Biodegradable Hierarchical Porous Magnesium Alloys Produced by Directional Solid-Gas Eutectic Reaction Combined with Infiltration Technique

The aim of the project is to design, manufacture and research a new generation of highly porous, **biodegradable materials** based on magnesium. It is planned to conduct research in two directions.

The first one concerns the use of **porous salt preforms infiltrated under pressure** with liquid magnesium saturated with hydrogen under pressure (Mg-H_2 system) and then subjected to **directional solidification** according to the principle of production of gasars, i.e. **porous materials** obtained in the liquid-phase process using the **gas-eutectic reaction**. After the directional solidification process is completed, the salt preform is removed by dissolving in water. The materials produced in this way are intended to be **completely biodegradable** and will have a highly porous **hierarchical structure** impossible to obtain by any of the previously known methods. Their characteristic feature will be the **gradient porosity** created by two different mechanisms: 1) through the use of a temporary / **removable continuous carcass** from the salt and 2) the reaction taking place in the liquid metal during its directional solidification.

The second direction concerns the use of **solid metal preforms**, also with a porous structure, obtained by **3D-printing**, which are then **infiltrated in situ** with liquid magnesium, also saturated with hydrogen (Mg-H_2 system) and also subjected to directional solidification accompanied with **gas-eutectic reaction**. Materials obtained according to this method will be **biocompatible**, showing **partial biodegradability**.

In-depth investigation of the physico-chemical interaction in selected ***liquid metal/solid*** **systems** (including Mg/salt; Mg/metal; Mg/ceramic material), structural characterization using SEM, TEM, EDS methods, X-ray analysis, non-destructive testing using computed tomography methods, measurements of thermophysical and mechanical properties as well as studies on biodegradability and biocompatibility of manufactured materials are planned.

The proposed innovative methods of synthesizing a new group of magnesium-based alloys with varying degrees of biodegradability will be subjected to mathematical modeling in order to explain the role of individual parameters of the **liquid-phase process** on the formation of a highly porous structure, especially the process of **infiltration** of a porous shape (preform) with liquid metal and the influence of the presence of a preform on the course of **nucleation** and the **growth of gas bubbles** in the process of directional solidification.