The general idea of presented project is to explore the possibility of producing of new type of ultrafine grained metal matrix composites exhibiting high strength and increased thermal stability. Mechanical properties of metallic materials strongly depend on their characteristic microstructural dimensions (eg. the grain size and the density of dislocation). It has been proved that fragmentation of the structure to the micro- and nano scale changes the properties of the material observed in a macro scale. The most popular and efficient way for their production are so called severe plastic deformation (SPD) methods. Unfortunately, the microstructure of SPD processed metals in the as-deformed state is thermally unstable and annealing at low temperatures leads to significant grain growth in the microstructure, which in turn alters material properties. For this reason, one major goal for material development must be the enhancement of the thermal stability of the produced microstructure to make it suitable for technical applications.

The potential solution to this problem lies in the application of SPD processes to produce a new class of metal matrix composites reinforced by dispersive nanoparticles. Nano-particles uniformly distributed in the metal matrix will have a pinning effect on lattice defects, such as dislocations and grain boundaries, stabilizing the nanocrystalline microstructure and expanding the temperature window for their potential technological applications. The intensity of this phenomenon depends on the microstructure formed during deformation, which on the other hand will be affected by the shape (2D and 3D particles), type, fraction and size of reinforcing phases. Moreover, a homogeneous distribution of particles in the matrix will also have a strong impact on the thermal stability. This project is aimed to investigate the issue.

In this project a high pressure torsion (HPT) technique will be used in order to fabricate new class of advanced MMCs. The planned studies will be focused on the evaluation of the influence of composition of MMCs and HPT processing parameters on the final microstructure, mechanical properties and thermal stability of fabricated composites. The quality of fabricated MMCs will be verified by microhardness measurements, tensile tests. Then the samples are subjected to a detailed microstructure analysis with the use of advanced electron microscopy techniques. Microstructures will be a subject of quantitative and qualitative analysis, taking into account evaluation of microstructure and distribution of reinforcing nanoparticles in the metal matrix after the process of HPT. Thermal stability will be tested by using: differential scanning calorimetry, conventional annealing and in-situ heating in transmission electron microscope.

The proposed project is of a great scientific importance and refers to the most current issues in the field of nanomaterials. The project will contribute to the creation of new class of materials having unique microstructure and mechanical properties and increased thermal stability.