High Entropy Alloys (HEAs) are a new group of a very promising materials. Their main concept was presented for the first time in 1995, however it was not until 2004, when their progressively intensive development had started. The name of high entropy alloys is used for the alloys which consist of at least 5 different principal elements, in most cases in equimolar or near equimolar proportions (the general definition assumes content 5-35% at.). Such approach to development of the alloys is radically different to traditional one, in which the alloy is based on one or two main components, with the rest of the components acting as an alloying additions and properties of the alloy are defined mostly by the properties of the main component. This novel approach also results in a number of additional consequences, which determines the unusual properties of these materials. Due to the presence of multiple principal elements in large quantities, so called "entropy effects" occur. They result from the fact, that due to a large number of possibilities of filling the structure, the thermodynamics of such systems favors the formation of solid-state solutions in which all atoms are randomly distributed within just one or two metallic phases. This generates a number of new properties of the alloys, which differs from the properties of each of the components on their own. This rule applies for example to the mechanical properties, but also to the kinetics of transport phenomena in this materials.

The objective of the project involves primarily an investigation of the properties of the materials under conditions which correspond to their possible applications. Due to their unique structures, HEAs exhibit extraordinary mechanical properties in very high temperatures, as well as high corrosion resistance, what makes them suited for such applications as: heat-resistant and wear-resistant coatings, thermal-resistant coatings, materials for nuclear industries and structural materials for transportation and energy. In all those applications, resistance to high-temperature oxidation plays crucial role. Up to this day, most of the studies on the subject of high entropy alloys were concerned mainly with structure of the materials and production methods. Only a few publications on the topic of high-temperature oxidation of HEAs are available and most of them is focused on a very small variety of materials. In my project, I decided to take care of this problem in much wider, methodical way. During the project a variety of alloys form the Al-Co-Cr-Fe-Ni metallic system will be investigated, with the oxidation experiments being carried out in the temperature range of 1000-1200 °C. The choice of Al-Co-Cr-Fe-Ni system is dictated by high thermal stability, relatively low costs and high availability of components and high mechanical properties of alloys from this system. Extremely important here is the role of the aluminum, which exhibits a bit different properties to those of the rest of the components. The Al atoms are much bigger than others, stretching the unit cells of the alloys' structure and introducing the strains in the structure. As a result, the Al content controls the crystallographic structure of the whole alloy and as a consequence its mechanical properties. What's more, the alumina oxide Al_2O_3 which forms during the high-temperature oxidation is well known for its extremely good protective properties. As a result, by manipulation of the aluminum content it should be possible to observe a huge variety of oxidation mechanisms and to investigate the influence of a number of different factors on the kinetics of this process. It should also enable the verification of the currently acknowledge theories concerning the oxidation mechanism, which are based on rather incomplete and erratic data. Since the materials will be investigated in a range of temperatures, it will be possible to determine so called energy of activation of oxidation process, which will allow to extrapolate the kinetic data on a wider temperature range.

The main objective of the project is to expand our current state of knowledge on the high-temperature corrosion processes in the high entropy alloys, namely by investigation of the oxidation mechanisms and kinetics. However, information resulting from this project could have much bigger impact. In the bigger picture, the understanding of this process, and understanding of the influence of e.g. structure on its course, should greatly ease the complicated process of alloy design, enabling the more conscious choice of components and their contents, depending on the given application of the material.