1. Objective of the project

The main goal of the proposed project is the determination of relationships between grain boundary morphology and several other parameters describing microstructure of copper and aluminum, such as grain size and shape as well as crystallographic orientation. Grain boundary networks in polycrystalline materials influence several of their properties such as corrosion resistance, diffusion rates and electric resistance, as well as their behavior during plastic deformation and grain growth. A detailed description of grain boundary morphology was difficult for a long time because of lack of proper experiential techniques. However, a relatively new experimental method, three-dimensional electron backscatter diffraction (3D-EBSD) allows for the investigation of grain boundary networks.

2. Research to be carried out in the project

Samples of pure copper and aluminum will be subjected to plastic straining using two deformation methods: cold rolling and channel die pressing. The channel die limits the way the material can deform, so that it is contracted along pressing direction, elongated along extrusion direction, whereas its thickness along the third dimension remains unaltered. The investigated samples will be strained to various contraction levels, up to 80%. Subsequently, the samples will be annealed to obtain partially recrystallized microstructure using heating stage and electric furnace. The heating stage is installed inside the chamber of scanning electron microscope. It allows for live observations of the changes taking place in the sample during heat treatment.

At each stage of materials processing procedure, the microstructure of the samples will be investigated using EBSD, 3D-EBSD and XRD techniques. The EBSD technique in scanning electron microscope is based on the analysis of diffraction patterns formed by electrons focused at a particular point on investigated surface. Based on these diffraction patterns it is possible to determine the local crystallographic orientation of the sample. By acquiring and analyzing diffractions from a certain area of the sample surface it is possible to construct a map of local orientations, which allows to distinguish particular crystallites and determine their sizes and shapes, as well as several other microstructural parameters. The 3D-EBSD technique couples the regular EBSD with cutting of a series of cross sections through the sample using focused ion beam, giving the possibility to investigate materials microstructure in three dimensions. The 3D-EBSD technique provides additional information about the microstructure of the investigated material and the most important piece of this information is the morphology of grain boundaries. The X-ray diffraction technique (XRD) allows for the determination of average grain size and orientation in the analyzed sample, therefore it is a complementary experimental method to the EBSD.

3. Reasons for choosing the topic

Due to the fact that the 3D-EBSD technique is currently the only one providing full information about grain boundary geometry it is of great scientific importance to develop this technique towards analysis of various types of engineering materials. Results of the proposed project will bring a valuable contribution to the understanding of evolution of boundary morphology in materials subjected to plastic deformation and recrystallization. So far, little attention was paid to analyze copper as well as aluminum and its alloys using this method, thus the expected results of the project will broaden the knowledge in this topic.