World Academy of Science, Engineering and Technology
International Journal of Industrial and Systems Engineering
Vol:12, No:04, 2018

# Multi-Scale Modeling of Ti-6Al-4V Mechanical Behavior: Size, Dispersion and Crystallographic Texture of Grains Effects

**Authors :** Fatna Benmessaoud, Mohammed Cheikh, Vencent Velay, Vanessa Vidal, Farhad Rezai-Aria, Christine Boher

**Abstract :** Ti-6Al-4V titanium alloy is one of the most widely used materials in aeronautical and aerospace industries. Because of its high specific strength, good fatigue, and corrosion resistance, this alloy is very suitable for moderate temperature applications. At room temperature, Ti-6Al-4V mechanical behavior is generally controlled by the behavior of alpha phase (beta phase percent is less than 8%). The plastic strain of this phase notably based on crystallographic slip can be hindered by various obstacles and mechanisms (crystal lattice friction, sessile dislocations, strengthening by solute atoms and grain boundaries...). The grains aspect of alpha phase (its morphology and texture) and the nature of its crystallographic lattice (which is hexagonal compact) give to plastic strain heterogeneous, discontinuous and anisotropic characteristics at the local scale. The aim of this work is to develop a multi-scale model for Ti-6Al-4V mechanical behavior using crystal plasticity approach; this multi-scale model is used then to investigate grains size, dispersion of grains size, crystallographic texture and slip systems activation effects on Ti-6Al-4V mechanical behavior under monotone quasi-static loading. Nine representative elementary volume (REV) are built for taking into account the physical elements (grains size, dispersion and crystallographic) mentioned above, then boundary conditions of tension test are applied. Finally, simulation of the mechanical behavior of Ti-6Al-4V and study of slip systems activation in alpha phase is reported. The results show that the macroscopic mechanical behavior of Ti-6Al-4V is strongly linked to the active slip systems family (prismatic, basal or pyramidal). The crystallographic texture determines which family of slip systems can be activated; therefore it gives to the plastic strain a heterogeneous character thus an anisotropic macroscopic mechanical behavior of Ti-6Al-4V alloy modeled. The grains size influences also on mechanical proprieties of Ti-6Al-4V, especially on the yield stress; by decreasing of the grain size, the yield strength increases. Finally, the grains' distribution which characterizes the morphology aspect (homogeneous or heterogeneous) gives to the deformation fields distribution enough heterogeneity because the crystallographic slip is easier in large grains compared to small grains, which generates a localization of plastic deformation in certain areas and a concentration of stresses in others.

**Keywords :** multi-scale modeling, Ti-6Al-4V alloy, crystal plasticity, grains size, crystallographic texture
**Conference Title :** ICMMPSE 2018 : International Conference on Multiscale Modeling and Process Systems Engineering
**Conference Location :** London, United Kingdom
**Conference Dates :** April 24-25, 2018