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TAGUCHI METHOD PREDICTION OF EDM DIE-SINKING PARAMETERS ON SURFACE INTEGRITY FOR ALUMINIUM COMPOSITE USING COPPER ELECTRODE

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ABSTRACT :*This paper investigates the performance of copper electrode on the surface integrity of aluminium alloy LM6 (Al-Sil2) in the electrical discharge machine (EDM) die sinking.The relationship between the machining parameters which is pulse-on time, pulse-off time, peak current and voltage on surface integrity has been investigated. Copper tool of diameter 10mm was chosen as an electrode. Scanning electrone microscope (SEM) was used to observe the microstructure of LM6 after machining process and the average of recast layer (RL). It was found that the current and pulse on time significantly affected the recast layer, while the pulse off time and voltage are the less significant factor that affected the responses. Result shows that increasing the pulse on time, increases the recast layer. Thus, it shows that copper have the capability to cut aluminium alloy LM6 using EDM die sinking.*

KEYWORDS: EDM Die-Sinking, Aluminium alloy LM6, Recast Layer, Surface Integrity

1.0 INTRODUCTION

Electrical discharge machine (EDM) die-sinking is one of the best alternative process for machining high strength and good resistance material which is usually found in the application in mold industries [1]. EDM machining utilizes rapid, repetitive spark discharges from a pulsating direct-current power supply between the workpiece and electrode submerged into the dielectric fluid. Due to high temperature of the sparks generated, leads to intense heat conditions on the workpiece cause melting and vaporising of workpiece material. Electrode material is also melted and vaporised due to the high temperature of the spark [2,3]. A special advantage of EDM, where conventional machining cannot offer is a material removed without mechanical contact between the electrode and the work piece. As the result, mechanical stresses and vibration problems during machining can be eliminated [4,5].

It is known that LM6, which is aluminium containing 12% silicon has good resistance to corrosion and excellent cast ability. It is widely used in many fabrication devices due to its characteristics properties, such as the applications for motor housings, manifolds, marine components and pumping cases. Further, LM6 is also appropriate when castings sometimes require to be welded [6,7]. Aluminium LM6 castings have excellent resistance to corrosion in marine environments, possess excellent ductility, but it is of medium strength and is not heat treated. Its strength falls off rapidly at high temperatures. Its elastic limit is low and it is fairly difficult to machine. Some researchers have performed aluminium alloy LM6 as the main workpiece by using copper tungsten [8] and graphite [9] as their electrode, and they found a good result in term of material removal and surface roughness.

Furthermore, at the end of each discharge, the remaining in the crater is re-solidified, which is called the recast layer or white layer. Besides, this layer is softer than the underlying base material. Since the quality of the EDM surface machine is becoming more important lately, to fulfil the high requirement of component performance, the selection of machining parameters is required to get the result of minimum thickness of the recast layer. Thus, this study is to define the interaction between machine process parameters with the surface integrity.

2.0 EXPERIMENTAL

This project used EDM die-sinking Sodick AQ35L series. The metal matrix material used was aluminium having reinforced agents of 12% silicon, which is known as aluminium LM6. The dielectric fluid used in this project was Kerosene. Further, the selected factors for maching parameters have three levels as shown in Table 1.

In this project, the input parameters, such as the peak current, voltage, pulse on time, and pulse of time with low, medium and high of three levels were selected. Orthogonal array design using Taguchi method having 9 runs with three factors and three levels were investigated. The three repetitions of every run had been done with a total of preparing sample of 27 runs.The analysis of surface integrity was done by using a scanning electron microscope (SEM). The length of the recast layer was measured and the average was calculated for every sample

3.0 RESULT AND DISCUSSION

Table 1: Factors and levels for the experiment

Factors	Input Parameters	Level		
		Low (-1)	Medium (0)	High (+1)
A	Peak Current (A)	2	15	30
B	Voltage (V)	21	25	30
C	Pulse on Time (µs)	1	200	400
D	Pulse off Time (µs)	1	5	9

Table 2: Results of experimental material of recast layer (RL)

Run sample	Current (A)	Voltage (V)	Pulse on time (µs)	Pulse off time (µs)	Avrg RL (µm)
1	2	21	1	1	14.44
2	2	25	200	5	16.02
3	2	30	400	9	19.63
4	15	21	200	9	15.38
5	15	25	400	1	19.90
6	15	30	1	5	15.05
7	30	21	400	5	21.97
8	30	25	1	9	14.96
9	30	30	200	1	19.51

