Mechanical and microstructural properties of two metallic materials with hexagonal crystal structure, i.e., polycrystalline magnesium and titanium, will be studied in this project. Titanium has a low density, high resistance for corrosion and high mechanical strength combined with low density. Due to these properties it is increasingly applied in chemical plant construction, in aerospace industries and in the biomedical technology. On the other hand, magnesium belongs to a group of light weight materials, demanded in structural applications and in the automotive and aerospace industries. It has high specific strength (the ratio of the yield stress to density), superior damping capacity and high thermal conductivity - these properties predetermine this material for use in many structural applications; the problem is, however, a relatively low ductility at ambient temperature (e.g.., it cracks easily). One of the objectives in this project will be enhancement of its ductility and formability.

Due to a low crystal symmetry of hexagonal metals, their deformation mechanisms are much more complex than that those of cubic structure metals and their exact description requires a further research. The goal of the project is to study the plastic deformation mechanisms of both metals on the crystalline level and optimization of their mechanical properties choosing appropriate microstructures and crystallographic textures. In parallel, an advanced self-consistent deformation model will be developed. It will serve to interpret experimental data and to search optimal microstructure parameters of the studied materials. The following hypotheses will be examined in the project:

- complex examination of lattice strains in grains during diffraction *in-situ* measurements can identify precisely the families of slip and twin systems activated during deformation,
- application of different diffraction techniques (X-ray, neutron, electron backscatter diffraction -EBSD) and the acoustic emission (AE) technique will enable to determine precisely the critical resolved shear stresses (CRSS) of slip and twinning systems and their hardening parameters as well as to investigate the formation and morphology of twins,
- hardening intensity function versus strain and crystal orientation, which will be determined from EBSD data, is crucial for a correct description of plastic deformation (also in the frame of the deformation model),
- an improved description of the twining and de-twinning mechanisms is necessary for a reliable deformation modeling of the examined materials; it will be included in the self-consistent model calculations.

Three *in-situ* diffraction methods will be used during tensile loading of titanium and magnesium in order to investigate their deformation mechanism; internal stresses, crystallographic textures and microstructure parameters will be determined. Experimental data will be analyzed using the crystalline deformation model. Anisotropic elastic and plastic properties of these materials will be examined by performing loading tests in different sample directions. Also AE technique will be used to study formation and morphology of twins. In conclusion, the following experimental methods will be used in the project:

- in-situ X-Ray and neutron (time of flight method) diffraction measurements during tensile tests performed in different directions; they will supply data on lattice strains in groups of grains,
- in-situ EBSD measurements during tensile loading; they will supply information on individual grain microstructure and orientation, useful for identification of twin variants and their morphology,
- in-situ AE measurements with a high time resolution; they will enable monitoring of micromechanics events, including twin formation.

An important feature of this project is that in-situ experimental observations will be performed simultaneously on global scale (information on group of grains) and on local scale (individual grains).

All measured characteristics of the studied hexagonal metals, obtained from different experimental techniques will serve to deepen our understanding of their deformation mechanisms on crystalline and micro-structural level. These materials play an important role in the modern technology. The collected data will also contribute to the development of the crystallographic self-consistent deformation model. Moreover, the results obtained in the project will be published in international journals and presented in scientific conferences.