# YIELD SURFACE IDENTIFICATION OF Ti-Cu BIMETAL AND ITS EVOLUTION REFLECTING DEFORMATION HISTORY UNDER COMPLEX LOADINGS

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## 1. Introduction

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]. Due to the combination of mechanical, thermal, and diverse functional properties, the bimetals formed from two dissimilar constituent materials have been used in many industrial applications [2][3]. Therefore, this article presents an experimental and theoretical 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 interface of titanium–copper bimetal.

## 2. Results

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 bi-metal (Ti-Cu) in the form of stress-strain are shown in Figure 1. The curve shows decrease in yield limit or increased inelastic response under simultaneous loading executed by the axial tension and proportional cyclic torsion. This effect is also shown in Figure 2, where an evolution of the initial yield surface of the bi-metal (Ti-Cu) is identified in the plane stress state.

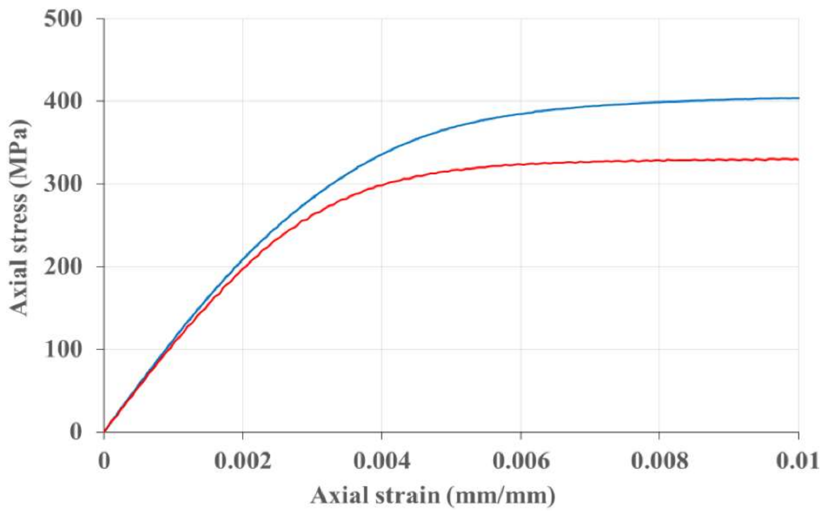


Fig. 1. Material characteristics of the bimetal (Ti-Cu) under monotonic axial tension (blue continuous line) and subjected to simultaneous monotonic axial tension and proportional cyclic torsion of strain amplitude ± 0.1% at 0.5 Hz frequency (red broken line)

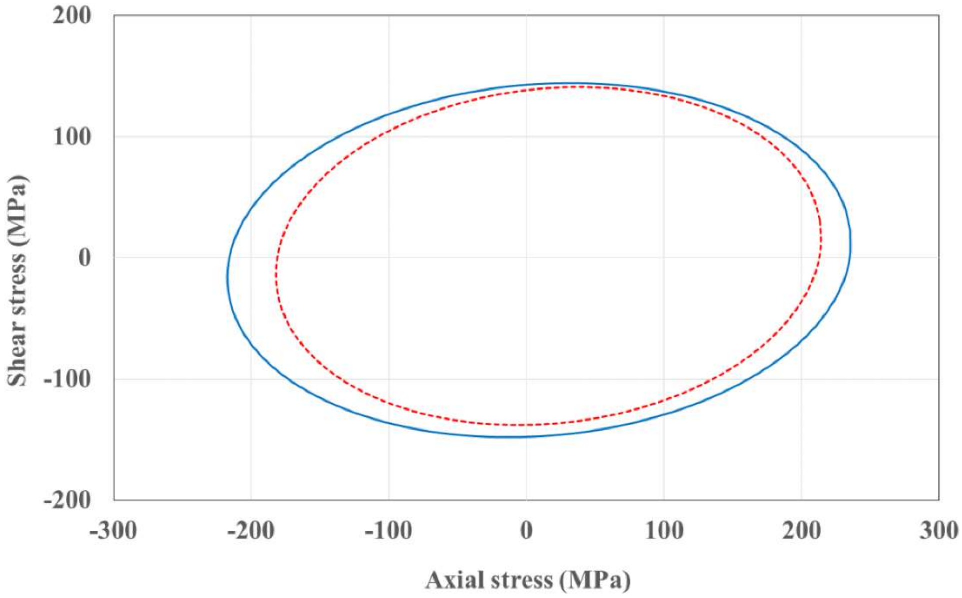


Fig. 2. Yield surfaces (1 * $10^{-4}$ offset strain) for the bimetal (Ti-Cu) in 'as received' state (blue continuous line) and in the pre-deformed state due to simultaneous monotonic axial tension up to permanent strain equal to 1% and proportional cyclic torsion of strain amplitude ± 0.1% at 0.5 Hz frequency (red broken line)

## 3. Conclusions

The effect of prior plastic deformation induced by cyclic torsion and monotonic tension on the shape and size of yield surface has been studied experimentally for the bimetal (Ti-Cu). 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.

*(1)* The 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.

*(2)* The yield surface sizes of the material in the pre-deformed state are mostly reduced in the axial direction, especially for the compression. This means, that the complex loading of the bimetal (Ti-Cu) leads to the significant softening resulting from plastic anisotropy introduction, that may have created and then increased some of the defects . This issue will be studied in further steps of the experimental program.

## 4. References

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