3D microstructural investigation of texture development of two-phase titanium alloys

Conghui Liu*[1], Jack Donoghue[1], Xiaohan Zeng[1], Tim L. Burnett[1], Bernadeta Karnasiewicz[1], and João Quinta Da Fonseca[1]

[1]The University of Manchester – United Kingdom

Abstract

The in-service mechanical properties and performance of Ti alloys depend on their inherently complex multi-phase microstructures. Recent advances in the laser-PFIB Tribeam microscopy now allow for large-scale serial sectioning of statistically valid volumes of material, up to mm3 with sub-micron resolution. The present study is an attempt to exploit this new toolkit to perform 3D microstructural investigations of Ti-6Al-4V alloys after two different thermo-mechanical treatments: beta annealed and hot rolled. The findings reveal that in the beta annealed Ti-6Al-4V material, the coarse alpha laths in the colony microstructure are highly interconnected, forming a single large, clustered domain. Additionally, there are notable features of growth ledges or notches on the broad face of alpha laths, that could lead to the penetration of beta phase through the alpha laths during the alpha/beta phase transformation at elevated temperature, and as a result to the break-up of alpha laths during heating. In the case of the hot-rolled Ti-6Al-4V material, the 3D shape and breakup of alpha grains strongly depends on their crystallographic orientations. The 3D EBSD analysis also provides the indication of how different texture components contribute to the overall rolling texture. The majority of the elongated soft alpha grains develop lower misorientation within themselves and surrounding beta grains, suggesting that soft oriented alpha grains can deform as easy as beta grains and stabilise the transverse alpha texture component, typically the strongest texture component in hot-rolled, dual-phase Ti. In addition, it is particularly striking to observe that local deformation is not in-plane strain during hot rolling. This observation has been recently supported by crystal plasticity simulations. The actual 3D shapes and misorientation of the alpha grains distributed within the beta matrix, and their interconnectivity, determined in the current study provide valuable insights into the co-deformation of alpha and beta phases, and their impact on the texture development during thermomechanical processing.

Keywords: 3D EBSD, Laser PFIB, texture development, alpha lath, misorientation, 3D reconstruction

*Speaker