Characterization and corrosion behavior of TiO_2 thin films deposited onto Mg-based alloy for orthopedic applications

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Abstract:

Metallic biomaterials are widely used in medicine. However, the material used for biomedical applications shall comply with the following factors: biotolerance, corrosion resistance and mechanical properties [1]. Magnesium alloys have been recently investigated as potential candidates for orthopedic implants because of good mechanical properties [2]. Nevertheless, magnesium, as a major mineral in human body, is characterized by poor corrosion resistance. Therefore, various protective coatings are used to slow down the corrosion process [3].

The article presents the investigation results of a structure and properties of TiO_2 thin films (about 300 nm thick) deposited onto MgCa4Zn1Gd1 alloy using sol-gel and magnetron sputtering methods.

The structure observations of thin oxide films in scanning electron microscopy (SEM) are shown. The phase analysis was made with X-ray diffractometer. The structural studies were confirmed by Raman spectrometer. Moreover, roughness measurements in atomic force microscopy (AFM) are discussed. The results of corrosion resistance of TiO_2 films using the potentiodynamic and immersion tests are also presented.

The analysis of investigation results has shown that the surface of TiO_2 applied by magnetron sputtering is characterized by smaller and more uniform grains compared to the TiO_2 film deposited by sol-gel. The results of structural testing determined the structure of TiO_2 thin films as an anatase. The sol-gel coated film has slightly higher roughness parameters (Ra = 11.2 nm; RMS = 15.1 nm) compared to the layer applied using PVD (Ra = 7.1 nm; RMS = 9.2 nm). The immersion test results have shown that the alloy with TiO2 film applied by sol-gel is more corrosion resistant

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[1] S. Agarwal, J. Curtin, B. Duffy, S. Jaiswal, Biodegradable magnesium alloys for orthopaedic applications: A review on corrosion, biocompatibility and surface modifications, Mater. Sci. Eng. C 68 (2016) 948-963.

[2] M. Peron, J. Torgersen, F. Berto, Mg and its alloys for biomedical applications: exploring corrosion and its interplay with mechanical failure, Metals 7 (2017) 252.

[3] A. Kania, W. Pilarczyk, R. Babilas, Selected properties of ZnO coating on Mg-based alloy for biomedical application, Acta Phys. Pol. A 133 (2018) 222-224.

Key words:

TiO2 thin films, structure analysis, roughness measurements, electrochemical and immersion tests