ARPN Journal of Engineering and Applied Sciences

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MORPHOLOGICAL ANALYSIS OF THE CARBIDE DRILL BIT IN DRILLING METAL MATRIX COMPOSITES AND HYBRID METAL MATRIX COMPOSITES

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ABSTRACT

The objective of this work is to compare the loss of material in the drill bit after drilling the metal matrix composites coated with carbon nano tubes with uncoated metal composites. In this work, two different specimens are fabricated using stir casting process. The fabricated specimen includes coated silicon carbide particles reinforced in LM 25 alloy and uncoated ceramics reinforced in LM 25 alloy. The carbide drill bit is analysed after drilling metal matrix composites with 10% silicon carbide particles in LM 25 and hybrid metal matrix composites with 10% of silicon carbide particle and 1.5% of Multi Wall Carbon Nano Tubes (MWCNT) in LM 25 alloy. Morphology of the drill bit is recorded using Scanning Electron Microscope (SEM). The metal matrix composites (LM 25/SiCp) and hybrid metal matrix composites (LM 25/MWCNT coated SiCp) are prepared using semi-solid stir casting method. The fabricated specimen is subjected to machining. After machining the flank, chisel edge and flute of the tool are analysed using SEM. The wear and the built up edges are studied using morphology in the flank, chisel edge and the flute. From the morphological study it is proved that the depth of wear in the carbide tool used to machine the uncoated metal matrix composite is more compared to the depth of wear used to machine the coated metal matrix composites. It is also proved that distribution of coated ceramics; silicon carbide particles on the LM 25 matrix are uniform.

Keywords: built up edge, carbide drill bit, casting, hybrid metal matrix composites, morphology, multi wall carbon Nano tubes, scanning electron microscope, tool wear.

1. INTRODUCTION

Nowadays the tool wear leads to decrease in tool life in turn resulted in reducing the tool replacement time. Changing the tool often leads to high cost. In order to reduce the cost and increase the tool life either the tool is coated or the abrasiveness of the ceramics reinforced in the composites should be treated. The coating of tool by various process leads to high cost compared to treating the ceramics

The author Anil Jindal made the holes in aluminium metal matrix composites in two conditions, namely dry condition and high pressure cooling. The hole deviation is more in case of dry condition. The author also explained that the chips adhered on the cutting lip of the coated drill after the 10th drilling.

The tool life of the carbide tool is increased by minimizing the amount of coolant and introduces a micro pool during the machining process and it was proved by the author shuting Lei, *et al*.

The author K.B. Ahsan, *et al*. Proved by his experiment that when the cutting speed increases the tool life is decreased. The author also suggested that the uncoated carbide tools were best suited for low speed machining.

Bhadrabasol Revappa Raju, *et al.* tested the composites with High Speed Steel (HSS) and Carbide tool in drilling. It was proved that carbide tool bit was better than the HSS tool bit in drilling composite materials.

Nagaraja, *et al.* by the SEM analysis proved that the damage cause by HSS drill bit was more compared to carbide tool.

Redone Zitoune, *et al* studied the tool subjected to machining and proved that the generation of build up edges were purely due to mechanical adhesion and not by any diffusion or oxidation. The tools used to machine carbon fibre reinforced plastic and Aluminium sandwich.

The aim of this experiment to compare the depth of tool wear of the drill bit in machining both the coated ceramics in metal matrix composites and uncoated ceramics in metal matrix composites.

2. EXPERIMENTAL

2.1 Materials

LM 25 is chosen as a base metal due to its improved properties in automotive applications. The disadvantage of A 356 is less hardness value. This disadvantage of A 356 is overcome by reinforcing silicon carbide particle (SiCp) of improved hardness value. Due to the hardness of reinforced composites

The machining of composite is difficult due to the high hardness value of SiCp. In order to achieve smooth machining, the SiCp is treated with carbon nano tubes. The coating of carbon nano tubes (CNT) over the surface of SiCp reinforced on LM 25 tool wear is reduced. The tool used for machining is carbide tool. High Speed Steel (HSS) drills bit leads to more tool wear than carbide tool in drilling. Although the coating of carbide tool results in less tool wear compares to carbide tool. The coating process is more expensive [7].

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A 356 + SiCp + CNT ⇨ A 356/SiCp/CNT

2.2 Methods

SiCp is an abrasive ceramic. It is treated with CNT in order to achieve good bonding between the matrix and reinforced material and improve the surface texture. The surface of SiCp is treated with the CNT using sonication process. After sonication the treated SiCp is mixed with molten A 356 using semi solid stirs casting process at 605°C and poured into a mould. 10% of SiCp treated by 1.5% of CNT and mixed with molten base metal. In this experiment the carbide tool is used to drill 27 holes based on orthogonal array [8] [9].

