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Aluminium Composites Materials using Stir Casting Process: Challenges and Opportunities

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***Abstract*—This paper studies the effect of aluminium base metal with the different percentage of reinforcement of SiC(3,6,9) and Cu(0.5,0.75,1) with Mg (2 gram) in each. The basic reason of metal reinforced is to improve the properties then its original materials like hardness, cutting force, etc. The paper content of experimental work as stir casting process and preparation of aluminium matrix composites material by using aluminium as matrix form and Sic and Cu as reinforcement by varying proportion. Here hardness decreases on increase percentage of reinforcement. X-Ray Diffraction test shows degree of angle is between 35 to 45. Scanning Electron Microscope test shows electron variation at different magnification it also shows the distribution of Sic and cu particles in aluminium alloy.**

Keywords—stir casting, hardness test, cutting force, xrd test, sem test.

I. INTRODUCTION

Now days with the modern development need of developments of advanced engineering materials for various engineering applications goes on increasing. To meet such demands metal matrix composite is one of reliable sources. Composite material is one of the reliable solutions for such requirement. In composites, materials are combined in such a way as to enable us to make better use of their parent material while minimizing to some extent the effects of their deficiencies [1]. The simple term 'composites' gives indication of the combinations of two or more material in order to improve the properties [1]. Matrix composites are made to lower the cost, reduced weight and high performance which can be easily available in the market for our use. The present work done on the stir casting metal of aluminiun as base metal with the reinforcement of Sic(3,6,9) percentages and Cu(0.5,0.75,1) percentages.

II. EXPERIMENTAL WORK

The simple and most commercially used technique is known as stir casting technique and vortex technique [2]. It involves the reinforcement of SiC and Cu particulate into liquid aluminium melt with Mg and allowing the mixtures to solidify. During process reinforcement particles are preheated to 600 degree celcius to 650 degree celcius for half an hour to remove the volatile substances. In the molten metal of aluminiun SiC, Cu and Mg are uniformly feed after that the stirrer action are performed to maintain the particles temperature closer to the melting temperature of 700 degree celcius. The stir operation was performed for 10 minutes at an average speed of 300 rpm. After effective degassing the molten metal was poured into permanent moulds for casting. Fig. 1 shows the process [2]. Here we performed casting with different % of reinforcement i.e SiC(3,6,9) and Cu(.05,0.75,1) respectively with 2 gram of Mg in each composition.

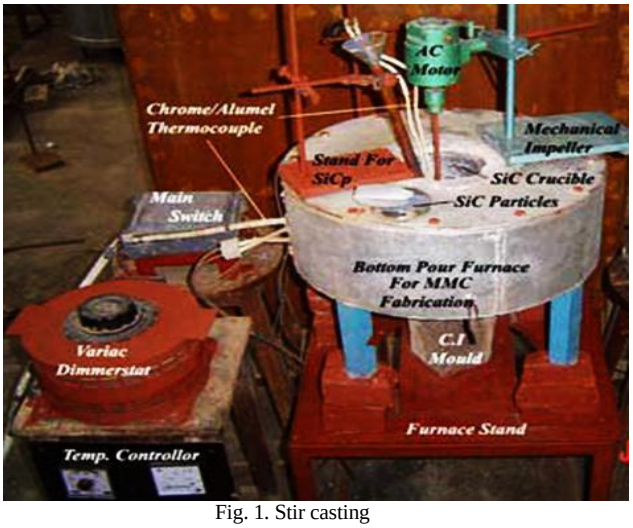

Fig. 1. Stir casting

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Fig. 2. Specimens after casting

A. HARDNESS TEST

The hardness testing was carried out for three composite specimens. The hardness of the specimens determined by Rock well scale B load 100 kg/f. Steel ball indenter dia of 1.58 mm. Its uniform time interval in indenter was 10 second. Fig.3. after hardness of the specimens.

Fig.3. After Hardness test the specimens.

B. CUTTING FORCE

The experimental planning was prepared by using cutting parameters and test condition that are adviced for a couple of tool-work piece by the tool manufacturer [3]. In order to measure cutting force (main Cutting force Fc, Feed force Ff, and Thrust force Ft) a two component turning dynometer was used [3]. The cutting tests were carried out on a lathe equipped with Fanuc control system. The cutting speed v was assigned for 3 different levels (80,100,120) rpm, feed rate f and depth of cut d (0.06,0.09,0.12) mm/rev and (0.5,0.75,1)mm respectively. The values of cutting parameters selected are recommended by the tool manufacturer for general purpose and finish turning operation of medium carbon steels [3]. Total 9 experiments were carried out by the cutting parameters.

