

INVESTIGATION ON FATIGUE PROPERTIES OF ALUMINUM ALLOYS AA5083 COATED BY THE MEANS OF MICRO ARC OXIDATION PROCESS

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Abstract

The need and usage of aluminum alloys are becoming increasingly important every passing day. That is why improving the properties of the aluminum and its alloys are one of the most common topics for engineers studying on materials. By the means of spark treatment coating method also known as micro arc oxidation, improving the properties of these alloys become possible.

In this paper, AA5083 aluminum alloys are used as specimens, firstly the specimens are coated with micro arc oxidation for different times to gain 30, 60 and 90µm thicknesses respectively with constant voltage value. After the coating, the fatigue properties are investigated on the specimens with fatigue tests and the results are presented with graphics and tables.

Keywords: Oxidation, micro-arc, micro-arc discharge Oxidation, seramic coating, fatigue test, AA5083.

INTRODUCTION

For technical and economical considerations, it is certain that recent industrial plants are preferring lighter, more durable, recyclable, and easy replaceable materials. Because of that reasons, aluminum and its alloys are seem to be one of the most preferred materials but their poor surface hardness and wear resistance are reducing the lifetime of the components that are limits its use in applications [1].

Previous coating treatments on aluminum and its alloys such as detonation spray coating, anodizing, cold spray coating, diamond-like carbon coating, plasma spray coating, pulsed electrodeposition and thermal spraying have suffered from the low load support from the underlying material and insufficient adhesion more and more these methods are harder and more expensive to perform. Also some coated aluminum alloys can achieve high surface hardness but when it comes to practice they often show poor performance under mechanical loading [2].

On the other hand, by the means of MAO process which is also known as plasma electrolytic oxidation, spark anodisation or microarc discharge oxidation, with the combination of electrochemical oxidation and high voltage spark treatment, the engineering

equipments which has excellent adhesive strength, friction, corrosion, wear, electrical and thermal properties are obtained moreover it is easy and cheaper to perform and shortens the time required for the coating [3].

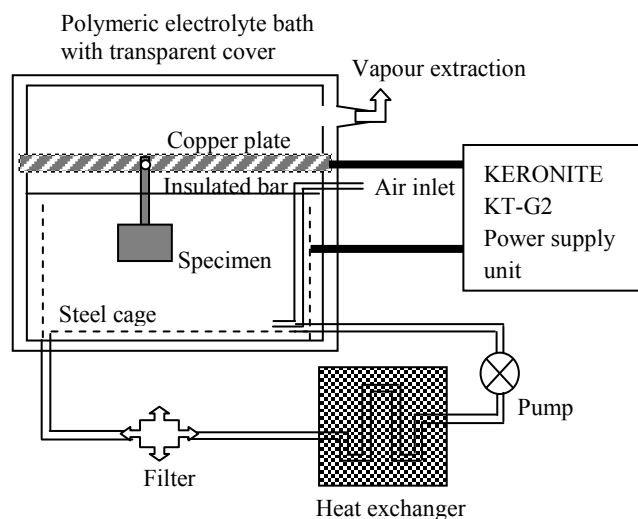


Fig. 1. MAO Process[4].

In this study, by the sections below the process of the MAO, the materials that are shaped as fatigue specimens and these specimens are coated by the means of MAO process with different coating thicknesses with the help of different time interval spark treatments.

EXPOSITION

Thick hard oxide coatings are fabricated on aluminum alloys by these process. The process uses aqueous electrolytic solution consisting salts that are dissolved in reservoir and with the help of high voltage spark treatment these dissolved salts are incorporated into resulting alumina coatings become thick, hard oxide ceramic coatings. Processing unit requires an insulation bar and copper plate for holding the specimen. The reservoir usually happens to be a steel cage and polymeric electrolyte bath with transparent cover supported with a filter pump and a heat exchanger. The required electrical energy for the spark treatment comes from a 20 kW -2lab- scale Keronite generator.



Fig. 2. MAO Unit

In figure 2, a 20 kW -2 lab-scale MAO unit is shown. Generally, These equipments have a 25 liters electrolyte bath containing a micro bubble generator. The processing unit operates at 50 Hz constant frequency with maximum power output of 20 kW. It applies anodic voltages up to 200 V in order to maintain a constant current density during MAO treatment.

