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Anisotropy and variability in tensile properties of Ti-10V-2Fe-3Al metastable β alloy: an interplay between strain localization and competing fracture mechanisms

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High strength metastable β titanium alloys are increasingly employed in the aircraft industry due to their outstanding strength-to-weight ratio. In particular, the Ti-10V-2Fe-3Al alloy has been successfully used in landing gears of modern aircrafts. However, the tensile properties are often associated with a substantial scatter, which is a major issue for industrial manufacturers. In the present study, anisotropy and variability in tensile properties were assessed using multiple sampling directions in Ti-10V-2Fe-3Al processed via different thermomechanical routes. In particular, elongation values and the associated standard deviation were observed to vary significantly depending on the testing direction. A key role of β phase was highlighted using a combination of SEM, EBSD, µ-CT and in-situ DIC during tensile tests. Strain heterogeneity and localization were found markedly related to the β grain features such as its orientation and aspect ratio. Based on advanced fractographic analyzes, several fracture mechanisms were observed to derive from the differences in deformation behaviors and eventually compete to trigger specimen failure. These findings provide a new understanding of the role of microstructure on anisotropy and variability in tensile properties observed in high strength metastable β titanium alloys.

Keywords: Metastable β titanium alloy, β grain, tensile tests, anisotropy, deformation and fracture mechanisms.

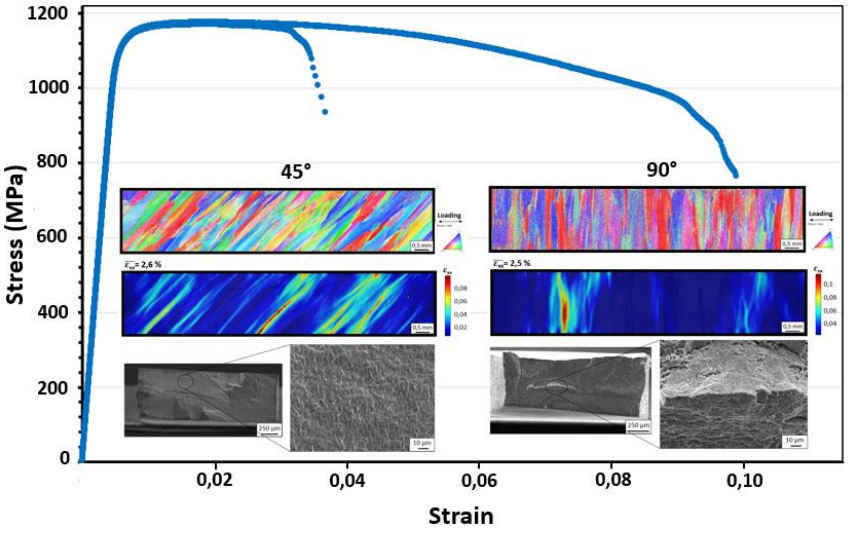

Fig.1: Tensile curves, crystallographic orientations of the β phase and effective in-plane strain along the loading direction of Ti-10V-2Fe-3Al specimens extracted along two different directions. SEM micrographs show two different fracture mechanisms.