Effect of thickness of ultra-thin Ti6242S alloy specimens on tensile strength at 450°C in air and argon atmosphere

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Oxidation of titanium alloys results in both the formation of an oxide layer and a change in the chemical composition of the alloy beneath the oxide layer. This is due to the presence of an oxygen-enriched zone because oxygen, which has a high solubility in titanium, diffuses under the oxide layer [1,2].

The material beneath the oxide layer is therefore not homogeneous and presents a chemical gradient, thus inducing a gradient in mechanical properties. Micromechanical tests on ultrathin specimens can be used to evaluate the mechanical properties of the oxygen-enriched zone [3]. However, given the high surface-to-volume ratio of such specimens, and the small volume tested, it is important to see the effects of this type of sample geometry on the measured mechanical behaviour, starting with the study of the non-oxidised alloy.

In this study, Ti6242S tensile specimens with different thicknesses ranging from 100 µm to 1 mm have been submitted to tensile tests at 450°C in both air atmosphere and argon atmosphere. The preparation protocol allowing less than 1% variation in cross-section is presented. Digital image correlation is used to evaluate the deformation along the 5 mm gauge length.

Yield strength and tensile strength are analysed as a function of the specimen thickness and test conditions and are found to decrease with the decrease in specimen thickness. These results highlight the transition from a polycrystalline behaviour (of the representative elementary volume) obtained for a 1 mm thick specimen to a multicrystalline behaviour for a specimen of 100 micrometrse. The results are discussed in relation to the characteristic microstructural quantities.

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