One of the fields of technology that allows the development of various areas of human activity is materials engineering. New materials, and in particular new technological processes of their production, arise all over the world and contribute to the increase in the degree of meeting the constantly growing application requirements, for example in such areas as nuclear reactors or spacecraft.

High-Entropy Alloys (HEAs) deserve special attention in the context of a wide range of high requirements. Such alloys have a unique composition - they are made of 5 or more metallic elements mixed in similar proportions. If we also add non-metallic elements to such an alloy, for example carbon or nitrogen, we can obtain High-Entropy Ceramics HECs. Both of these groups of materials are difficult to analyze due to the possible number of combinations of material composition, however, some of the tested compositions are characterized by parameters that exceed classic materials.

The aim of this project is to produce a material that will consist of a layer of High Entropy Ceramics obtained on the surface of High Entropy Alloys. In this way, the high properties of the entire material will be ensured, while at the same time strengthening the part exposed to the environment - the surface of the material.
The path leading to the production of such a designed material consists of the alternate repetition of two processes - ion implantation and rapid thermal processing. Implantation with ions will be a source of non-metallic atoms (in the project - nitrogen atoms), while thermal treatment will allow to control the microstructure of the obtained material and ensure diffusion of nitrogen ions into the material. The experimental approach will be supported by advanced simulation techniques (CALPHAD - Computer Coupling of Phase Diagrams and Thermochemistry; DFT - Density Functional Theory), which will enable the estimation of the most favorable chemical compositions for our material. In order to confirm the high properties of the obtained samples, experimental nanohardness, compression of micro-pillars and scratch tests will be performed. These techniques will not only enable the numerical indication of material properties, but also allow to describe the interaction between the ceramic layer formed during the process and the alloy and its importance for applications.

The results obtained during the project will contribute to the determination of the usefulness of the proposed technological process for the production of High Entropy Ceramics, will increase the scope of data on the properties of High Entropy Alloys and Ceramics, and in the event of obtaining distinctive properties - they will constitute the basis for extending the technological process to materials with other chemical compositions. In addition, the impact of ion implantation and thermal treatment on the crystallographic structure will be understood, which may also contribute to indicating new directions in the development of manufacturing engineering of High Entropy Ceramics.