3. RESULTS AND DISCUSSIONS

3.1 Morphological studies of fabricated specimen

Morphology of the fabricated part reveals the equal distribution of coated SiCp over the base metal aluminium alloy A 356. The porosity is reduced as in the case of a specimen with uncoated ceramics in aluminium alloy. There is a good interfacial bonding between the reinforcement and base metal. The surface of the specimen is smooth since the abrasiveness of ceramics is reduced by CNT. Figure-1 proves that the treated SiCp is distributed uniformly over the parent metal alloy.

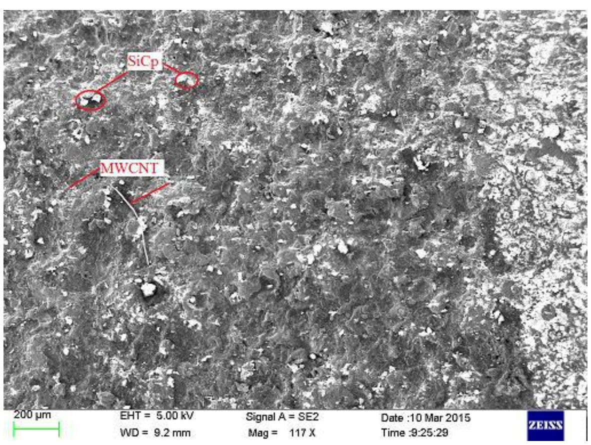

Figure-1. Morphology and qualitative analysis of fabricated specimen using casting process.

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3.2 Drilling of fabricated specimen

The specimen is subjected to a machining operation called drilling. Based on L27 array 27 holes are drilled by taking the inputs such as speed ranges between 600 RPM to 1860 RPM, feed rate ranges from 25m/min to 75m/min and drill diameter ranges between 4 to 12 mm. Figure 2 shows the drilled specimen in a Vertical Milling Machine (VMC). While drilling the thrust force and torque values are recorded as output responses. Figure-3 reveals the output torque values with respect to the number of cycles. The output response torque in Newton-meter and it is measured using Kistler dynamometer. The torque values are measured using a drill bit of three different diameters. This figure shows the measurement of thrust force with 4mm diameter, spindle speed is 1260 RPM and the feed value is 25mm/min. The dynamometer records the entry of the drill bit, exit of the drill bit and the drilling process. Figure-4 explains the measurement of output response thrust force in Newton. This figure shows the thrust force with 4mm diameter. It explains the effect of thrust force from the entry of drill bit to the retrieval of drill bit. At the entry and at the exit the thrust force remains zero. During drilling there are variations in the thrust forces. This graph is obtained from the Krystler dynamometer with the thrust force along the Y axis and number of cycles along the X axis [10].

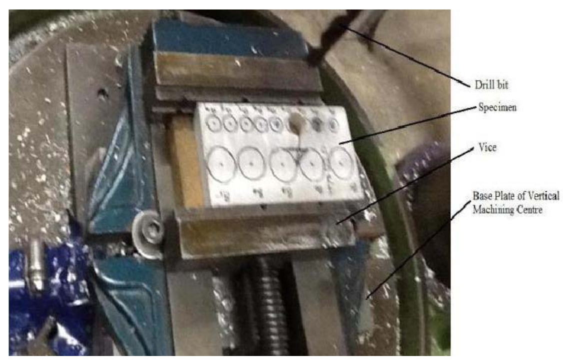

Figure-2. Drilling of prepared specimen in vertical machining centre.

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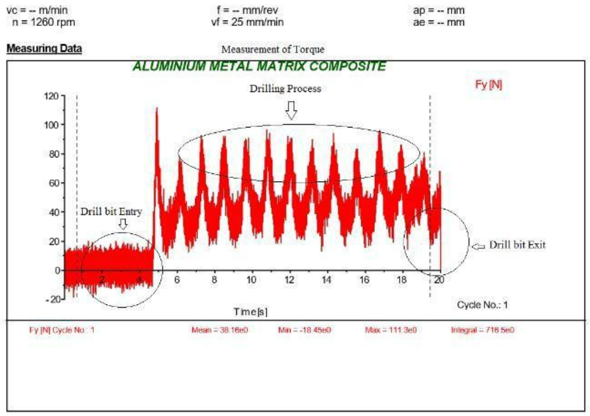

Figure-3. Output - Torque measured during drilling operation.

