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Abstract

Localized Corrosion Degradation of Bioresorbable Mg Alloys Promising for Medicine †

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Abstract: Magnesium is very light metal which possesses many useful properties, such as a high strength to weight ratio and good electrical and thermal conductivity. Magnesium and its alloys can be used in implant surgery as biodegradable materials. Taking into account the rapid degradation process of Mg alloys in chloride-containing solutions and the very complex composition of human body media, it is worthwhile to study the mechanism and kinetics of Mg alloy corrosion in solutions which closely resemble those of human body fluids. A comparative analysis of the corrosion activity of MA8 magnesium alloy (intended to be a bioresorbable material) in a medium for the cultivation of mammalian cells (minimum essential medium, MEM) and 0.83% NaCl solution was performed using the scanning vibrating electrode technique; local pH measurements; hydrogen evolution tests; and OCP, PDP, and EIS tests. Corrosion products formed on the alloy surface were characterized using XRD, SEM-EDX analysis and Raman spectroscopy. The hydrogen evolution rate was higher for samples in NaCl solution compared with MEM. The impedance modulus in the frequency range from 10^5 Hz down to 10^{-1} Hz for the sample immersed in MEM was higher than that for the sample immersed in NaCl. This indicates higher protective ability of the corrosion film formed in MEM compared to that formed during immersion in NaCl solution. Ca- and P-rich deposits were formed in the corrosion layer. The model of corrosion mechanism of MA8 magnesium alloy in MEM, which includes three stages of the development of corrosion product film, is hereby proposed. The corrosion product layer formation on the surface of the magnesium alloy sample in MEM), which included magnesium-substituted hydroxyapatite, stabilized the local pH below 9.0 and, along with the organic acids, did not allow the pH to increase during the corrosion of the Mg alloy. The obtained results indicate the prospect of using bioresorbable magnesium in implant surgery [1,2].

Keywords: magnesium alloy; degradation; in vitro studies; electrochemistry; corrosion rate

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