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Experimental Investigation on Al-Cu-Sic MMC in Turning Operation

Senthilkumar. D,
Assistant Professor,
Mechanical Engineering,
MAM School of Engineering,
Trichy, India.

Parthiban. K,
Assistant Professor,
Mechanical Engineering,
MAM School of Engineering,
Trichy, India.

Maniamramasamy. S,
Assistant Professor,
Mechanical Engineering,
MAM School of Engineering,
Trichy, India.

***Abstract*- Metal Matrix Composites (MMC) have become a large leading material in composite materials and particles reinforced aluminium MMCs have received considerable attention due to their excellent engineering properties. These materials are known as the difficult-to-machine materials, because of the hardness and abrasive nature of reinforcement element like Silicon Carbide (SiC) particle. In this project work, the Al-Cu-SiC MMC material will be selected for experimental investigation of Surface Roughness, Power Consumption, Cutting Force. First, 10w% of Cu has been added with Al, then SiC added with Al-Cu alloy and this cutting parameters of various cutting conditions will be noted. 10w% of SiC will be taken as a percentage of Al-Cu-SiC and this will undergo Turning process.When machining, hardness of the Al-Cu-SiC is greater than the pure aluminium. When increasing Cutting Speed and depth of cut, the surface roughness is improved. The experimental results show that main cutting force has an increasing trend with the increasing of the feed rate. Correspondingly power has been increased with cutting force.**

I. INTRODUCTON

1.1 COMPOSITE

Conventional monolithic materials have limitations in achieving good combination of strength, stiffness, toughness and density. To overcome these shortcomings and to meet the ever increasing demand of modern day technology, composites are most promising materials of recent interest. Metal matrix composites (MMCs) possess significantly improved properties including high specific strength; specific modulus, damping capacity and good wear resistance compared to unreinforced alloys. A metal matrix composite is composite material with at least two constituent parts, one being a metal. The other material may be a different material, such as a ceramic or organic compound. One of the constituent materials acts as the matrix and at least one other constituent material act as the reinforcement in the composite. There has been an increasing interest in composites containing low density and low cost reinforcements

1.2 MATRIX PHASE

The role of the matrix material is 1. to protect the reinforcement materials, 2. to distribute the stress to the reinforcement material(s), 3. to provide for the final shape of the composite part.

1.3 REINFORCING PHASE

The role of the reinforcement material(s) is: 1. to provide the composite high mechanical properties, 2. to reinforce the matrix in preferential directions

As the matrix element, aluminium, copper, titanium and magnesium alloy are used, while the popular reinforcements are silicon carbide (SiC) and alumina (Al_2O_3). Aluminium-copper alloy based SiC particle reinforced MMC materials have become useful engineering materials due to their properties such as low weight, heat-resistant, wear-resistant. There has been an increasing interest in composites containing low density and low cost reinforcements.

1.4 METHODS OF MANUFACTURING

Many techniques have been developed to fabricate MMC materials, including liquid phase and solid-phase processing techniques. Liquid phase processing techniques include squeeze casting, metal spray, metal infiltration. The high speed and low cost are the primary benefits of liquid phase processing techniques. Solid-phase processing technique is powder metallurgy method.

1 Powder Metallurgy
2 Plaster Casting
3 Die Casting
4 Permanent Mold Casting
5. Stir Casting

1.5 STIR CASTING

Stir Casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring. The liquid composite material is then cast by conventional casting methods and may also be processed by conventional Metal forming technologies.

II. PROCESSING

The synthesis of the metal matrix composites used in this study was carried out using conventional casting and disintegrated melt deposition techniques. The synthesis of MMCs using conventional casting was carried out according to the following procedure. The metal ingots, prior to melting, were properly cleaned to eliminate surface impurities. The cleaned metal ingots were melted to the desired superheating temperature. SiC particulates, preheated to 900 °C, were then added into the molten metal and stirred using an impeller. The composite melt thus obtained was poured into cylindrical steel molds (25 mm diameter and 178 mm height). In all the cases, stirring time of SiC particulates in the melt was maintained between 10 and 15 min. Regarding the disintegrated melt deposition of MMCs, the synthesis process involved: superheating the properly cleaned metal ingots to 940 °C in a graphite crucible, addition of SiC particulates preheated to 900 °C in the liquid metallic melt, argon gas assisted composite melt disintegration at 0.18 m from the melting point and subsequent deposition on metallic substrate located at 0.25 m from the gas disintegration point. Both conventional casting and disintegrated melt deposition processing of metal matrix composites were carried out in the ambientAtmospheric conditions.

