Machining of Aluminum metal matrix composites in wire cut EDM an Analysis

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ABSTRACT

The composite materials are widely used in many industries and are very difficult to machine the metal matrix composite by conventional machining methods. Hence unconventional machining techniques are used to machine the materials. Wire Electrical discharge machining (WEDM) gives larger capability for cutting complex shapes with high precision for composite materials. In this present work, the effect of a process parameter of Wire Electrical discharge machinings such as Voltage, Pulse on-time, pulse-off time and current were studied for the reinforced metal matrix composite composites. Aluminum 7075 reinforced with Silicon carbide are fabricated using stir casting process and machining was done in WEDM using the design of experiments approach. The material removal rate for the different set of experiments was studied. The influence of weight fraction of reinforcement on metal removal rate was discussed.

Keywords: Surface roughness, Material removal rate, Wire electrical discharge machining

1. INTRODUCTION

When compared to metals, Aluminum Metal Matrix Composites are used in many areas where weight and potency are of most significant factors. The main merits of the particulate reinforced composite are its different strengthening mechanisms and their formability [1, 2]. Composites can be made-up by stir casting process. Standardized mixing can be obtained by selecting appropriate processing parameters in the vein of stirring speed, time and temperature of the molten metal, preheating temperature of the mould and uniform feed rate of the particles [3, 4]. Amongst them a variety of aluminum alloys, 7075 is best opted choice to get ready metal matrix composites due to its better formability characteristics. [5-8]. The addition of SiC particles into the aluminum matrix increases the hardness and their mechanical properties. In particulate reinforced HAMMCs, reinforcement is added to the matrix of the bulk material to increase its stiffness and strength [9-11].

2. EXPERIMENTAL PROCEDURE

MMCs Specimens were made-up using stir casting process. A die with the 50X 50X 50 mm is used to prepare the specimen. Al 7075 was heated above its melting point and the reinforcement SiC, 15 microns are added. Stirring is done using stirrer uniformly. When the reinforcement is mixed well, the bottom portion of the furnace is opened and made to flow in the die which was kept down the furnace. After solidification, the sample was taken from the die. One specimen Al7075 reinforced with 20% SiC, composites were fabricated. The machining was conducted on the wire electrical discharge machine manufactured by Electronica India Pvt Ltd. A brass wire of 0.5 mm diameter was employed as the cutting tool. Fabricated MMCs of dimension 50x50x50 mm was used as the workpiece. The dielectric medium used was distilled water. The four input process parameters namely voltage (V), pulse-on time (TON), pulse-off time (TOFF) and current (C) were chosen and experiments are conducted based on the design of experiments approach using an L18 orthogonal array. The various process parameters were shown in the table. Rockwell hardness test at a load of 200kgf was conceded out on the composite specimens. The surface roughness on the EDM machined surface was measured using Mitutuyo surface roughness tester. The material removal rate is calculated using the formula below:

$$MRR = (2Wg+D) X t X (L/ T) \text{ mm}^3/\text{min}$$
Where, $W_g$ is the spark gap in mm, $D$ is the diameter of the wire, $t$ is the thickness of the workpiece in mm, $L$ is the distance traveled by the tool in mm and $T$ is the time taken to cut one profile in a min.

L18 orthogonal array:

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<th>S. No.</th>
<th>Voltage</th>
<th>Pulse on time</th>
<th>Pulse Off time</th>
<th>Current in Amps</th>
<th>Al7075 5 20% SiC MRR</th>
<th>Al7075 20% SiC Ra</th>
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3. RESULTS AND DISCUSSION

Material removal rate:

It has been pragmatic that the pulse on time and pulse off time are the imperative influencing factor for MMCs considered in this work. It is seen that for Al7075 20% high voltage, high pulse on time and low pulse off time and high current resulted in higher Material removal rate. Also low voltage, medium pulse on time, low pulse off time and low current results in an increase in MRR for Al7075 20% SiC composites. The average MRR for Al7075 20% SiC is 3.97 mm$^3$/min. Low pulse on time- high voltage, low pulse off time with high current decreases the material removal rate in aluminum metal matrix composites. Hence the results show that the increase in weight percentage of SiC decreases the Material removal rate in the composite material. The mechanical and thermal properties of MMC can be improved with the addition of SiC particulates.

Surface roughness:

The reinforcement particles size and weight fraction determine the surface roughness. Increase in pulse time gives the superior surface finish. It has been observed that the average Ra for Al7075 20% SiC was found to be 3.98 µm. when the weight fraction of SiC increases the Ra value increases. Higher roughness results due to the presence of reinforcement. It has been established that when the intensity of electric spark is supplementary it creates a crater on the workpiece and consequent in the poor surface finish. Alternatively, amplify in pulse off time leads to lower Ra, owing to erosion. Therefore pulse on time and pulse off time are the majority influencing parameters that decide the surface roughness.

The additional amount of SiC particles hardness, as these particles are harder than Al alloy, which causes to be their intrinsic property of hardness to the squishy matrix. Elevated the percentage of particulates in the matrix slighter is the hardness. Composites with privileged hardness might be achieved by this technique which possibly will be owed to the fact that silicon carbide particles act as a barrier to the movement of displacement. For that reason, starting this study it is obviously indicated that 20% SiC composite sample have towering hardness and superior toughness. Consequently, this may perhaps be well thought-out as the optimum weight percentage of the particulate to accomplish better hybrid composite properties for the heavy vehicle manufacturer.

4. CONCLUSION

Aluminum metal matrix composite sample with 20% SiC composition shows high-quality machining distinctiveness The input parameters influencing the machining are a pulse on time, pulse off time and current. Material removal rate decreases due to the addition of Silicon carbide reinforcement in the composite materials. Ra value increases with the addition of reinforcement particles.

5. REFERENCES


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