High Cycle Fatigue Response of Solution-Treated and Aged Ti-15V-3Cr-3Al-3Sn Sheet

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A recent study of the fatigue performance of aged Ti-15V-3Cr-3Al-3Sn indicates that the *high-cycle* un-notched endurance limit of this alloy can be enhanced through judicious selection of thermo-mechanical processing procedures. Notwithstanding this advance, the smooth fatigue strength-to-ultimate tensile strength ratio remained at 0.5, that is similar to other metastable β titanium alloys. In contrast the fatigue strength-to-ultimate tensile strength ratio of $\alpha+\beta$ titanium alloys can equal or exceed 0.7.

The present investigation has extended this prior study by examining the high-cycle fatigue performance of two production size solution-treated and aged Ti-15V-3Cr-3Al-3Sn sheets of differing thickness, i.e. 2.0 and 2.2mm. A single aging treatment undertaken at 813K for 8 hours followed by air-cooling was considered. This treatment resulted in similar tensile properties, independent of sheet thickness, i.e., σ_y = 1013-1034 MPa, σ_u = 1130-1151 MPa, elongation = 10 pct.

Differences in high-cycle fatigue performance were however noted between the two solution-treated and aged Ti-15V-3Cr-3Al-3Sn sheets. An un-notched fatigue endurance limit of 620 MPa was observed for the 2.2mm sheet. In contrast the 2.0mm Ti-15V-3Cr-3Al-3Sn sheet exhibited an endurance limit of 827 MPa, that is the fatigue strength-to-ultimate tensile strength ratio increased from 0.55 to 0.72. Examination of the aged microstructure suggested that these differences in high-cycle fatigue response could be related to variations in α precipitation. Aging of the 2.2mm sheet resulted in uniform α precipitation. However aging of the 2.0mm sheet resulted in a non-uniform, grain-to-grain, variation in α formation.

This presentation will discuss the relationship between the high cycle fatigue performance of Ti-15V-3Cr-3Al-3Sn sheet and the observed microstructures. Particular attention will be drawn to the response of the differing microstructural features to cyclic loading, this response being monitored by nano-indentation measurements of the individual constituents.