Yield Surface Identification of Functional Materials and Its Evolution Reflecting Deformation History under Complex Loadings

It is well known that 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 coming from manufacturing processes used to produce them. Therefore, **the aim of the project is to carry out experimental and theoretical analysis of 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 interface of aluminum–copper and titanium–copper bimetals. The materials will be tested in the as-received state and after prior deformation due to monotonic or cyclic loading. The yield surface concept will be used to identify an initial texture of the tested materials and subsequent modifications of their properties by its evolution due to loading history induced.**

The proposal deals with development of original experimental techniques for materials characterization under complex stress states using thin-walled tubular and cruciform specimens. A novelty in this area will be an application of the unique testing stands like: Instron 1343 enabling simultaneous loading of thin-walled specimens by the axial force, twisting moment and internal pressure; and Instron 8800 Biaxial Testing Machine for tests on the cruciform specimens, which is the first such machine in Poland. The last important aim of the project is related to modelling of the deformation mechanisms and degradation processes associated with the local stress-strain evolution. Finite element method (FEM) coupled with Chaboche model will be used to simulate the low-cycle behaviour of materials. Ultimately, the optimal thickness ratio of bimetals components, that guaranties the best values of basic mechanical parameters like yield point or ultimate tensile strength will be defined.

Experiments will be carried out on materials in the form of two-layers metal composites (bimetals) with a significant asymmetry of the mechanical properties of their layers. The material in the as-received state for cylindrical specimens will have the form of a tube with clearly physically different layers of metals, arranged coaxially with respect to its geometrical axis. The same materials for cruciform specimens will have the form of a plate. Basic research will be preceded by preliminary tests that will provide results necessary to determine the basic mechanical properties. Also microstructural analysis is planned to be performed using light and scanning microscopes. The main experimental program will contain a determination of the yield surface for both bimetals and for their components as well. It will be performed using thin-walled tubular specimens, Fig. 1b, and cruciform ones, Fig.1c, as well.

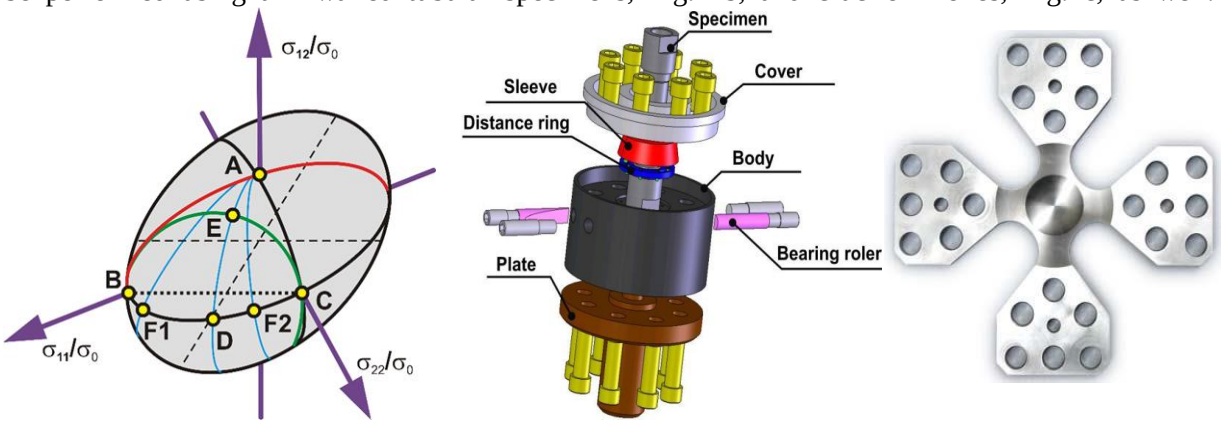

Fig.1. a) HMH yield criterion b)Thin-walled tubular specimens and gripping device for tests under complex stress states (axial force, twisting moment and internal pressure) c) Cruciform specimen

Such procedure give a possibility to determine selected cross-sections of the stress ellipsoid, Fig. 1a).

Contact:
Prof. Zbigniew L. Kowalewski, Department of Experimental Mechanics
Room 036; Phone: +4822 826 98 00