

論文内容要旨

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学位論文題目	STUDY ON PLASMA EMISSION BEHAVIOR DURING PLASMA ELECTROLYTIC OXIDATION (PEO) ON MAGNESIUM ALLOY (マグネシウム合金のプラズマ酸化処理におけるプラズマ発光特性に関する研究)		
内容要旨			
<p>The high sensitivity of magnesium weakens the corrosion and wear resistance of this metal and its alloys, especially in corrosion media. The protection of magnesium and its alloys from corrosion is a significant concern in a real application. A great effort has been made in the last few decades to solve this problem. The proper surface treatment can improve corrosion and wear resistance of magnesium and its alloys. Various types of surface coatings have been developed to provide corrosion protection, among which plasma electrolytic oxidation (PEO) is one of the most promising techniques. The PEO treatment can produce a hard ceramic-like oxide coating on magnesium and its alloys, leading to significantly enhanced wear and corrosion resistance. However, the intrinsic porous morphology of the PEO coatings still limits their effect of corrosion protection. The plasma during the PEO coating formation responsible for these microstructural drawbacks. Controlling the plasma during the process can improve the formed coating quality.</p> <p>The objective of this study is to overcome these microstructural drawbacks and further improve the quality of PEO coatings. Therefore, the time-dependent plasma behavior was studied in terms of emission intensity and plasma temperature. The bipolar current pulse mode was applied to the sample to form a zirconia oxide coating on AZ91D Mg-alloy by the PEO process. The plasma emission and output anodic voltage were investigated by changing the ON / OFF timing of bipolar pulse current cycle and the ratio of anodic to cathodic current at the same frequency and duty ratio. The spatial and time resolved measurement approach was adopted to</p>			

study the time dependent plasma emission behavior during the PEO process. The plasma emission during the PEO process was monitored using Intensified Charged Coupled Device (ICCD) camera concerning time. The measured spatially resolved and time resolved emission during anodic pulse was characterized using Optical Emission Spectroscopy (OES) and further plasma temperature throughout the PEO process. The time averaged and time resolved with spatially resolved plasma emission was also monitored using photodetector during anodic pulse throughout the PEO process. The plasma images were also used to study plasma emission behavior during the PEO process.

It was found that changes in the ON / OFF timing of bipolar pulse current effect on plasma stability and variation in output anodic voltage. Change in the current ratio (anodic to cathodic) at the same frequency and duty ratio effect on the appearance of plasma spark during the PEO process. The current ratio of greater than 1 shows the continuous increase and then stabilization in emission intensity with a gradual increase in voltage throughout the PEO process. In contrast, the current ratio of less than 1, a sudden drop in plasma emission intensity with voltage, was found during the process. Therefore, the PEO process can be divided into two regimes, 'arc regime' and 'soft regime' before and after voltage drop, respectively. Results of measured emission spectra using ICCD camera shows that arc regime has atomic or ionic excitation. However, the soft regime does not have atomic or ionic excitation during the PEO process. The plasma temperature in the arc regime was found varying in the range of 4200 K to 6400 K, which was calculated using the relative emission intensity of Na-I optical lines. However, the plasma temperature in the soft regime could not be calculated because of no atomic or ionic excitation during the process. The emission due to collision radiative recombination in arc regime was found after 130 μ s of anodic pulse time in emission spectra during the PEO process. The emission intensity and the plasma temperature show stable behavior until 130 μ s of anodic pulse time and 1800 s of the PEO process time and increase with time.

Therefore, it can be said that high-intensity plasma discharges, which are responsible for microstructural drawbacks in the formed coating, observed after anodic pulse 130 μ s and processing time of 1800 s. It is demonstrated that the growth of the porous layer during the PEO process can be controlled by controlling these timings, which is benefit for the protective oxide coating on the sample. Therefore, the PEO process can be controlled by regulating; the anodic to cathodic current ratio, the ON / OFF timing of bipolar current pulse, and the PEO process time to improve the performance of the alloy.