Contemporary medicine widely utilizes the development of materials dedicated to bone implants or stents. Commonly used short-term implants made of steel or titanium alloys can lead to undesirable side effects, such as bone weakening due to the use of bone-fixing plates. Moreover, such implants should be removed after the tissue recovery period, but this procedure is often not performed due to potential postoperative complications, including infections. A solution may be implants made from materials that degrade within the human body, known as biodegradable implants. To date, short-term implants made from magnesium alloys or polymers have been introduced, but these are not without flaws. The latest alternative may be zinc alloys, intensively developed in recent years, which are fully biocompatible and undergo gradual degradation during tissue regeneration. However, the development of new zinc alloys for medical use is an extremely extensive topic.

The proposed project suggests a method for producing new multi-component zinc alloys consisting of rapid crystallization using the melt spinning method, followed by consolidation of the cast tapes through hot extrusion. This will produce ultra-fine-grained, high-strength rods. Rapid crystallization of chemically complex zinc alloys will significantly refine the microstructure and uniformly distribute strengthening particles. Hot extrusion will consolidate thin tapes, unsuitable for load-bearing elements while creating conditions for strengthening through heat treatment. The final product will be uniform zinc alloy rods with minimal chemical segregation and high mechanical properties.

This project involves research to determine how the complex chemical composition and manufacturing methodology affect the mechanical properties and microstructure of the zinc alloys created. Advanced electron microscopy techniques will enable detailed analysis of the microstructure both quantitatively and qualitatively. The effectiveness of the manufacturing technology will be verified through hardness tests and mechanical properties conducted in the form of tensile and compression tests. Additionally, the produced zinc alloys will also be tested for corrosion resistance to assess their durability in a simulated physiological solution under static immersion or dynamic solution flow conditions.

This project presents potential opportunities offered by the novel combination of rapid crystallization and hot extrusion of new multi-component zinc alloys. The ultimate result will be a significant expansion of scientific knowledge about the manufacturing techniques of fine-grained zinc alloys for use in implantology. The project also aims to accelerate the introduction of biodegradable implants made from zinc alloys to the market, with broader implications in the context of medical development.