The precision (PM) and ultra-precision machining techniques (UPM) are currently very often being conducted with the application of end mills with diameters not exceeding 1 millimeter. This kind of machining technique can be defined as micromilling.

Currently, the main application area of micromilling involves the production of elements made of titanium alloys and stainless steels, intended for the biomedical industry, such as bone and joint implants and parts for the neurovascular system. This process is also used in the production of microelectrodes as well as microforms from hardened alloy steels and elements of bio-microelectromechanical systems (bio-MEMS). Additionally, the use of single-edge diamond micromills enables the formation of pyramidal or prismatic structures used in diffraction optics and light directing systems. It should be noted that the main advantage of the micromilling over the other techniques (as: photolithography, micro-electro discharge machining, ultrasonic and laser beam techniques) employed for the manufacture of precise/miniature parts is its high productivity.

The division of machining into the conventional, precision and ultra-precision can be made with the consideration of uncut chip thickness h ranges, as well as the phenomena appearing during the chip decohesion process. In conventional cutting, the uncut chip thicknesses are $h \geq 0{,}1$ mm, in precision machining the uncut chip thickness is contained within the range: $1\ \mu m < h < 0{,}1$ mm, and during the ultra-precision machining the $h \leq 1\ \mu m$.

The extreme requirement towards a surface quality constitutes the fundamental objective of the UPM processes. Therefore the recognition of a specific physical phenomena occurring during the surface texture formation and the selection of input parameters enabling simultaneous improvement of machined surface quality together with a process economics is of high scientific importance. It should be stated here that problems of surface texture formation were insightfully investigated by the many researchers in relation to the conventional milling processes. However, the approaches and models proposed in these researches are usually not applicable towards the UPM micromilling processes. It is mainly caused by the specific conditions occurring during the UPM process, which are connected with a workpiece material's properties and microstructure, as well as errors and vibrations of a machining system. It should be emphasized that these phenomena are still insufficiently examined. Therefore the primary project objective is the development of a complex analytic-numerical models which describe: chip formation mechanisms during the ultra-precision micromilling in a three-dimensions, elastic and plastic deformations of a machined surface, tool trajectory, as well as formation of a surface texture during UPM for a diversified machining systems.

The studies conducted during the realization of this project will involve the theoretical simulations and experimental tests. The proposed models will be based on the analytical and numerical approaches. Thereafter, these models will be empirically validated during UPM processes with the variable input parameters.

The models developed in this project will include the factors which were not taken into the consideration in any previous works related to UPM. Thus it can contribute to the pioneering nature of the project.

The generalized surface texture formation model developed in this project will include the specific phenomena appearing during the ultra-precision micromilling process. In this way, its analysis can contribute to the better understanding of the complex physical phenomena occurring during the surface formation in UPM, and thus to the advancements in the ultra-precision micromilling technique. The obtained results can be applied to the improvement of the machined surface quality by the selection of the appropriate micromilling input parameters. Finally, the results can be an important basis for popularization of UPM technology, and its extension to the production of ultra-precise parts with a complex shapes, intended to the biomedical, electronic, aerospace and optical industries.