Here we see that cutting forces are exerted only in the directions of velocity and uncut specimens thickness. Rank angle is one of the most important parameters, which determines the tool and chip constant area [3]. As we increase the rank angle for the specimens from small values to the optimum values the contact area increases by this it is expected that the forces will reduced [3]. Hence in both the condition cutting force and heat generation are increased [3]. Here we see that the cutting forces are increased with the % increased in reinforcement.

C. XRD TEST

X-ray diffraction of different samples was carried out by X' Pert pro of PAN analytics using radiation. In x-ray diffraction test we get the physical contents of the constituents present in the samples are indicated in the form of graphs.

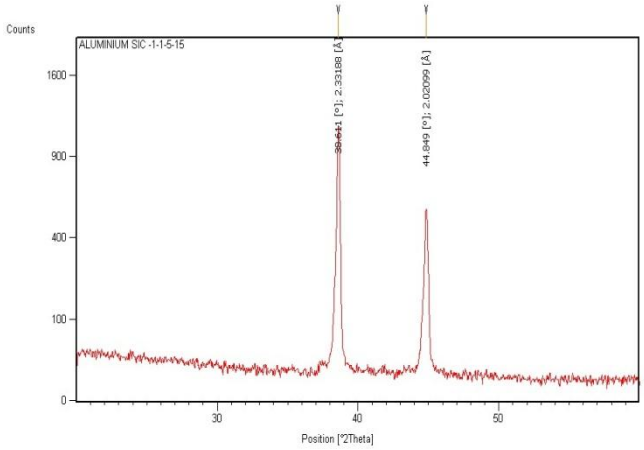

Fig.4. Shows Aluminium with SiC(3%),Cu(0.5%) and Mg(2 gram).

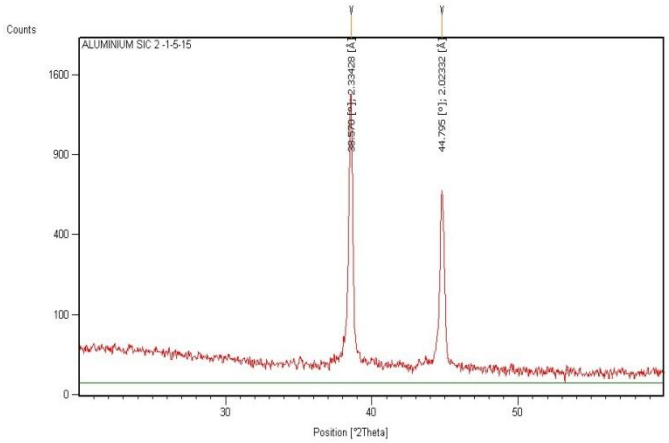

Fig.5. Shows Aluminium with SiC(6%),Cu(0.75%)and Mg(2 gram).

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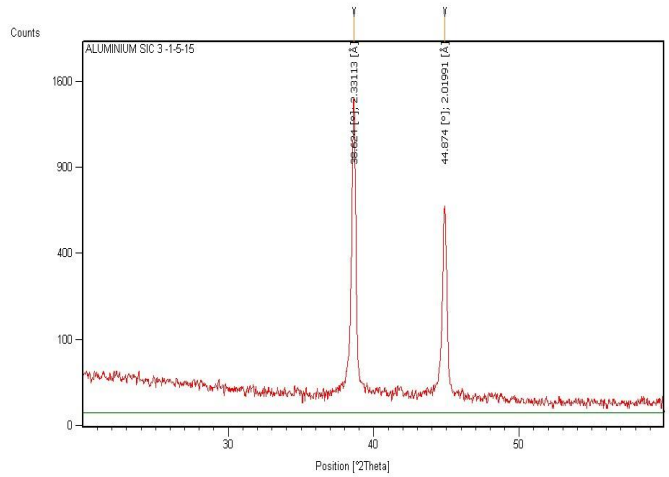

Fig.6. Shows Aluminium with SiC(9%),Cu(1%),and Mg(2 gram)

D. SEM TEST

The surface morphology and chemical composition were examined with the help of scanning electron microscope. It can be represented through the figures.

