

Biomaterials are a kind of materials which may be used to produce whatever product, which may have a contact with a living tissue. Among the others, the implants and the elements introduced into the interior of an organism, are made from the biomaterials. Nowadays the implants are being made from three main groups of engineering materials, that is: metals, ceramics and polymers. Since today the main materials that have been used for the metal implants were austenitic steels, cobalt and titanium based alloys, and precious metals. Each one of these groups is characterized by different mechanical and biological properties such as biocompatibility, biodegradability and bioresorbability. Metals and their alloys are defined by the beneficial set of mechanical properties (brittle fracture resistance, tensile/compression strength, fatigue corrosion resistance), moreover they have good biocompatibility, which is determined by the response of the tissues surrounding the implant. Unfortunately these materials are usually not biodegradable nor bioresorbable. It means that these implants are permanent, meaning that after set time arises the necessity to remove them. Every operation is an intervention in the patient's body, which may result in grave complications. A solution to that problem may be a creation of an implant, which after fulfilling its tasks will simply dissolve (biodegradability) and it will be absorbed by the host body (bioresorbability), enriching it with the microelements needed for its proper functioning.

Magnesium based alloys find a lot of potential in this field as they are both biodegradable and bioresorbable and they introduce a lot of different benefits as compared to the traditional permanent implants.

Nowadays the processes used to obtain the biodegradable metal materials encompass the casting and processing by solid state shaping and machining. Unfortunately they are characterized by high energy demand and restrictions resulting from the use of the different methods and devices. Those methods need the complicated supply of shielding atmosphere during the melting process, because of the high magnesium reactivity.

During the electrochemical dissolution of the magnesium alloys, large amounts of hydrogen are released that are not acceptable for human tissue. Therefore, the degradation of these alloys should be controlled and limited to an appropriate level in order to be suitable for medical applications, e.g. in orthopaedics. The factor that causes corrosion of magnesium alloys is primarily the composition of the alloy and microstructure as well as manufacturing techniques and their parameters.

Finding new production techniques and process parameters that will allow to obtain a unique microstructure of magnesium based alloys, while showing the characteristics of controlled corrosion, which is acceptable to human body, is of great importance. Hence the idea of producing biodegradable metal magnesium based materials by powder metallurgy. In addition, the project assumes the development and thorough characterization of new magnesium based alloys, doped with precious metals (e.g. gold, platinum, palladium) or / and rare earth metals (e.g. gadolinium, yttrium, praseodymium, scandium). The introduction of these alloy additives aims to create a specific structure that would provide optimal mechanical and corrosion properties.

The next step will be to examine the effect of the alloy chemical composition on the degradation rate to ensure a sufficiently long service life. Determining this property is crucial because the implant needs to fulfill its task before it can biodegrade and resorb. Characterization of these properties will require specific research of a cognitive nature, such as structure and composition analysis (X-ray diffractometry, photoelectron spectrometry, and electron microscopy, both transmission and scanning). Subsequent research will concern mechanical properties, such as tensile, compression, bending and abrasion resistance tests.

The results obtained in this project will be a novelty in the field of material engineering research, because they can contribute to a deeper understanding of the correlation between the chemical composition, structure, mechanical properties and the dissolution rate of implants in body fluids. The development of the characteristics of the structure and properties of magnesium-based alloys is important both from the scientific point of view and, in the long-term, from the point of practical implementation. Currently, special screws, metal plates or nails are used to connect broken bones which are mainly made of stainless steel or titanium alloys. The scale of the problem is evidenced by the fact that in 2012 almost 17 thousand reconstructive arthroscopic operations were performed in Poland using fastening implants. The increase in global production of magnesium and its alloys exceeded 10% in 2013 and has been growing strongly for several years.