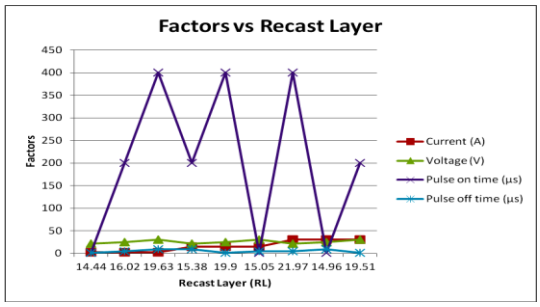

Figure 1: Graph on factors against average of recast layer

An explanation of the result analysis is described by the observation and calculated length of the recast layer. The correlation between machining characteristic and pulse on time in machining aluminium alloy LM6 is shown in Table 2. The average of recast layer for every sample after the analysis using SEM is show in Table 3.

Table 2 shows the experimental result of recast layer. It can be stated that at low pulse on time, 1µs with low current, 2A results in a low average of recast layer. It can be obviously seen on the setting of high pulse on time, 400µs and high current, 30A gets a high average of recast layer. It also performed in Figure 1 that shows the interaction between all the factors with average of recast layer. Pulse on time shows the obvious plot interaction compare with others factors. It can be showed that pulse on time is the main factors that affected the average of recast layer.

Table 3 shows the cross-sectional view of the recast layer of aluminium alloy LM6 with 1.0K magnification with different setting of machine parameters. It was found that average of recast layer increase with increase of pulse on time. This is due to the long pulse duration causes plasma channel to expand and this expansion causes less energy density on the workpiece, which is insufficient to melt and vaporise the workpiece material, which ultimately results in thick white layer or recast layer [9,10,11]. Basically, the recast layer is formed when the current melt the workpiece material and the molten material are not flushed away by the dielectric. Moreover, the amount of the molten metal depends on the plasma flushing efficiency (%PFE). Obviously the %PFE is dependent on the discharge energy and pressure of the gap. Depending of these, plasma flushing efficiency decrease as pulse on time increase. As a result, the ability of plasma channel for ejecting the molten material from the molten puddle decrease [11].

4.0 CONCLUSION

The effect of EDM die sinking parameters on surface integrity for aluminum composite using copper electrode was investigated. Length of recast layer from the peak until the bottom was measure and the average was calculated. It can be concluded that pulse on time and peak current are the significant factors that can affect the recast layer. Other factors, the voltage and pulse off time just show less affected to the responses i.e, recast layer. Thus, it shows that increasing the pulse on time will increase the recast layer thickness.

