The focused ion beam (FIB) microscope has been extensively used in fundamental studies in materials science as witnessed by an increase of publications in this area. Nowadays, the manufacturing and characterization of smallest structures play a key role in the field of modern micro-/nano science. Moreover, combining microscopy techniques with FIB gives a huge potential for innovative research in multiple fields of modern materials science. Despite the potential of FIBs in many different areas of material sciences, the technique is most commonly used in preparation of transmission electron microscope (TEM) cross-section sample lamellae. The main advantage of using FIB technique is strong decrease of time needed for sample preparation (lamellae) in comparison to conventional methods which are used for sample preparation for transmission electron microscopy (TEM) analysis. Using this technique is possible to prepare samples of materials which have not previously been prepared by conventional techniques, or their performance was extremely laborious and complex. This technique is also used for sample preparation of thin films, layers and coatings cross-section investigations.

The main disadvantage of FIBs, however, is caused by the nature of the milling process such as the ion collisions initiating severe damage to the remaining bulk of the material occurring during the specimen preparation. The process has been observed, however is not well understood, mainly because it depends mostly on the type of material which was used for investigations. Since, the FIB lamella method spreads to more advanced TEM techniques, a research providing explanation of procedures preparation is of most desire in the field of material sciences, moreover this knowledge would help to reduce or avoid the damage of the sample during the ion beam milling. The basic research presented here, aim to demonstrate the impact of ion beam irradiation during sample preparation using the FIB technique on the microstructure of alloys and find the relationships between the irradiation parameters (ion dose) and microstructure changes. This may in the future contribute to better understanding of processes occurring during the io milling in materials, which have not been studied yet. It will allow users of FIB technique to avoid errors in their interpretation of results.

In order to specify the effect cause by the use of Ga+ ion beam on the microstructure of selected metals and their alloys, particular materials characterized by a low microstructural stability were chosen for investigations. The chosen materials require an adequate preparation in order to achieve the low stability of its microstructure. The materials will be characterized using following methods: SEM with EDX (energy-dispersive X-ray spectroscopy) and EBSD, X-ray diffraction (XRD), TEM and studies of phase transformations using differential scanning calorimetry (DSC) and dilatometry. The study of phase transformations will allow to correlate characteristic temperatures observed for the materials with the heat generated by the Ga+ ion beam. For the purpose of the studies commercially available iron-based alloys will be investigated. In order to obtain a large volume fraction of retained austenite, steel samples of high carbon content will be quenched from the range of homogeneous austenite (above the Ac_{cm} temperature). In the following part of the experimental work planned in the project a commercial pure aluminum will be irradiated by Ga+ ion beam. Under the ion beam treatment, processes of recovery, recrystallization, and grain growth are expected to occur in the aluminum alloys. The final stage of studies carried out within the project is an understanding of a structural changes caused by the interference of the ion beam irradiation onto the metallic glasses, which are characterized by low temperature of devitrification. The experiment assumes that by change of the ion beam milling parameters, it will be possible to observe whatever the devitrification take place in the material, and to define the condition in which this process occur.

The aim of this project is to evaluate effects of focused ion beam (FIB) milling on microstructure stability of selected alloys such as steels (iron based alloys), aluminum and its alloys, and metallic glasses with special focus on the degree of implantation of gallium ions (Ga+) into the structure, heat generation during the milling, and size of microscopic disruptions depending on the ion dose.