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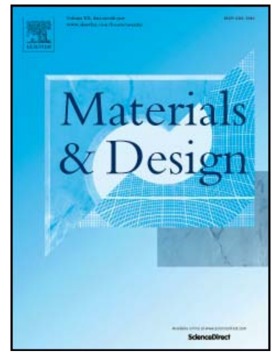

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A universal electrolyte for the plasma electrolytic oxidation of aluminum and magnesium alloys

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ABSTRACT

The plasma electrolytic oxidation (PEO) of aluminum and magnesium alloys is carried out in electrolytes which contain the same reactants, but in fundamentally different concentrations. In this research the possibility of the PEO of aluminum and magnesium alloys in a universal electrolyte is studied. The two most commonly encountered alloys, namely, aluminum alloy 5052 and magnesium alloy AZ91D, are chosen. The oxide layers obtained are studied using SEM, EDX, XRD, and a microhardness tester. The corrosion properties are determined using a potentiostat. The effect of variation of the silicate concentration in the electrolyte on the growth kinetics of the coating and its qualitative characteristics is discussed. It is shown that at $Na_2SiO_3{\cdot}5H_2O$ concentrations in the electrolyte ranging from 3.2 to 32 g l^{-1}, the rate of growth of the oxide layer increases from 15 to 55 µm h^{-1} with significant variation of the phase composition of the coating. The greatest hardness of an oxide ceramic layer was obtained in the outer sublayer on the magnesium alloys (874.7 HV_{10}) and in the inner sublayer on the aluminum alloys (1123 HV_{10}). The most favorable combination of physical and chemical properties for both alloys is obtained in an electrolyte containing 12.72 g l^{-1} $Na_2SiO_3{\cdot}5H_2O$.

Keywords:

Plasma electrolytic oxidation; universal electrolyte; surface treatment; aluminum; magnesium

1. Introduction

Plasma electrolytic oxidation (PEO) is an electrolytic process (similar to anodizing), but the use of a nontoxic, weakly alkaline electrolyte and a high voltage promotes the formation of millions of microscopic discharges with a very short lifetime. They melt and modify the growing oxide layer, changing its structure and making it harder and denser [1].

Different electrolytes and electrical regimes for the PEO treatment of aluminum [2], magnesium [3], titanium [4], and several other alloys [5] can be used to produce hard corrosion-resistant coatings [6]. The most popular, currently existing basic silicate electrolytes offer the creation of an oxide ceramic layer only for aluminum alloys [2, 7-12] or only for magnesium alloys [13-18]. The fundamental difference between these electrolytes is that the electrolytes intended for the oxidation of magnesium alloys contain an increased amount of alkali (up to 10 g l^{-1} of alkali or much higher: 4 g l^{-1} KOH [19-