Dynamic progress of technology in the last century is accompanied by the development of material science and engineering. According to the Olympic motto "faster, higher, stronger" we demand from technology fast transport, high effectiveness and powerful computers. Realization of these challenging tasks is possible by application of modern materials with dedicated parameters.

Manufacturing of the material that meets the design requirements is possible using composite materials. Macroscopic parameters of composites depend on the microstructure and related phenomena occurring at the "micro" level. The terms "micro" and "macro" are arbitrary. In ceramic-metal composites the basic scale parameter is the dimension of ceramic inclusions. Composites consist of two or more components (phases), which build the material structure at the micro scale level. The components of heterogeneous materials are: a matrix, which binds phases, and inclusions, that reinforced a composite.

Material parameters of the composite strongly depend on the properties of the matrix, which occupies most of the volume of non-homogeneous material. To obtain the desired material properties, the matrix is reinforced. Inclusions can be in the form of particles of shapes like ellipsoids or edgy like cuboids. Composites can also be reinforced with fibers or platelets. The geometric parameters and the distribution of the reinforcement affect the macroscopic parameters of the composite and strongly effect its failure scheme.

The effective properties of composite materials differ from the properties of individual constituents under the same conditions. A good example is a composite made of ceramics and metal. Ceramic is resistant to high temperatures, but its disadvantage is its brittle fracture, while in general the metal alloy is plasticized under high stress but rapidly soften under higher temperatures. Ceramic-metal composite has the advantages of the ceramics and metal alloy: it is resistant to high temperatures and has good fracture toughness.

Micromechanical models support the understanding of local mechanisms that govern the influence of morphological features of microstructure on the material properties at a macro scale. Unfortunately, classical micromechanical models take into account only the volume fraction of inclusions and sometimes their ellipsoidal shape. The main goal of the project is to developed a model within the Morphology-based Representative Pattern approach (MRP), which takes into account additional microstructure parameters: packing, shape and particle size, phase adhesion quality, and the nonlinear response of the composite due to the damage evolution.

The material design has an important role during the process of the composites production and is based on the outcomes of the micromechanical models or numerical simulations. Properly selected model should account for the morphology of the composite microstructure, in order to correctly estimates the material parameters of the resulting composite. The aim of the project is to expand the existing micromechanical model, which has already taken into account some of the morphology features, to new aspects: the different shapes of particles and the damage development in the material. Such micromechanical model allows for a more accurate prediction of the composite response and answers the question of how the damage evolution affects the composite response. Results of the analytical micromechanical models will be verified by comparison with the results of numerical simulations and conducted experiments.