Fig: 1 Stir Casting

2.1. MICROSTRUCTURE CHARACTERIZATION

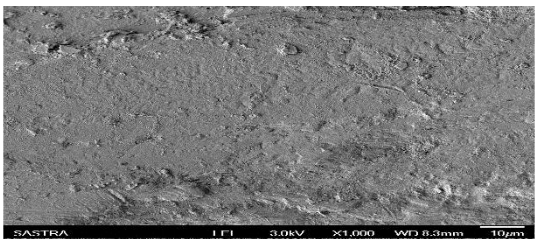

Fig :2 The microstructure of the work material (Al-Cu-SiC Composite)

Microstructure characterization Studied were conduct on the unreinforced and reinforced sample in order the investigation the distribution of cu and Sic particulate and the presence of porosity the elements of interfacial resign between the Al-Cu/SiC matrix and ceramics particulates

Microstructure characterization studied primarily accomplished using scanning electron microscopies. The composition sample were metallographic ally polished prior to examination microstructure characterization of sample were conduct.

The result of scanning microscopy conducted on conventionally Al-cu-SiC sample revealed parting presence of porosity and predominant. The addition of interface formed between SiC particulates are Al-Cu matrix. The predominantly SiC particulates were present in the small clusters located at the grain boundaries.

III. ADVANTAGES

- Aluminium copper alloys have a high machinability index and have been enormously used in aerospace and automobile industries due to their superior properties such as higher strength to weight ratio, excellent low temperature performance
- Additions of fly ash can make automotive castings lighter, leading to further energy savings during the use of cars and trucks by means of reduced fuel consumption.
- High yield strength
- High compressive and tensile strength.
- High hardness at room temperature and elevated temperature
- Low weight
- High young's modules of elasticity
- Higher wear resistance
- High thermal conductivity
- Low thermal expansion

IV. METHODOLOGY:

4.1 FABRICATION

In our experiment, SiC particles reinforced Al–Cu alloy composites were fabricated by the stir casting method.

4.2 MACHINING

TURNING TECHNOLOGY

Simple turning parts are shaped by a feed motion in the turning axis direction or normal to it. The associated methods are named according to the direction of the feed motion during machining. The contour of the finished part is usually created in a number of cuts. In feed is performed outside the work piece before each cut.

The machining processes are conducted in the lathe machine to measuring the surface roughness of sample MMC material of Al-Cu/SiC. The effect of the turning parameters for surface roughness according to the level of the turning parameters, wide range of each level of parameter means the more effect of surface roughness for the changes of depth of cut, spindle speed and feed applied in this effect of the surface roughness compared to the other parameter.

Through the experiments, the selection of each level of turning parameters such as spindle speed 1020,700,400 rpm, depth of cut 0.25,0.50,0.75 and different feed with respected. The experiment of evaluating of surface roughness the optimal of turning parameter to improve turning performance.

4.3 OPTIMUM SURFACE ROUGHNESS

The second order response surface roughness model for predicting the cutting force were developed and then the usefulness of the developed response of surface roughness was discussed in view point of selecting the turning condition. For example, The fig (9) showing, how to get the good achievement with in contour plot by spindle speed, depth of cut and feed for same material and find out the optimum value of surface roughness .

4.4 FORCE MEASUREMENT

Material removal when turning in orthogonal cutting, producing only two cutting forces these are axial and tangential forces. Tangential cutting force is by far the greater (if translated to the planer this is the force acting on the tool in the direction of the workpiece travel).Axial cutting force is the force required to keep the cutting edge in contact with the workpiece (perpendicular to the surface of the work piece on the planer).

Tangential cutting force resists the rotation of the work, as relatively high speeds are used the bulk of power consumption lies here.

Axial cutting force resists the travel of the tool, however this is a relatively low speed compared with rotation of the work, so for all practical purposes power consumption may be ignored.

Radial cutting force produces no movement therefore consumes no power, however, the effect can improve stability during cutting as it ensures the cross slide nut and screw are kept in contact, thus improving accuracy.

4.5. HARDNESS TEST OF Al-Cu-SiC MMC

The hardness test for the Al-Cu-SiC MMC casting workpiece rod of 25mm dia and 250mm length is carried on Brinell hardness test machine. It is compared with pure aluminium. The table shows the hardness of the Al-Cu-SiC is more than the pure aluminium is concluded.

Fig :3Brinell hardness test for Al-Cu-SiC

Table :1 Comparison of Hardness of Aluminium and Al-Cu-SiC

Sr no	Indent ball dia(inch)	Material	Hardness number	Material	Hardness Number
1	1/16	Aluminium	36	Al-Cu-SiC	48
2			38		44
3			35		46
4			31		42
Average			35	Average	45

Fig :4 Turning operation of Al-Cu-SiC work piece with force dynamometer

Fig:5Surface roughness measurement

V. RESULT AND DISCUSSIONS

The comparison of Surface roughness for different depth of cut ,feed and speed is shown on following tables.

