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Experimental Analysis on Surface Roughness and Tool Wear Rate during Machining of Fabricated Al/SiC$_p$ MMC Using Electric Discharge Machining Process

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ABSTRACT: The novel manufacturing techniques enables to design and fabricate new materials which are better in strength and other mechanical properties. The machining of these kinds of materials also provides a wide area to explore the proper parametric combinations for surface roughness and tool wear rate. Electric discharge machining process is one of the most widely used machining techniques of the present arena which enables to machine electrically conductive materials. The present composite is fabricated using SiC as reinforcement and aluminum as matrix. In the present paper, EDM is used to check the quality of surface and state of tool during machining of composite. The results shows that Ra was found best at parametric combination of $A_1B_3C_2D_2$ and less tool wear was reported at parametric combination.

I. INTRODUCTION

In the EDM process, the metal is eliminating from the work piece due to erosion case by quickly recurrent spark discharge taking place between the tool and work piece. Both tool and work piece are immersed in a dielectric fluid. Deionized water is very common kind of liquid dielectric while vaporous dielectrics are also used in certain cases. The tool is ended cathode and work piece is anode. Once the voltage across the gap becomes adequately high it releases through the gap in the form of the spark in interval of from 10 of micro seconds. And positive ions and electrons are accelerated, producing a discharge channel that becomes conductive. It is fair at this point when the spark fences initiating collisions between ions and electrons and making a passage of plasma. During Electric Discharge Machining process several material loadings take place on the workpiece surface within the processing zone. To model the comprehensive material removal and its effects on the resulting material properties especially in the rim zone and on surface integrity it is necessary to describe these loadings on several length scales in detail [1]. Due to an inefficient removal of debris when increasing hole depth, a new strategy based on the use of helical-shaped electrodes has been proposed [2]. Dhar and Purohit [3] evaluates the effect of current (c), pulse-on time (p) and air gap voltage (v) on MRR, TWR, ROC of EDM with Al–4Cu–6Si alloy–10 wt. % SiC_Pcomposites. This experiment can be using the PS LEADER ZNC EDM machine and a cylindrical brass electrode of 30 mm diameter. The MRR was found to decrease with an increase in the percent volume of SiC, whereas the TWR and the surface roughness increase with an increase in the volume of SiC [4]. Composite electrode is found to be more sensitive to peak current and Pulse on time than conventional electrode [5]. The MRR increased with increased in discharge current and specific current it decreased with increasing in pulse duration. Increasing the speed of the rotation electrode resulted in a positive effect with MRR, TWR and better SR than stationary [6]. During the experiment MRR increases with peak current MRR initially increased to a peak at around 100 µs, and then decreases [7]. J. Simao et al [8] was developed the surface modification using by EDM, details are given of operations involving powder metallurgy (PM) tool electrodes and the use of powders suspended in the dielectric fluid, typically aluminum, nickel, titanium, etc. experimental results are presented on the surface alloying of AISI H13 hot work tool steel during a die sink operation using partially sintered WC / Co electrodes operating in a hydrocarbon oil dielectric.

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II. FABRICATION OF MMC

The material for the experimentation i.e. MMC was fabricated using aluminum as a matrix and SiC as reinforcement. The SiC particles were of 63 micron size and were used as 10% by weight. To fabricate the composite, molten aluminum metal was mixed with the SiC particles by means of mechanical stirring. The mixture was cast with the help of traditional casting method at a temperature of near about 750ºC as shown in figure 1.

