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An evolution of yield surface for Ti-Cu bimetal after plastic pre-deformation under complex loading

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Alloys were developed to overcome the limitations of pure metals, achieved through conventional alloying, mixing metals or non-metals in powder or molten states. They offer enhanced properties like toughness, strength and corrosion resistance. Over centuries, alloys like stainless steels, Cu-based alloys, Ni-based super alloys (Inconel) and Ti-based alloys have been developed for diverse industrial uses. Whereas, bimetallic structures, combining two different metals, can overcome individual material limitations while maintaining desired properties [1]. This approach addresses material selection challenges and allows customization based on specific performance requirements in engineering applications. The selection of manufacturing techniques and component materials substantially impacts the mechanical properties of bimetals. Therefore, this research presents an experimental and theoretical investigation by applying the yield surface approach to identify the physical mechanisms responsible for the plastic deformation of Ti-Cu bimetal resulting from the complex mechanical loading.

The initial yield surface of Ti-Cu bimetal and its evolution were determined by the sequential probe technique using single specimen along 17 different strain-controlled directions in the plane stress state [2]. The subsequent yield surfaces were determined after plastic pre-deformation caused by monotonic tension and combined monotonic tension-cyclic torsion up to 1% axial strain.

It was found that the initial yield surface obtained for the as-received Ti-Cu bimetal exhibits anisotropic behaviour. Such behaviour could have come from the preferred texture obtained during the bimetal production. The yield surface after monotonic tensile pre-deformation shows a significant shift towards the tensile direction, i.e. kinematic hardening within the bimetal. Whereas, pre-deformation caused by combined monotonic tension-cyclic torsion leads to the significant softening of the bimetal components in all directions.

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