Table : 2 Surface rough vs Depth of cut

PARAMETER	depth of cut(mm)		
	0.25	0.5	0.75
surface roughnessRA(µa)	3.27	2.54	2.23
Feed -0.16m/rev, Speed 480 rpm			

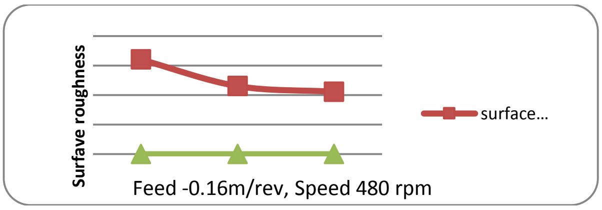

Fig 6 Feed , Speed vs Surfave roughness

Table : 3 Surface rough vs Depth of cut

	depth of cut(mm)		
	0.25	0.5	0.75
surface roughnessRA(µa)	3.2	2.3	2.11

Feed -0.20m/rev, Speed 480 rpm

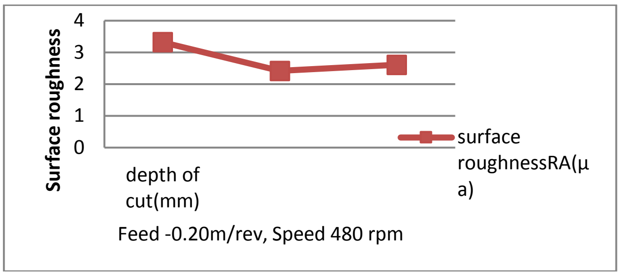

Fig 7 Feed , Speed vs Surfave roughness

Table :4 Surface rough vs Depth of cut

	depth of cut(mm)		
	0.25	0.5	0.75
surface roughnessRA(μa)	3.51	2.73	2.03

Feed -0.10m/rev, Speed 700 rpm

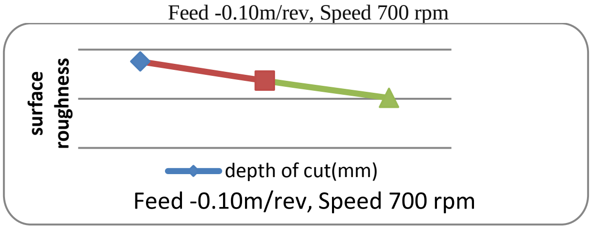

Fig 8 Feed vs surface roughness

Table : 5 Surface rough vs Depth of cut

	depth of cut(mm)		
	0.25	0.5	0.75
surface roughnessRA(μa)	3.53	2.74	2.13

Feed -0.17m/rev, Speed 700 rpm

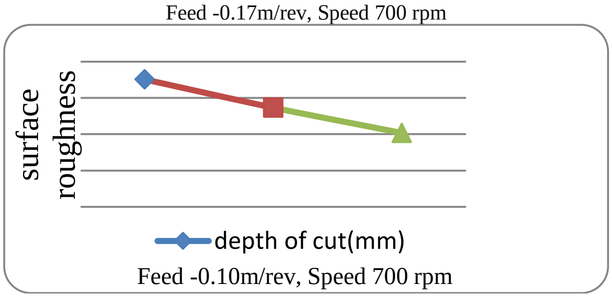

Fig 9 Depth vs Surface roughness

Table : 6 Surface rough vs Depth of cut

	depth of cut(mm)		
	0.25	0.5	0.75
surface roughnessRA(μa)	3.21	2.3	1.02

Feed -0.07m/rev, Speed 1020 rpm

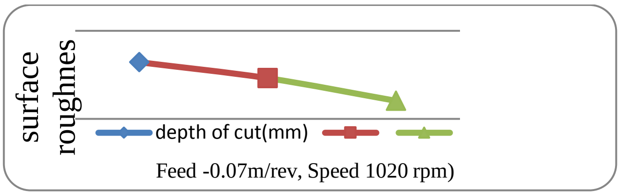

Fig 10 Feed vs Surface roughness

Table : 7 Surface rough vs Depth of cut

	depth of cut(mm)		
	0.25	0.5	0.75
surface roughnessRA(μa)	3.59	2.67	2.04

Feed -0.12m/rev, Speed 1020 rpm

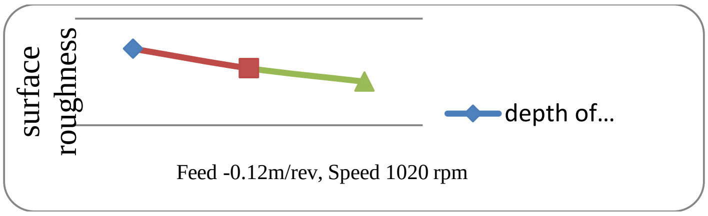

Fig 11 Feed vs surface roughness

VI. CONCLUSION

Al-Cu-SiC has been selected for machining in lathe. When machining this, hardness of the Al-Cu-SiC is greater than the pure aluminium. When increasing Cutting Speed and depth of cut the surface roughness is improved. The experimental results show that main cutting force has an increasing trend with the increasing of the feed rate. Correspondingly power has been increased with cutting force. All the values of speed, feed, depth of cut and surface roughness are plotted in the graph.

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