Figure 1Fabrication of MMC

III. EXPERIMENTAL ANALYSIS

The experiments were performed on the EDM to evaluate the surface roughness and tool wear rate of the Al/SiC$_p$ metal matrix composite

Table 1 Tool Wear Rate

S.no	TWR 1	TWR2	TWR3	Average TWR	S/N
1	0.0005	0.0005	0.0005	0.0005	66.0206
2	0.002	0.004	0.002	0.002667	51.4795
3	0.0025	0.0025	0.005	0.003333	49.5433
4	0.003333	0.005	0.003333	0.003889	48.2032
5	0.001	0.000909	0.001	0.00097	60.2646
6	0.001667	0.001667	0.001667	0.001667	55.5613
7	0.005	0.005	0.005	0.005	46.0206
8	0.004	0.004	0.004	0.004	47.9588
9	0.005	0.005	0.005	0.005	46.0206

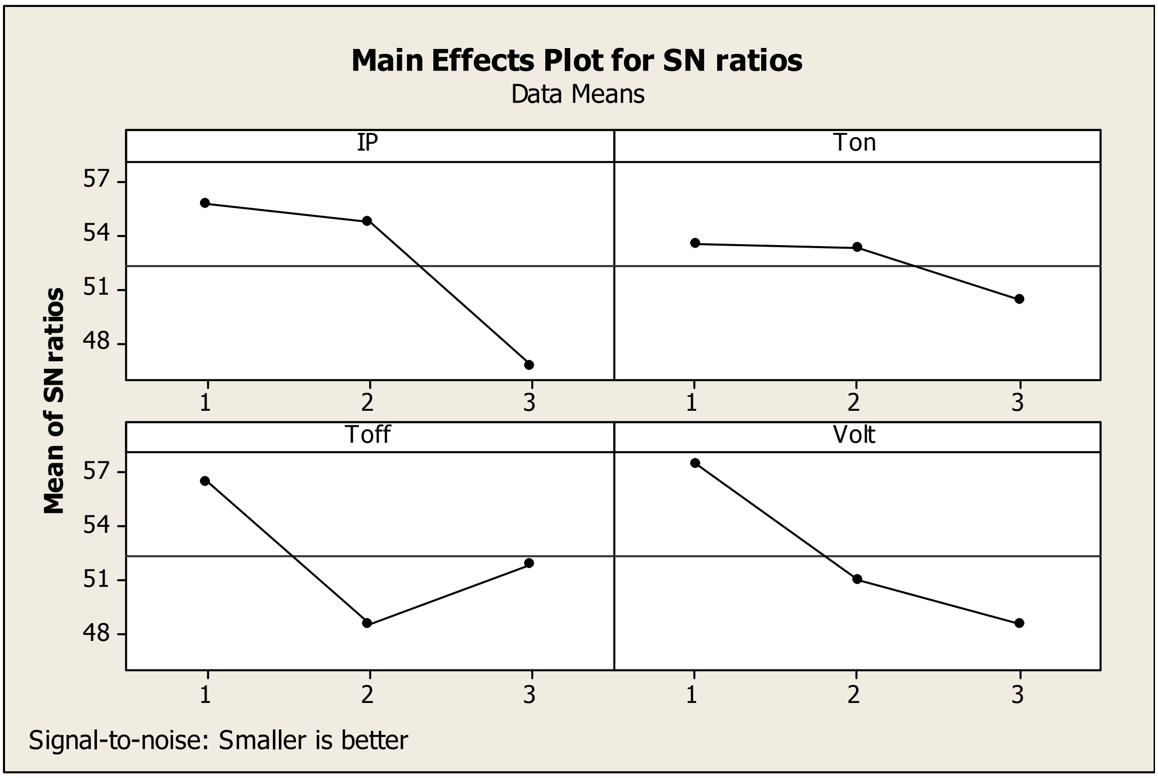

Figure 2 S/N ratio for Tool Wear Rate

Mathematical model for TWR = -0.000691919 - 0.00371633 IP - 0.00264226 Ton + 0.005617 Toff + 0.00144192 Volt + 0.00124158 IP*Ip + 0.000686027 Ton*Ton - 0.00127357Toff*Toff - 0.000162458 Volt*Volt

Table 2 ANOVA for TWR

Source	DF	Seq SS	Adj SS	Adj MS	F	P
IP	2	0.0000374	0.0000374	0.0000187	38.70	0.000
Ton	2	0.0000030	0.0000030	0.0000015	3.12	0.069
Toff	2	0.0000147	0.0000147	0.0000073	15.17	0.000
Volt	2	0.0000115	0.0000115	0.0000057	11.86	0.001
Error	18	0.0000087	0.0000087	0.0000005		
Total	26	0.0000752				