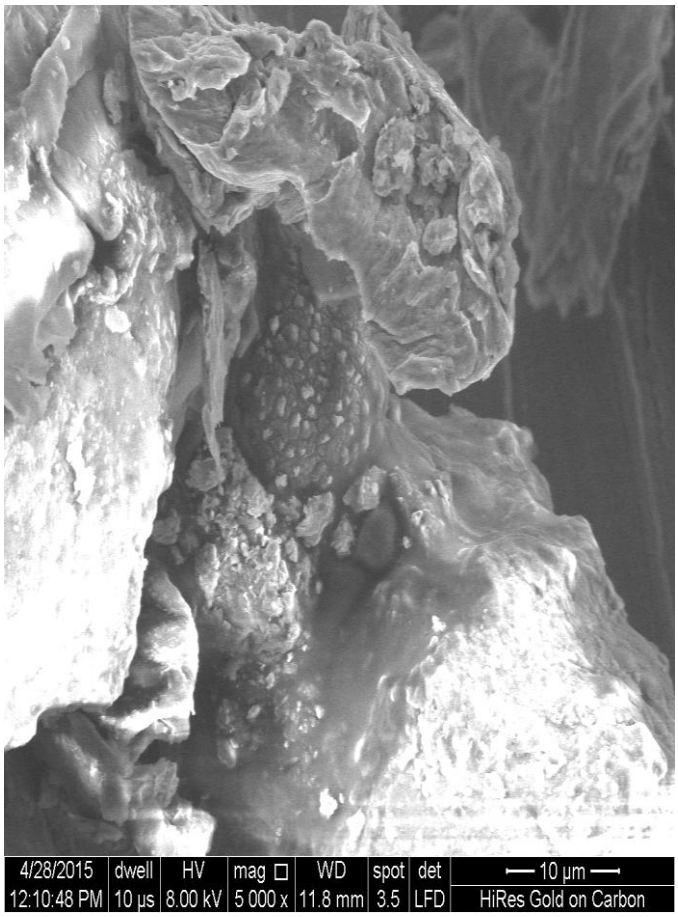

Fig.7. Shows Aluminium with SiC(3%),Cu(0.5%) and Mg(2 gram).

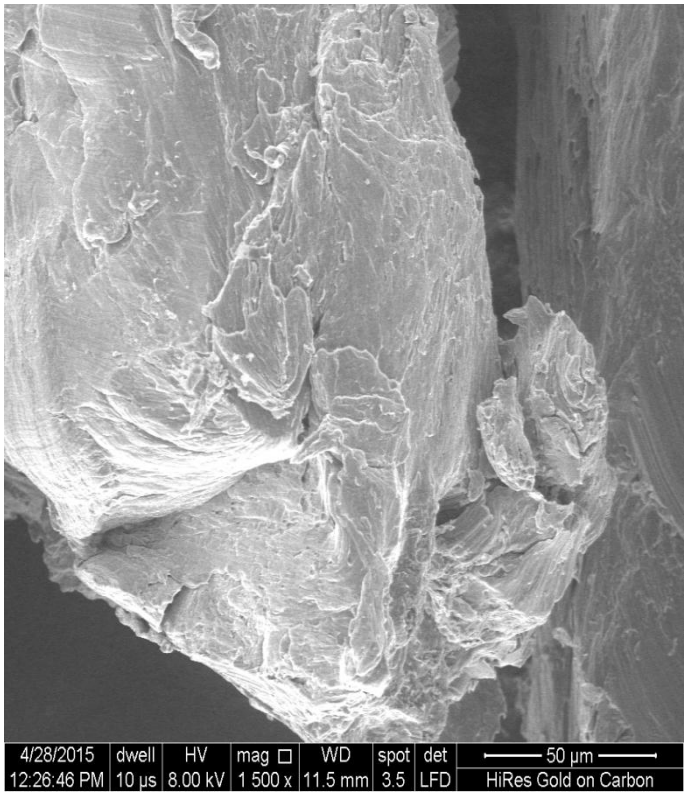

Fig.8. Shows Aluminium with SiC(6%),Cu(0.75%) and Mg(2 gram).

