MAGNESIUM BIODEGRADABLE IMPLANTS COATED WITH POLYLACTIC ACID

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Introduction

Magnesium alloys and polylactic acid polymer (PLA) coatings are optimum materials for biodegradable implants [1,2], but their combination is limited because of the low adhesion of PLA on Mg alloys. Plasma electrolytic oxidation (PEO) is a valuable surface modification technique for Mg alloys to promote adhesion of coatings, but limited studies have systematically evaluated this effect.

In the present report, dipping method has been used to deposit a PLA coating on AZ31 Mg alloy to tailor its corrosion properties. Furthermore, the surface of the alloy has been modified by PEO [3] to produce a porous coating on AZ31 Mg alloy as an intermediate layer to improve the adhesion strength between PLA layer and the magnesium alloy, and at the same time enhancing the properties of the PLA coating.

The influence of dipping parameters (number of layers, withdrawal speed and polymer concentration) in several properties of the coating (mass increment, thickness, roughness, adhesion and resistance polarization) has been evaluated by using the Taguchi design of experiment (DOE) method [4]. In addition, the effect of the PEO treatment has been evaluated for the different coating parameters. Finally, the corrosion behavior of the different systems was also studied.

Materials and Methods

AZ31 commercially available magnesium alloy was used as the base substrate and PLA was used as the coating material. PLA was dissolved in chloroform and coated on the samples using the dip-coating technique. PEO treatments were carried out using alternating current (AC) voltage. The large number of variables involved in dip coating processes, are reduced to a limited number of experiments by the Taguchi design of experiment (DOE) method. This methodology was used to analyze the influence of the dip coating conditions (number of layers, withdrawal speed and polymer concentration) in the main characteristics of the coatings (mass increment, thickness, rugosity, adhesion and resistance polarization). Every parameter was evaluated for three levels (different values), as we can see in TABLE 1:

TABLE 1. Manufacturing factors and values used for each

FACTORS	LEVEL 1	LEVEL 2	LEVEL 3
LAYERS	3	4	5
SPEED (cm/min)	8	35	75
CONCENTRATION (%w/w)	1.23	2.5	6

In terms of the coating, concentration of PLA in the dipping solution seems to be the most important parameter controlling the properties of the coatings.

The results show that PEO treatment did not increase the adhesion strength of the PLA coating, although the corrosion potential and polarization resistance were increased.

Results and Discussion

The potentiodynamic polarization curves of the samples are shown in FIG. 1 and the corresponding electrochemical data are listed in TABLE 2.

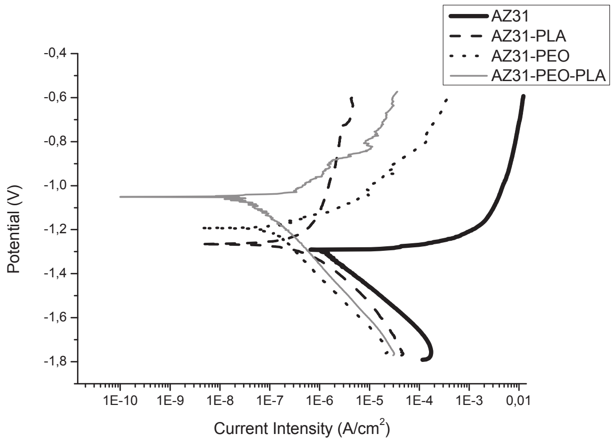

FIG. 1. Potentiodynamic polarization curves of the samples exposed to Hanks solution.

The corrosion potential value of double coated sample is higher than for single coated and uncoated Magnesium sample (FIG. 1). There is also a reduction in the corrosion current of the double-coated sample compared to uncoated Mg alloy (TABLE 2).

TABLE 2. Electrochemical data for the coated and uncoated samples.

	Potential (V)	Current Density
AZ31	-1.3232	1.48E-06
AZ31-PLA	-1.2643	2.38E-07
AZ31-PEO	-1.1897	9.27E-08
AZ31-PEO-PLA	-1.0928	5.96E-08

Conclusions

PEO treatment did not increase the adhesion strength of the PLA coating, although the corrosion potential and polarization resistance were increased. In terms of the coating, concentration of PLA in the dipping solution seems to be the most important parameter controlling the properties of the coatings.

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