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YIELD SURFACE IDENTIFICATION OF TITANIUM ALLOY AND ITS EVOLUTION REFLECTING COMPLEX PRE-DEFORMATION

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Abstract text

Mechanical tests of materials generally performed under simple stress conditions do not simulate real-world stress conditions that can occur in most engineering applications. The characterization 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 coming from the manufacturing processes used to produce them [1]. Titanium and its alloys have been widely used in significant engineering disciplines such as medical devices, aerospace, and marine engineering, due to their high specific strength, corrosion resistance, high impact resistance, and other properties [2]. Therefore, this article presents an experimental investigations identifying the physical mechanisms responsible for the plastic deformation resulting from the complex mechanical loading and initiation and subsequent propagation of micro-cracks from inherent defects in the titanium metal.

Complex loading tests were performed on tubular specimens under simultaneous application of axial force and torque to produce axial and shear stresses. Material characteristics of pure titanium in the form of stress-strain show decrease in yield limit or increased inelastic response under simultaneous loading executed by the axial tension and proportional cyclic torsion. Subsequently, the effect of prior plastic deformation induced by cyclic torsion and monotonic tension on the shape and size of yield surface has been studied. Yield surfaces were 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 material in its as-received state exhibits anisotropic behaviour for the defined plastic offset strain. Such an effect could have come from either the bimetal production, or specimen manufacturing process applied. Furthermore, the yield surface sizes of the material in the pre-deformed state are reduced in all directions, except of that representing axial tension.

References:
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