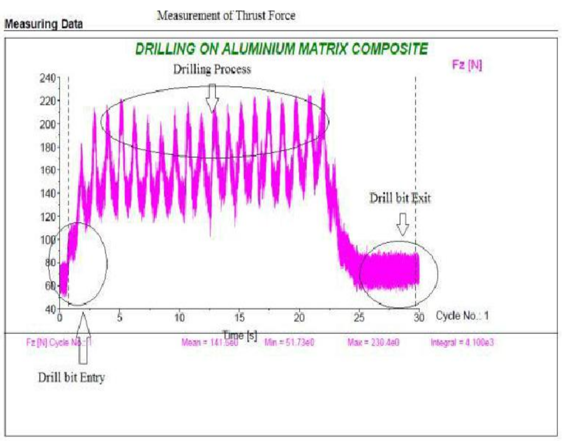

Figure-4. Output - Thrust force is measured during drilling process.

3.3 Morphology of drilling tool bit

Carbide drill bit is used to drill 27 holes in prepared specimen of metal matrix composites (A356/10% SiCp) and hybrid metal matrix composites (A 356/10% SiCp/1.5%CNT). The morphology of carbide drill bit after machining hybrid metal matrix composites and metal matrix composites are analyzed using Scanning Electron Microscope (SEM).

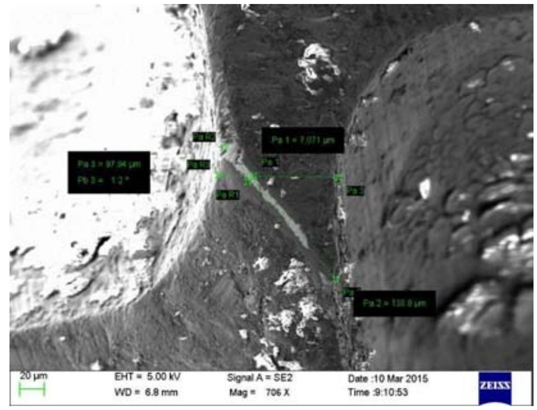

Figure-5. Morphology of drill bit after machining metal, metal matrix composites.

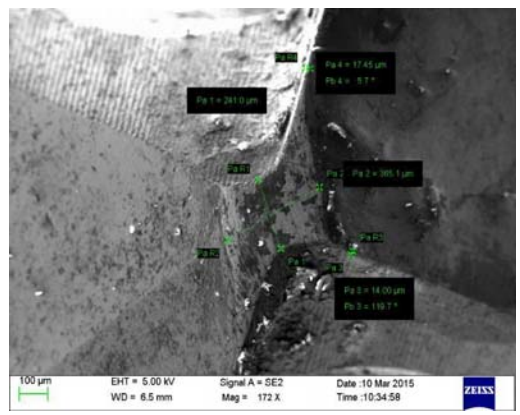

Figure-6. Morphology of drill bit after machining hybrid metal matrix composites.

Table-1. Tools wear details.

Dimensions of the carbide tool after machining			
Materials	**Pa1**	**Pa2**	**Pa3**
Hybrid metal matrix composites	241µm	365.1µm	14µm
Metal matrix composites composites	7.071µm	38 µm	97.94µm

The Table-1 describes that the tool wear of both the hybrid metal matrix composites and metal matrix composites and this table proves that the reduction of tool material while drilling is high for metal matrix composites [11]. The tool wear is more due to the presence of hardest silicon carbide particle. In machining hybrid metal matrix composites the carbon allows the tool smoothly and there is less wear. The tool compared here is having the diameter of 4 mm. Figure-5 displays the morphology of 4mm drill bit after machining metal matrix composite. This Figure expresses the loss of tool material is more? Figure-6 illustrates the morphology of drill bit after machining hybrid metal matrix composites. This figure confirms the loss of material in the tool is less and it is also displayed in the Table-1. The values of Pa1 and Pa2 proves that the tool wear is more while machining metal matrix composites compared to hybrid metal matrix composites.

4. CONCLUSIONS

In this paper the loss of tool material for the carbide tool is measured and analyzed using SEM while machining metal matrix composites (A 356/SiCp) and hybrid metal matrix composites (A 356/SiCp/CNT).

- It is proved that the loss of tool material is high in machining metal matrix composites. It is confirmed by the Pa1 = 7.071 μm and Pa2 = 38 μm values. Pa1 and Pa2 denote the measurement of tool cutting edges after machining.
- The loss of tool material is less in machining hybrid metal matrix composites. It is proved by Pa1 = 241μm and Pa2 = 365.1μm values of hybrid metal matrix composites and it is the measurement of cutting edge after machining hybrid metal matrix
- It is proved by this experiment that the carbon present in the hybrid metal matrix composites allows the tool smoothly with less tool wear.

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