In this method, the metal used as anode is put into an alkaline electrolytes and the dielectric breakdown happens to be by the initiation of discharges with the help of which the microarching voltage is reached. After this, the oxide film coating the specimens occur. During MAO treatment, the electrolyte is pumped through a filter and subsequently a heat exchanger then introduced into the

process chamber with micro bubbles oxygenating the electrolyte effectively. The oxide film proceeds via substrate metal oxidation and contribution of electrolyte additives such as phosphates and silicates into the coating structure. By other means, when high voltage is applied to the anode in an electrolytic solution, an oxide layer occurs. This is anodic oxidation. When the critical voltage degree is exceeded which is called dielectric breakdown, micro arcs starts to occur and this is called micro arc oxidation.

EXPERIMENTAL PROCEDURE

The chemical composition of the AA5083 aluminum alloy is given in Table 1.

Chemical composition of the AA5083 used in experiments.

Mg(%)	Mn(%)
4,5	0,7

Table 1.

The AA5083 aluminum specimens were cut from long bar and machined to 10 mm. diameter and 55 mm. in length and the center part of the specimens are machined to 5 mm. diameter, as shown in figure 3.

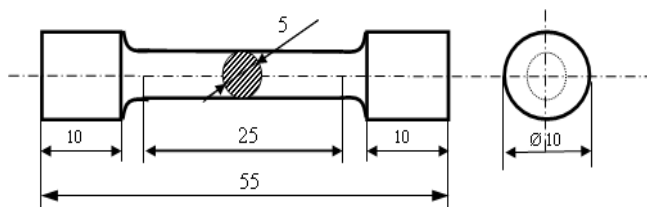


Fig. 3. The shape of aluminium specimens for coating and fatigue tests (AA5083)

The micro arc process were performed using a 20 kw Keronite Generation-2 lab-scale Plasma Electrolytic Oxidation unit. The equipment has a 25 liters electrolyte bath containing a microbubble generator. The processing unit operates at 50 Hz constant frequency with a maximum power output of 20 kW. It applies anodic voltages up to 200 V in order to maintain a constant current density during PEO treatment. The treatment of the specimens are made for 30, 60 and 90 μ m thicknesses with different time intervals respectively [5-6].

The fatigue tests were applied on the specimens 50 kN capacity testing machine (Instron 8051). The machine used for fatigue tests is shown in figure 4. Testing were undertaken at room temperature with no further atmospheric controls at a frequency of 25 Hz. The tensile tests were performed on the basic specimen with Instron 8051 having a frequency range of 0.5-100 Hz. Maximum tensile strength of AA5083 was found as 297,7 MPa.



Fig. 4. Instron 8051

EXPERIMENTAL RESULTS

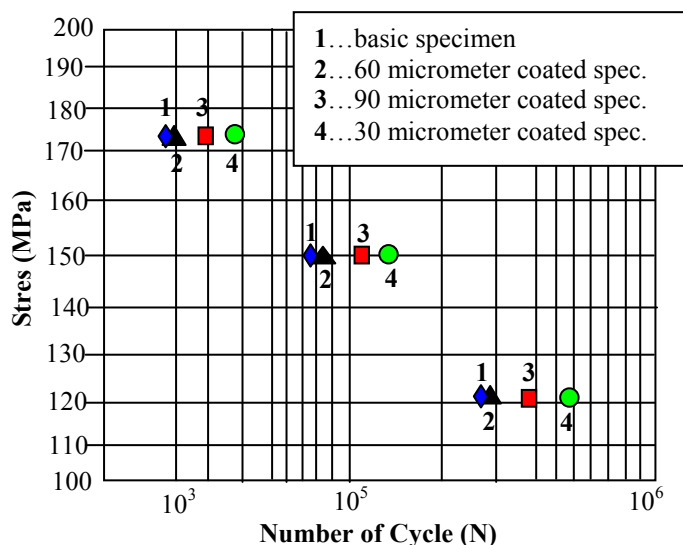


Fig. 5. Fatigue tests results of the specimens

The coating thicknesses and fatigue tests results are shown in figure 5.

From the figure 5., it can easily be seen that because of the increase of hardness in micro arc oxidation process it requires more cycles to make deformation on the coated specimens than the basic specimens. It also gives us information that coating thickness has a positive effect on fatigue in minor thicknesses and high thicknesses but has a negative effect on middle thicknesses.

CONCLUSION

The fatigue tests show that the specimens coated by the means of micro arc oxidation coating process has better fatigue results than the original specimens. These results proves that when optimized, the process of micro arc oxidation increases the fatigue as well as the surface quality and hardness.

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