

DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

Ultrafine grained materials have been the subject of intensive research for about 20 years. The motivation to carry out these experiments were the unique properties, i.e. very high strength and ability to superplastic deformation at high strain rates. High strength is caused by the grain refinement and grain boundaries strengthening, which is quantitatively described by Hall and Petch. The formulated dependence predicts a linear increase in the yield stress with the increase in inverse square root of average grain size. The high mechanical properties of ultrafine grained and nanocrystalline materials have been proved in numerous experiments.

The unique properties of these materials resulted in the intense development of their processing methods. Effective grain refinement in metallic materials can be achieved through the Severe Plastic Deformation (SPD) processes. The most common SPD methods include Equal Channel Angular Pressing (ECAP), High Pressure Torsion (HPT) and Hydrostatic Extrusion (HE). The final products in these methods are rods, bars or small disks (HPT). From the further plastic deformation point of view (e.g. extrusion or shaping using superplasticity effect) the most desired material shape is sheet or plate. The materials in these forms may be prepared for example by Accumulative Roll Bonding (ARB). Although this method allows obtaining structure refinement of the multiple materials groups, it has certain disadvantages. These include very large anisotropy of mechanical properties and problems resulting from the nature of the process, such as lack of the consistent connection between the individual material layers.

The aim of the project is to identify the possibilities of producing plates with ultrafine grained structure and low anisotropy of mechanical properties by severe plastic deformation methods. This shape is more attractive from the shaping of the finished pieces point of view. At the same time, it can be expected that homogeneous ultrafine grained structure in plates will contribute to isotropy of mechanical properties, which is a feature particularly desired for further processing. The used methods will be modifications of traditional ECAP, which is Incremental ECAP and ECAP with parallel channels and subsequent upsetting. The samples in both, initial state and after severe plastic deformation processes will be tested for structural and mechanical properties anisotropy. For this purpose, the microstructure will be subjected to the characterization in terms of shape and grain size distribution, grain boundaries misorientation, microhardness measurements on different planes and tensile tests.

The proposed project will enable improving modern UFG materials and widening the range of products available, i.e. plates and (in the longer perspective) sheets beside currently available rods and wires. Plates in the past were rarely processed due to technological difficulties. However, the applicant assumes that the selected deformation methods and the process conditions will be appropriate for the formation of homogeneous (in terms of microstructure and mechanical properties) and isotropic plates. Plates are in general more suitable for further processing and industrial applications than rods or bars. In addition, the project will contribute to the creation of new knowledge about grain refinement mechanisms, structure and properties of these materials, and particularly their anisotropy.