Metallic glasses represent an exciting group of metallic materials, which, unlike conventional crystalline metals and alloys, are characterized by a lack of order between atoms. Therefore, they exhibit unique physical, chemical and mechanical properties, i.e. high strength, elasticity and corrosion resistance. To date, however, metallic glasses have not found widespread use as engineering materials. This is mainly due to their high brittleness, which is manifested by the absence of plastic deformation prior to cracking. This behaviour excludes the possibility of using metallic glass as materials for load-bearing applications. For this reason, in recent years the growing interest of scientists has been directed at bulk amorphous-crystalline composites that can combine high strength of a glassy matrix with the plasticity of crystalline precipitates.

Among many glass-forming systems, the Cu-Zr-Al alloys deserve special attention. Even binary Cu-Zr alloy can be cast into amorphous rod samples with diameters up to 2 mm. The addition of a few percent of Al significantly improves its glass-forming ability. In the Cu-Zr-Al alloy with a similar concentration of copper and zirconium, an amorphous-crystalline composite, with B2 CuZr crystals, can be obtained in-situ during solidification. The extraordinary properties of such composites are the result of deformation-induced martensitic transformation. This phenomenon is referred to in the literature as a TRIP (TRansformation Induced Plasticity) effect and is commonly used in other engineering materials. Good examples are TRIP steels that are widely used in car body parts due to the combination of high strength and ductility.

The main goal of the project is to understand basic factors influencing the formation of B2 CuZr phase during solidification and the deformation-induced martensitic transformation, which will pave the way for future commercial applications of such materials. In addition, the effect of doping the Cu-Zr-Al alloys with rare earth metals on the B2 CuZr formation and mechanical properties of composites will be studied.

The alloys will be synthesized by melting high purity elements in an arc furnace under protective argon atmosphere. The alloys will then be produced in the form of rods by casting into copper moulds. The mechanical properties of alloys will be determined in compression and tension. The structure of alloys in the as-cast as well as deformed states will be determined by X-ray diffraction and microscopic observations (light and electron microscopy). Moreover, calorimetric studies during heating and cooling will allow to determine the glass-forming abilities of alloys and their susceptibilities to the formation of the B2 CuZr phase during solidification.

Mechanical properties of amorphous-crystalline composites with the B2 CuZr phase depend strongly on the volume fraction and distribution of both phases. Therefore, three different ways of influencing the structure of composites will be tested: (i) changing the cooling rate of alloys by varying the rod diameter, (ii) changing the water cooling system temperature, and (iii) changing the susceptibility to the B2 CuZr phase formation due to minor doping the alloy with rare earth metals.