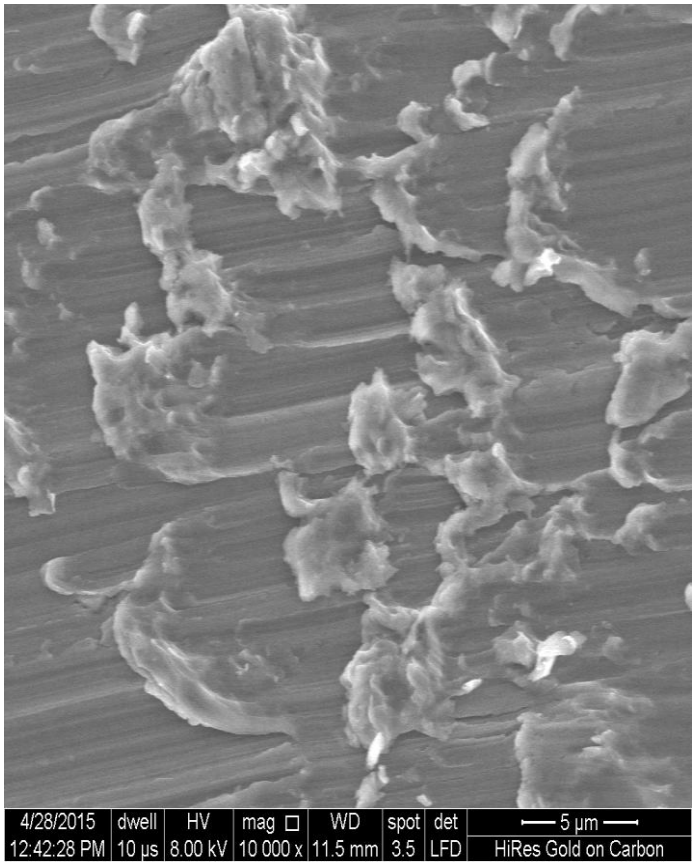

Fig.9. Shows Aluminium with SiC(9%),Cu(1%) and Mg(2 gram).

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III. RESULTS

1. Hardness test shows that on the increasement of SiC and Cu as reinforcement hardness decreases. Table 1. Shows the average hardness.

TABLE 1. Hardness test

Sr. No.	Material	Rockwell Hardness Number					Avg. hardness
		Trail 1	Trail 2	Trail 3	Trail 4	Trail 5	
1.	Al+SiC 3%+Cu 0.5%+Mg (2 gram)	86.5	86	86	88	88	86.9
2.	Al+SiC 6%+Cu 0.75%+Mg (2 gram)	84	85	86	84.5	85	84.9
3.	Al+SiC 9%+Cu 1%+Mg (2 gram)	84	84	86	83.5	85	84.5

2. Cutting forces increases gradually with the increment of SiC and Cu as reinforcement cutting forces increases also when rankle angle increases with small value to optimum value its contact area increases so force is reduced. Table 2. Shows the cutting force, radial force and feed force.

TABLE 2. Cutting force, Radial force and Feed force

Sr.no	Cutting speed	Depth of cut	Feed rate	SiC %	Cutting force	Radial force	Feed force
1.	80.74	0.5	0.03	3	44.15	22.43	3.81
2.	101.64	0.75	0.09	3	63.13	29.5	9.43
3.	120.79	1.0	0.12	3	98.62	77.9	38.49
4.	80.74	0.5	0.06	6	62.59	24.19	11.9
5.	101.64	0.75	0.09	6	132.59	32.19	17.5
6.	120.79	1.0	0.12	6	189.2	49.2	24.9
7.	80.74	0.5	0.06	9	68.48	46.28	17.62
8.	101.64	0.75	0.09	9	137.7	64.62	29.82
9.	120.79	1.0	0.12	9	196.79	92.5	47.05

3. X-ray diffraction test shows that the images found at nearly same degree of angle are as (38.611, 38.570, 38.624) respectively. The result also shows from the figure that the counts of the reinforcement increases towards 1600.

4. Magnification under which our results are shown clearly in SEM is 10k. Its spots are at 3.5 respectively.

Conclusion

1. The results confirmed that stir formed Al alloy with (SiC and Cu) reinforced composition is clearly giving the best results in xrd and cutting force. The oxide phase dispersed uniformly in the MMCs (like SiC, Cu).
2. The hardness decreases on increasement of reinforcement (SiC and Cu). Mainly Cu is responsible for decrement of hardness.
3. XRD results shows that the reinforcement particles SiC and Cu mixture are in uniform rate.
4. The surface roughness also decreases by the cutting speed of aluminiun MMCs.
5. The cutting force increases on the increment of depth of cut.

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