Mechanism and kinetics of hydroxyapatite nucleation on biodegradable Mg alloy

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The current metallic biomaterials such as stainless steels, Co-Cr alloys, and Ti-based alloys must be removed by a second surgical procedure after the tissue has healed sufficiently. Therefore, the development of biodegradable implants is one of the important areas in medical science. Magnesium and its alloys show many advantages over current metallic and non-metallic materials; their mechanical properties are similar to natural bone, and they are biocompatible and biodegradable in the physiological solutions.[1,2]

The biocompatibility and bioactivity of Mg alloy can be improved by coating the alloy surface with hydroxyapatite (HAp), which has been recognized as being osteoconductive and able to enhance ossteointegration.

The aim of this work was to study the kinetics of HAp nucleation/electrocrystallization on the Mg-alloys and to characterize the structural, morphological and barrier properties of the electrodeposited coating using SEM, FTIR, EDS, EIS and voltammetry methods.

The early stage of a new phase formation takes place as a 2D or 3D nucleation process.[3] The rate of electronucleation and the number of nuclei depend on the potential applied. Fig. 1 presents the potentiostatic transients recorded on Mg alloy in a solution containing $Ca(NO_3)_2$ and $NH_4H_2PO_4$.

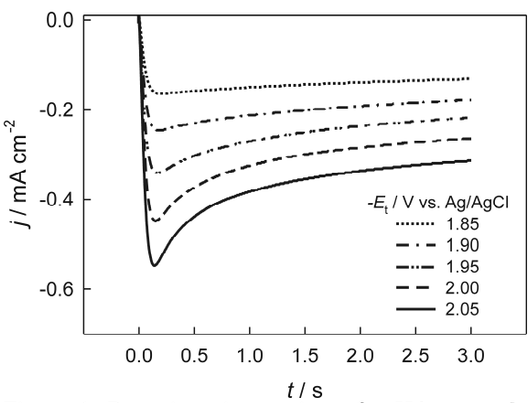

Figure 1. Potentiostatic transients for HAp recorded on Mg alloy

The current density maxima (j_m) and the corresponding times (t_m) were used to determine the mechanism of nucleation/crystallization and growth of the HAp film on the alloy surface. The analysis performed has shown that the process proceeds according the three-dimensional instantaneous nucleation.

Figure 2 presents the SEM image of a HAp film electrodeposited on Mg alloy at -2.0 V vs. Ag/AgCl. The HAp film shows porous and needle-like morphology.

Electrochemical/corrosion properties of the system:

Mg alloy | HAp coating | physiological solution

were investigated in situ. The discussion of the results obtained contributes to better understanding of crystallization, control of morphology, and chemical stability of biocompatible and bioactive coatings of calcium phosphate on biodegradable implants.

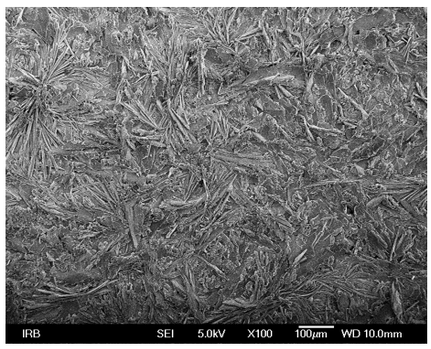

Figure 2. The SEM image of a HAp film electrodeposited on Mg alloy

References

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