The development of science, engineering and technology leads to the simultaneous development of engineering materials. New technologies, common miniaturization results in the creation of devices that are characterized by smaller dimensions, and are lighter, cheaper, more durable and energy-efficient. Meeting all these requirements is possible, among others, thanks to the use of newer and newer materials with better properties than those commonly used several years ago. Hence the main scientific objective of the project - to learn about the mechanisms underlying the high mechanical strength of innovative high entropy alloys with nanocrystalline structure. The aim of the project may sound very complicated, but analysing its individual components will facilitate the understanding of the project.

Nanocrystalline materials are one of the intensely developed and studied groups of materials. They are materials whose structure consists of grains of the order of magnitude - as the name suggests - of tens of nanometers. Materials with this structure are characterized by higher hardness, stiffness and are more durable than similar materials with larger grain sizes. These and other similar effects are commonly known as scale effects. One of the most interesting materials in this group is chromium - which can be produced by easy and inexpensive galvanization methods. It also has a very wide range of applications - from decorative coatings on everyday objects, through key layers in electronics, to super-strong alloys and composites.

The second group on which many scientists in the world focus their attention are high entropy alloys. These are alloys that consist of at least five components (elements), mixed together in equal proportions. Although the definition itself sounds very simple, the actual production of such an alloy is not a trivial matter. Similarly complicated is the answer to the question of why these alloys have such good properties.

Especially interesting from the point of view of the mechanics of materials are high entropy alloys with nanocrystalline structure. They combine both classic scale effects and effects present only in high entropy alloys. Understanding which of them combine positively and which specific material parameters are influenced by them will be of great importance and will positively influence the understanding of the mechanics of nanocrystalline materials. This question can be answered by directly comparing two different nanocrystalline materials: (traditional) chromium and (innovative) high entropy alloy.

The project is mainly based on experimental research - tests performed with the same parameters on two materials of similar structure will allow assessing the influence of different effects on the behaviour of materials. All research will be carried out on a microscale, which will allow the scale effects to become more visible. Experiments will be similar to those used traditionally, but appropriately scaled. These will be compression tests, tensile tests and hardness measurements. All of them will be carried out with a variable speed of applied load, which is one of the innovative approaches in the project, and will allow to obtain very interesting results and describe the properties of materials with unprecedented precision.

The direct result of the project will be a better understanding of the mechanisms that determine the parameters of nanocrystalline high entropy alloys. This will expand the understanding of the fundamental laws that govern the world around us and will allow for easier prediction of material properties, easier modelling and simulation, as well as better selection of experimental testing methods. As a result, an indirect effect of the project may be a faster application of high entropy alloys in the production of modern machinery and equipment. Currently, many applications for high entropy alloys are proposed, including heavy-duty coatings in internal combustion engines, shafts, bearings, and also as a material for parts operating at very high temperatures.