Influence of Inorganic Surface Treatments on the Corrosion Resistance of Mg1Ca Biodegradable Alloy

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Abstract The addition of alloying elements such as aluminum (Al), Rare Earth Elements (REE), zinc (Zn) and calcium (Ca), can significantly improve the mechanical properties, corrosion resistance and biocompatibility of the Mg alloys and have been suggested to be used in biomedical applications as biodegradable materials. However, the potential cytotoxicity of Al and REE is a limitation to its use in such situations. Zn and Ca are both biological and essential elements in the human body. Thus, Mg alloys containing Zn and/or Ca such as Mg1Zn, Mg1Ca or Mg5Ca have been proposed for the development of biodegradable implants.

Concerning MgCa alloys our previous studies [1] indicated improvement of corrosion resistance and good biological performance, although it does not reach the level of corrosion resistance required. Therefore, taking into consideration the bio-based applications of this alloy, it is critical to minimize the localized corrosion to maintain its mechanical strength and reduce pernicious side effects, such as hydrogen evolution, that may occur during the alloy service time.

The application of surface treatments able to form a protective layer, which can delay the direct contact between Mg alloys and the surrounding environment could be a way to control the fast degradation of the alloys.

In the present work, the influence of five different surface treatments on electrochemical corrosion behavior of Mg1Ca alloy was evaluated using MEM as the selected body medium. Conversion layers obtained by acid pickling using phosphoric (H_3PO_4), hydrofluoric (HF) and acetic (CH_3COOH) acids, as well as the chemical surface modification with hydroxyapatite (HAp), and growth of aluminium oxide (Al_2O_3) by atomic layer deposition (ALD) were investigated. The results revealed that HAp gives the most promising result in terms of corrosion resistance.

Reference

[1] Neves, C. S., Sousa, I., Freitas, M. A., Moreira, L., Costa, C., Teixeira, J. P., Fraga, S., Pinto, E., Almeida, A., Scharnagl, N., Zheludkevich, M. L., Ferreira, M. G. S., & Tedim, J. (2021). Insights into corrosion behaviour of uncoated Mg alloys for biomedical applications in different aqueous media. Journal of Materials Research and Technology, 13, 1908–1922. https://doi.org/10.1016/j.jmrt.2021.05.090