S = 0.000694850 R-Sq = 88.44% R-Sq(adj) = 83.30%

Table 3 Surface Roughness

S.no	Ra1	Ra2	Ra3	Average Ra	S/N Ratio, η (dB)
1	1.7359	1.7601	1.7308	1.742267	-4.82229
2	1.96053	2.0478	2.0031	2.00381	-6.03713
3	2.0296	1.9753	1.9861	1.997	-6.00756
4	1.999	2.0111	1.9177	1.975933	-5.91544
5	1.8161	2.1938	1.8549	1.87531	-5.46146
6	1.8188	1.7619	1.7706	1.783767	-5.02676
7	1.975	1.963	1.9894	1.9758	-5.91486
8	1.9233	1.8614	1.8243	1.869667	-5.43529
9	1.0849	1.9142	1.9505	1.9493	-5.79757

Mathematical Model for Ra = 1.33767 - 0.169934 IP + 0.0550156 Ton + 0.484919 Toff + 0.124138 Volt +0.0446372 IP*Ip - 0.0122511 Ton*Ton - 0.102379 Toff*Toff - 0.0195461 Volt*Volt

Summary of Model

S = 0.0414909 R-Sq = 87.67% R-Sq(adj) = 82.19%PRESS = 0.0697204 R-Sq(pred) = 72.26%

Table 4 Analysis of Variance for Ra

Source	DF	Seq SS	Adj SS	Adj MS	F	P
IP	2	0.013291	0.013291	0.006645	3.86	0.040
Ton	2	0.001551	0.001551	0.000775	0.45	0.644
Toff2		0.165227	0.165227	0.082613	47.99	0.000
Volt	2	0.040304	0.040304	0.020152	11.71	0.001
Error	18	0.030987	0.030987	0.001721		
Total	26	0.251359				

S = 0.0414909 R-Sq = 87.67% R-Sq(adj) = 82.19%

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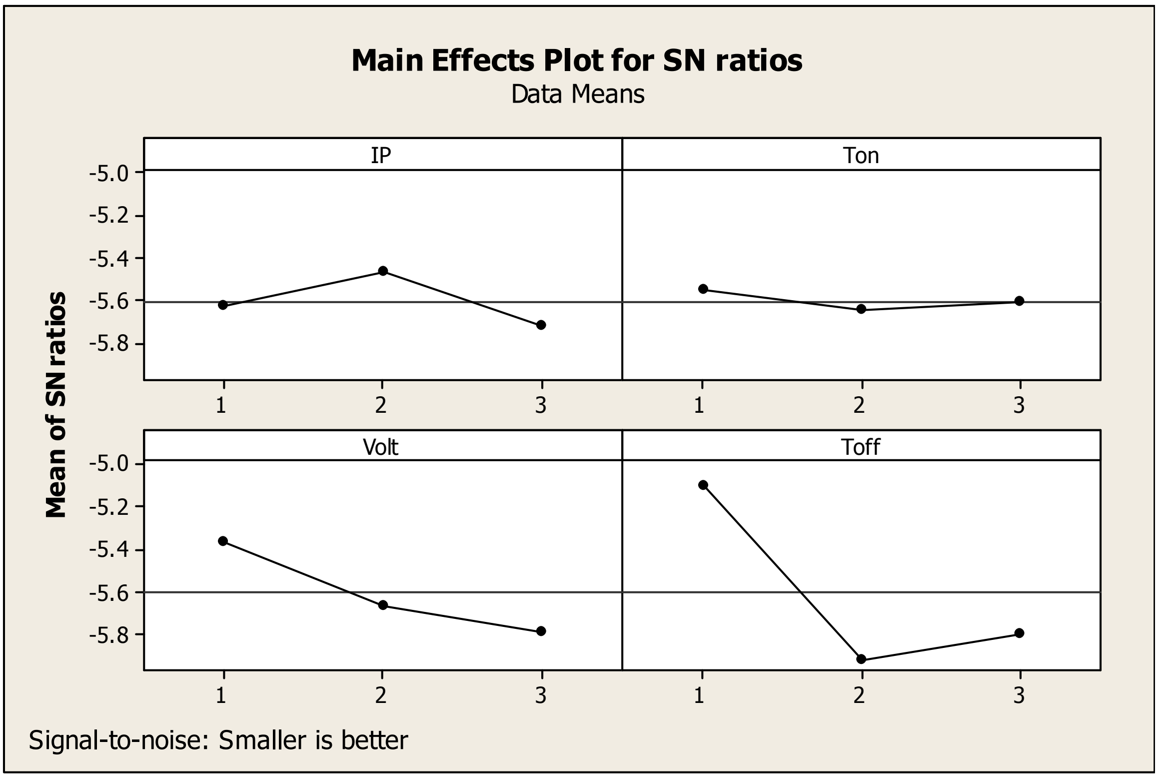

