DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

The main issue of interest in the proposed project is the analysis of relationship between dedicated manufacturing conditions (and consecutive microstructure) of yttria stabilized zirconia polycrystals (YSZ) and ionic conductivity of such a solid electrolyte.

Grain boundary distribution has a great impact on the material properties. In the project sponsored by Polish National Science Centre (2012/05/B/ST8/00117), which has been successfully completed in 2016, a quantitative description of grain boundary distribution in three dimensional space in the yttria stabilized zirconia cubic (YSZ) polycrystals was successfully presented. Surprisingly, an unexplained phenomenon was observed during experiments, mainly a disappearance of anisotropy in the YSZ polycrystals sintered above 1500^{o}C. This strange phenomenon was not only observed by our group, but also reported by researchers from Carnegie Mellon University, Pennsylvania, USA, however without any further explanation. In authors' opinion such a strange phenomenon deserves to be explained more thoroughly.

However, the main attention will be driven to the quantitative evaluation of the impact of microstructure, saying more precisely, grain boundary plane distribution (GBPD) and grain boundary character distribution (GBCD) on the ionic conductivity in solid electrolytes which should result in better solid oxide fuel cells performances.

The proposed investigations will be based on two experimental techniques. The first one is the three-dimensional electron backscatter diffraction (3D EBSD) technique in dual-beam scanning electron microscope. The 3D-EBSD acquisition allows to assess both grain misorientations and boundary plane orientations based on five parameters (i.e. relative orientation between abutting grains and inclinations of the boundary plane), contrary to the conventional 2D EBSD technique, insensitive to the grain boundary plane orientation. That creates the opportunity for complete macroscopic characterization of relatively large sets of boundaries. The Institute of Metallurgy and Materials Science of Polish Academy of Sciences has a broad experience both in running this kind of experiments and also in applying different software for diffraction post-processing analysis. Several types of geometrically characteristic grain boundaries have been distinguished. Based on all five parameters describing the geometry of grain boundary, several grain boundaries can be classified, e.g. tilt, twist, symmetric and 180^{o}-twist boundaries. Knowing such distributions, it will be possible to predict the macroscopical behaviour of the material and elaborate the way in which the material is to be manufactured (sintering, hot pressing etc.) to achieve its optimal properties.

The second experimental technique is the electrochemical impedance spectroscopy (EIS) – an extremely useful technique when researching the influence of the YSZ polycrystals microstructure on ionic conductivity. This techniques is used to measure three types of ionic conductivity, because it can distinguish between the different resistance contributions i.e. bulk, grain boundary and electrode resistances.

By correlating both techniques it will be possible to find and evaluate (in a quantative way) the relationship between crystallographic parameters of the YSZ polycrystals associated with manufacturing conditions and ionic conductivity both along grain boundaries and through the crystallites.

On behalf of the team preparing this Project we want to underline that it is a novel approach in the so called grain boundary engineering and to best our knowledge no one has tried to deal with this issue in that way.