

RESIDUAL STRESS ANALYSIS OF CERAMIC COATINGS ON BIOCOMPATIBLE MAGNESIUM ALLOYS

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Magnesium and its alloys have gained special interest in medical applications in recent years, as promising biodegradable metallic implant materials, due to their excellent mechanical properties and biocompatibilities. However, magnesium alloys rapidly corrode in human body. Therefore, a dense ceramic coating has been produced on the surface of the magnesium alloy through the method of microarc oxidation (MAO), which improves the corrosion resistance of the magnesium alloy. The objective of this study is to evaluate the residual stress of the ceramic coating on biocompatible AZ31 magnesium alloy. The corresponding residual stresses with different applied voltages have been examined in this study.

An integrated experimental and modeling approach has been employed. Residual stresses attributed to the MgO constituent of the coatings at oxidation voltages between 250 V to 350 V have been evaluated by X-ray diffraction (XRD) using $\sin^2\psi$ method. An analytic model is also used to compute the stress distributions in the coatings.

The residual stresses decreased with the increase of the applied voltage. The predicated stresses from the analytic model are in good agreement with the experimental measurements. At 350V, the coating has a uniform surface morphology and the lowest residual stress. This is the optimal voltage in the MAO process to produce the high-quality corrosion resistant coating. The measured stresses using $\sin^2\psi$ XRD method in the MgO constituent of the MAO coatings are tensile in nature. The voltage-dependent residual stress has been released during the microarc discharge process, which is attributed to the micro-pores and cracks formed in the coating.

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