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Improving the Corrosion Resistance of Magnesium by Application of TiO_2-MgO Coatings

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Abstract : Magnesium is a biocompatible and biodegradable material that has gained increased interest for application in resorbable orthopedic implants. However, to date, much research is being conducted to overcome the main disadvantage: its low corrosion resistance. In this work, we report our findings on the development and application of TiO_2-MgO coatings to improve and modulate the corrosion resistance of magnesium pieces. The plasma electrolytic oxidation (PEO) technique was employed to obtain the TiO_2-MgO coatings. The effect of the experimental parameters on the modulation of the TiO_2:MgO ratio was investigated. The most critical parameters were the chemical composition of the precursor electrolytic solution and the current density. According to scanning electron microscopy (SEM) observations, the coatings were porous; however, they become more compact as the current density increases. XRD measurements showed that the coatings are formed by a composite consisting of TiO_2 and MgO oxides, whose ratio can be changed by the experimental conditions. TiO_2 had the anatase crystalline structure, while the MgO had the FCC crystalline structure. The corrosion resistance was evaluated through the corrosion current (Icorr) measured at room temperature by the polarization technique (Tafel). For doing it, Hank's solution was used in order to simulate the body fluids. Also, immersion tests were conducted. Tafel curves showed an improvement of the corrosion resistance at some coated magnesium pieces in contrast to control pieces (uncoated). Corrosion currents were lower, and the corrosion potential changed to positive values. It was observed that the experimental parameters allowed to modulate the protective capacity of the coatings by changing the TiO_2:MgO ratio. Coatings with a higher content of TiO_2 (measured by energy dispersive spectroscopy) showed higher corrosion resistance. Results showed that TiO_2-MgO coatings can be successfully applied to improve the corrosion resistance of Mg pieces in simulated body fluid; even more, the corrosion resistance can be tuned by changing the TiO_2:MgO ratio.

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