring cracked grains, which leads to higher deviation from favorable planes causing a local variation in crack growth rate.

Key Words: Short crack propagation, Ti-6Al-4V, Synchrotron radiation, Tomography, Crystallographic orientations, Electron backscatter diffraction

Nomenclature

ND	normal direction	**D**	distance along crack front line at the last cycle
TD	transverse direction	**Δa**	crack length
RD	rolling direction	**Δθ**	image slice angle of crack in xy plane
α	grains with primary alpha phase	**α+β**	grains with alpha and beta phase
α/α+β	interface between α and α+ β	**da/dN**	crack growth rate
CRSS	critical resolved shear stress with the highest Schmid factor	$\boldsymbol{\varphi_{ave}}$	average crack plane mismatch angle with the neighbouring cracked grains
$\mathbf{Sch_{max}}$	Maximum Schmid factor	**Ψ**	deviation from crystallographic plane with the highest Schmid factor

1. Introduction

Small defects are inevitably formed during the fabrication process in many engineering components such as aircraft blisks made of Ti-6Al-4V. As the cyclic loads are applied, these small defects or cracks start to propagate with high variations in growth rates. These variations are caused by the three dimensional (3D) variation in the microstructural features, i.e. crystallographic orientations, and the morphology of the grains on the surface and inside the material [1,2].