Figure 3 S/NRatio for Surface Roughness

IV. CONCLUSION

This study concerns the fabrication and experimental investigation of SiC_p assisted metal matrix composite. The conclusions obtained from this investigation are as follow:

- The fabrication of Al/SiC_p was successfully completed using mechanical stir casting process.
- The composite was successfully machined using electrical discharge machining process and the best parametric combination for the smaller tool wear rate was found to be current =10A,Ton= 4 µs, volt=50V and Toff at 30 µs.
- The composite was successfully machined using electrical discharge machining process and lesser surface roughness was found at best parametric combination of current =12A,Ton= 4 µs, volt=50V and Toff at 30 µs.
- From the analysis of variance it was found that for Tool wear rate Current and pulse of time are the most significant factors.
- From the analysis of variance it was found that for Tool wear rate Current and pulse of time are the most significant factors.
- For Roughness analysis of variance is carried out and it was found that Voltage and pulse off time are the most significant parameters.
- Mathematical regression models were obtained from experimental data for both Tool wear rate and Surface roughness with R^2 value 88.44% and 87.67% respectively.

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REFERENCES

1. Fritz Klocke, Sebastian Schneider, Simon Harst, David Welling, Andreas Klink, Energy-based approaches for multi-scale modelling of material loadings during Electric Discharge Machining (EDM), Procedia CIRP 31 (2015) 191 – 196
2. Soraya Plaza, Jose A. Sanchez, Endika Perez, Ruben Gil, Borja Izquierdo, Naiara Ortega, Pombo, Experimental study on micro EDM-drilling of Ti6Al4V using helical electrode, Precision Engineering 38 (2014) 821–827
3. S. Leptidis, .G. Papageorgiou, C.Medrea, I. Chicinaş, Failure analysis of an EDM machined mold-printing die used for the production of truck spare parts, Engineering Failure Analysis xxx (2015) xxx–xxx
4. JianyangWu, MingZhou, XiaoyiXu, JianweiYang, XiangweiZeng, DonghuiXu, "Fast and stable electrical discharge machining (EDM)" Mechanical Systems and Signal Processing 72 73(2016) 420–431
5. Dhar, s., Purohit, r., Saini, n., Sharma, a. and Kumar, G.H., 2007. Mathematical modeling of electric discharge machining of cast Al-4Cu-6Si alloy-10 wt.% sicp composites. Journal of Materials Processing Technology, 193(1-3), 24-29.
6. Karthikeyan R, Lakshmi Narayanan, P.R. and Naagarazan, R.S., 1999. Mathematical modeling for electric discharge machining of aluminium-silicon carbide particulate composites. Journal of Materials Processing Technology, 87(1-3), 59-63.
7. El-Taweel, T.A., 2009. Multi-response optimization of EDM with Al-Cu-Si-tic P/M composite electrode. International Journal of Advanced Manufacturing Technology, 44(1-2), 100-113.
8. Mohan, B., Rajadurai, A. and Satyanarayana, K.G., 2002. Effect of sic and rotation of electrode on electric discharge machining of Al-sic composite. Journal of Materials Processing Technology, 124(3), 297-304.