5.0 ACKNOWLEDGEMENTS

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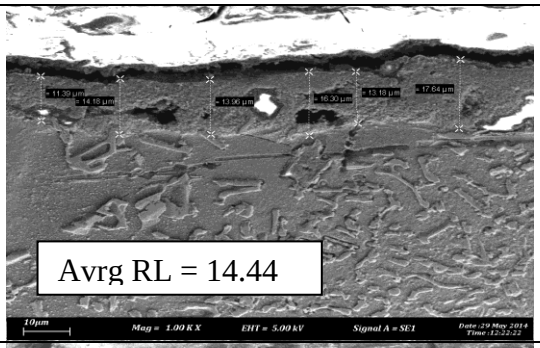
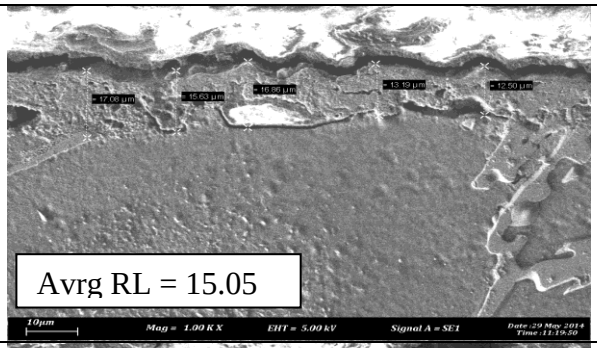
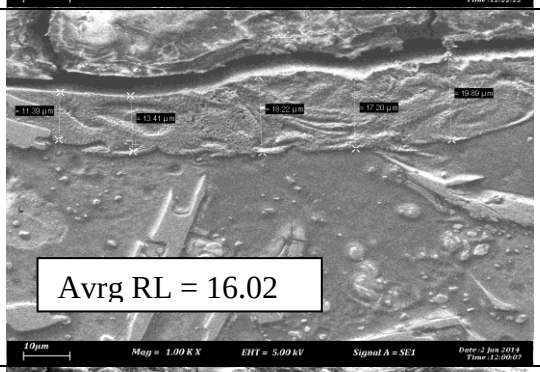
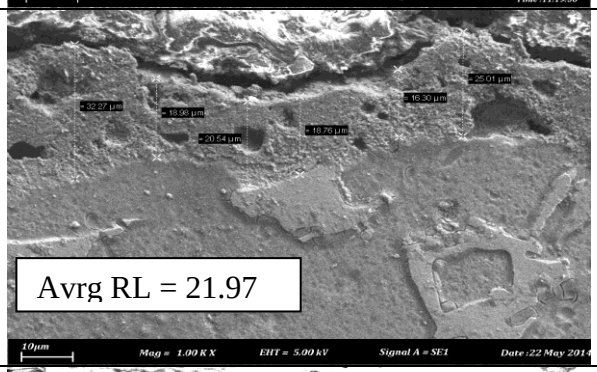
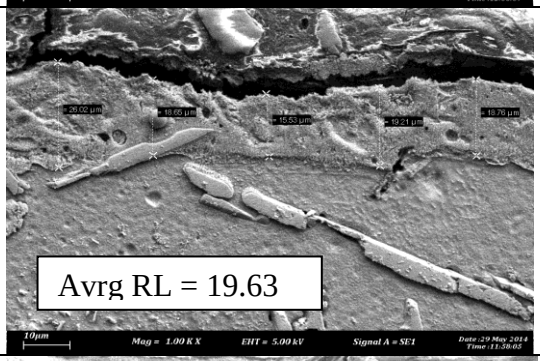
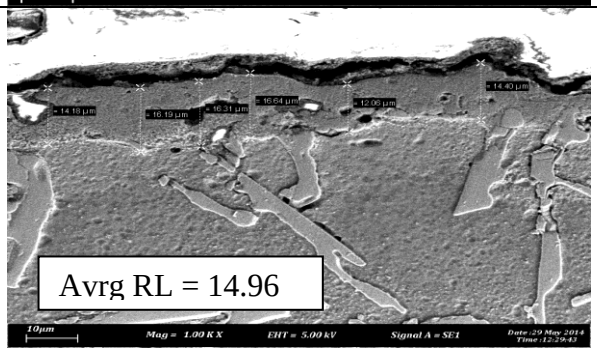
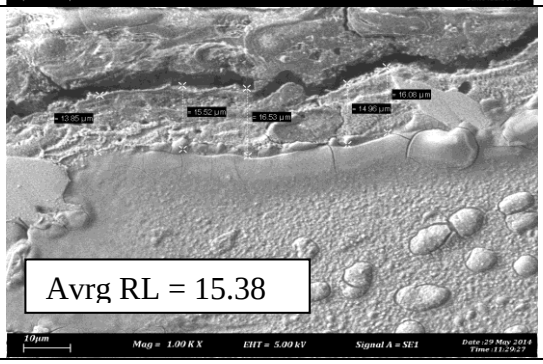
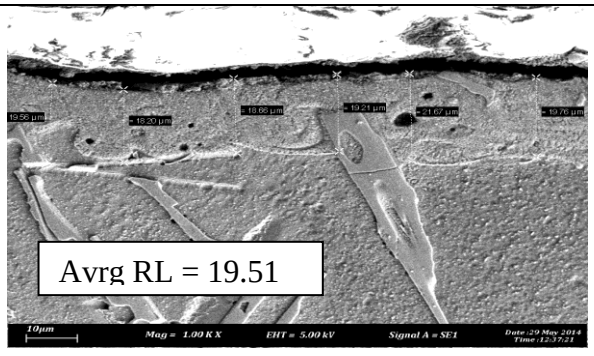
1.		6.	
2.		7.	
3.		8.	
4.		9.	

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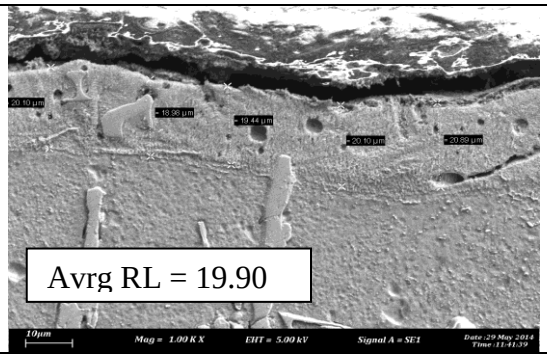

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