Yield Surface Identification of Technically Pure Titanium Alloy and Its Evolution Reflecting Deformation History Under Complex Loadings

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Abstract

Characterisation of materials using only uniaxial testing methods provides only limited data, that are not sufficient to identify all aspects of their behaviour like a texture or anisotropy. Therefore, the aim of this paper was to experimentally analyse the physical mechanisms responsible for the plastic deformation resulting from the complex mechanical loading and an initiation and subsequent propagation of micro-cracks from inherent defects in the technically pure titanium alloy.

Material characteristics of pure titanium alloy in the form of stress-strain graph (fig.1b) shown decrease in yield limit or increased inelastic response under simultaneous loading executed by the axial tension and proportional cyclic torsion on tubular specimens. Subsequently, the effect of plastic pre-deformation induced by cyclic torsion and monotonic tension on the shape and size of yield surface has been determined by the technique of sequential probes of the single specimen along 17 different strain-controlled paths in the plane stress state. It was found, that as-received specimen exhibits anisotropic behaviour whereas, yield surface sizes of pre-deformed specimen are reduced in all directions, except of that representing axial tension. Such an effect could have come from either the metal production, or specimen manufacturing process applied.

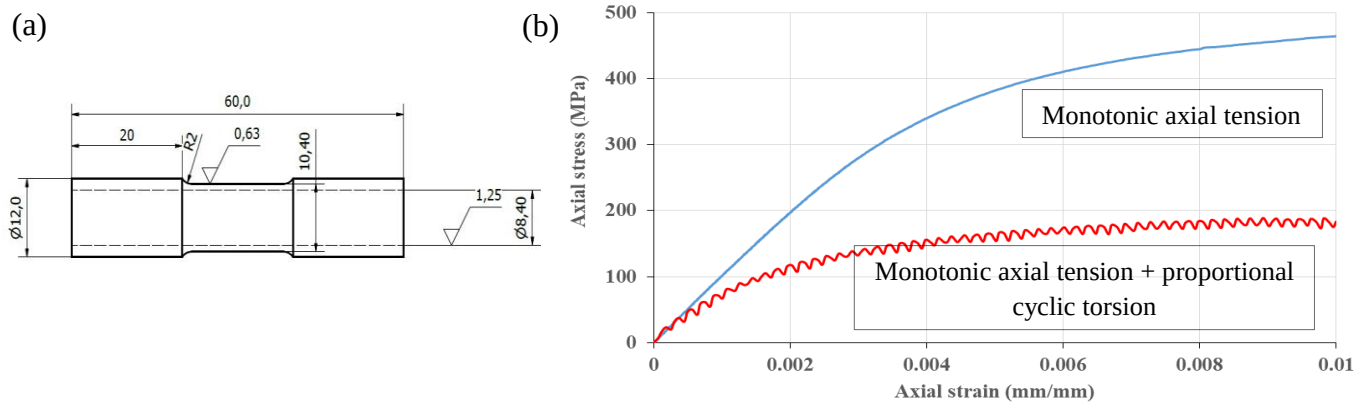

Figure 1. (a) Engineering drawing of the tubular specimen; (b) Material characteristics of the pure Ti under monotonic axial tension (blue continuous line) and simultaneous monotonic axial tension and proportional cyclic torsion of strain amplitude ± 0.4% at 0.5 Hz frequency (red broken line).

Keywords: Yield surface; Pre-deformation; Plastic anisotropy; Cycle loading.

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