PEO coating on AZ31 magnesium alloy for bone implant applications

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Most of the bone implant materials are currently bioinert metals like titanium alloys, which carry several problems like stress shielding effect, host rejection symptoms (as necrosis) and release of toxic substances, as aluminium. Thus, after the complete healing of the bone and to avoid these problems there is a need for a second surgery for the removal of the implant, causing increased pain in the patient and added costs to the health systems. The development of biodegradable materials that could be reabsorbed after bone healing, through a controlled dissolution process, could be a solution for these problems, provided the adequate materials are available.

Several studies have proven the biocompatibility of magnesium alloys and their corrosion products, making them promising candidates for biodegradable implant materials. On top of that, magnesium alloys have mechanical properties close to cortical human bone, which would mitigate several bonding and structural problems that arise from other metals.

The high corrosion rates typical of magnesium alloys do not guarantee their performance throughout the minimum period of twelve weeks needed for the bone regeneration, meaning that those alloys cannot ensure the bone implant structural function for enough time. Also the high rate of hydrogen release in the vicinity of soft tissues, due to the magnesium corrosion reactions, is too large for the body to deal with, inducing several inflammatory problems.

The aim of this work is to develop an inorganic coating that may control the corrosion rate of magnesium, maintaining the implant stable during the bone healing process and then allowing for its slow dissolution, at rates compatible with low levels of hydrogen release and appropriate concentration of magnesium ions both in the surrounding tissues and in blood.

In this work, an AZ31 magnesium alloy was coated by plasma electrolytic oxidation (PEO) with four different phosphate based electrolytes, and then, hydrothermally treated with two EDTA-Ca solution.

The coatings were characterised by SEM-EDS and XRD, and a good agreement was obtained between those techniques, and hydroxyapatite structures were observed.

The corrosion mechanisms were evaluated through OCP and EIS, showing a substantial decrease in the corrosion rates both in 0.1M NaCl and SBF.

A substantial increase in corrosion resistance and the appearing of needle like hydroxyapatite was observed after the hydrothermal treatment.