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Experimental Characterization of Mechanical Properties of Sic/Co Hybrid Reinforced 6061 Aluminum Metal Matrix Composites

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Abstract:- Vehicles and aviation applications require materials that have adjusted mechanical and tribological properties. In fact, it is difficult to achieve these altered properties in monolithic materials. Aluminum compounds share some of the basic properties that make them the most commonly used materials in a variety of applications, including automotive and aerospace. The Al 6061 alloy has been used as matrix material while % wt of cobalt is fixed at 3% while silicon carbide altered from 0% to 3% have been used as reinforcement materials. In the current work, the aluminum based metal framework composites have been manufactured. It was uncovered that MMC with 3%wt of Sic, 3%wt of Co showed brilliant mechanical properties among the all manufactured metal framework composites.

Keywords: *Aluminum, Metal Matrix Composites, Sic, Cobalt.*

I. INTRODUCTION

In the present era, automobiles and aerospace applications require materials that have modified mechanical and tribological properties like high strength, hardness, wear resistance and strength to weight ratio. It is very difficult to achieve these modified properties in any monolithic material. [1]

Metal matrix composites (MMCs) materials has been noted to offer such tailored property combinations due to their unique mechanical and physical properties such as high specific strength, low coefficient thermal expansion and high thermal resistance, good damping capacities, superior wear resistance, high specific stiffness and satisfactory levels of corrosion resistance. [2]

II. MATERIAL & METHODS

In the present work, Aluminum 6061 alloy was used as a matrix material (chemical composition of aluminum 6061 alloy is presented in table 1) while silicon Carbide and cobalt in different weight percentage were used as reinforcement material for the fabrication of MMCs.

Table 1 Chemical Composition of Alloy Al6061 in % wt

Element	Wt %
Si	0.4
Fe	0.5
Cu	3.7-4.7
Mn	0.3-.08
Mg	1-1.7
Zn	0.24
Ti	0.15
Al	Remaining

To fabricate the MMCs, initially Al 6061 alloy pieces putted in the graphite crucible according to required weight and heated up to 800 ◦C using an induction furnace and then mixed reinforced material Sic and Co up to homogeneous distribution. Then poured into the dies. After that solidification, the MMC was taken out from the mould. The MMCs having different percentage of Sic and Co were fabricated using same procedure. Mechanical testing such as hardness and flexural strength were carried out for all the fabricated metal matrix composite samples to identify the best % wt combination of Sic and Co in fabricated aluminium 6061 alloy based MMCs.

- *Tensile Strength*

The tensile tests on all fabricated MMCs were conducted on universal testing machine. The machine meets the accuracy requirements of IS 1828-1975. Flat specimens were used for the all tensile test having size (140 x 10 x 10) mm and (60 x 10 x 10) mm respectively. This type of test was carried out at constant crosshead speed of 1 mm/min.

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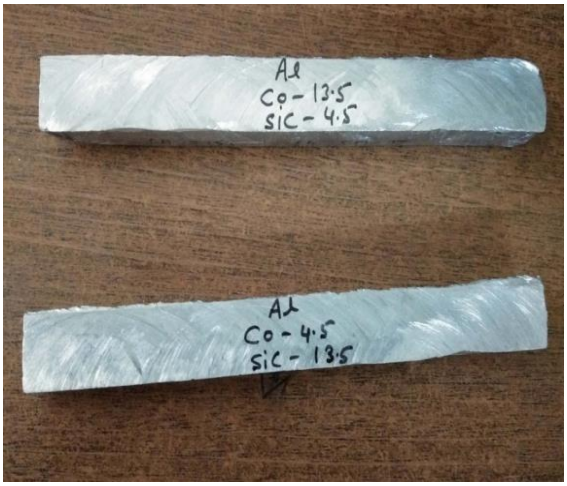

Fig 1 Specimen for Tensile & Impact Test

➢ *Impact Strength*

The Izod impact test for all specimens were conducted using impact tester, manufacturer by Engineering models and equipment, Roorkee as shown in figure 3.8. The figure 3.9 shows the specimen used for impact test. The impact strength of the specimen is calculated as:

$$I = \frac{K}{A}$$

where,

I = Impact strength,
K = Impact energy,
A = cross-section area

III. RESULT & DISCUSSION

➢ *Effect of Tensile strength on Sic & Co powder filled Al 6061 Composites*

The tensile strength and compressive strength of the material represents the resisting capacity of the material to withstand a static load in tension or compression [2]. The tensile properties of the composites depend on the composition of composites and the adhesion between the reinforcement and the matrix. The failure in the composites occurs due to the failure of reinforcement-matrix debonding followed by cracks at different cross sections under tensile loading . In the present work, the tensile test is carried out on two samples of each composition. Finally, the mean of two values of tensile strength is considered as tensile strength for that composition. The table 2 shows the tensile strength of all the fabricated MMCs. The figure 4 shows the bar chart for the average value of tensile strength for all the fabricated MMCs.

Table 2 Tensile strength of the fabricated MMCs

Composite Designation	Sample 1 (MPa)	Sample 2 (MPa)	Average tensile strength(MPa)
Al/Sic/Co MMC(3SAl0Co)	135	141	138
Al/Sic/Co MMC(3SAl1Co)	142	160	151
Al/Sic/Co MMC(3SAl2Co)	169	159	164
Al/Sic/Co MMC(3SAl3Co)	184	172	178
Al/Sic/Co MMC(0SAl3Co)	98	86	92
Al/Sic/Co MMC(1SAl3Co)	101	109	105
Al/Sic/Co MMC(2SAl3Co)	107	127	117

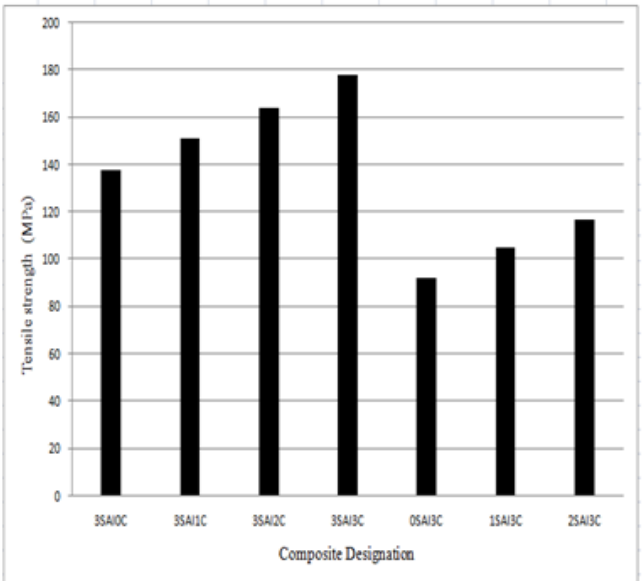

Fig 2 Bar Chart of Average Value of Tensile Strength For All MMCs

From the Table 2 and figure 2 it is cleared that the tensile strength of MMC increase with increasing weight percent of Sic and Co content. The resistance of Aluminum 6061 alloy is very small as compare to fabricated MMCs due to uniform distribution of Sic and Co particulates in the MMCs. The Sic and Co particles behave as an obstacle for the stress transfer from one place to another which further increases the tensile strength [4]. Also, the properties of the particulates control the transfer and distribution of load from one place to another place in the MMC, which further increase tensile strength. The Maximum tensile strength is achieved with 3SAl3C MMC i.e. MMC with 3%wt of Sic, 3%wt of Co because 3SAl3C MMC have more %wt of particulates among the all fabricated MMCs. So it will offer more obstacle for the stress transfer from one place to another.

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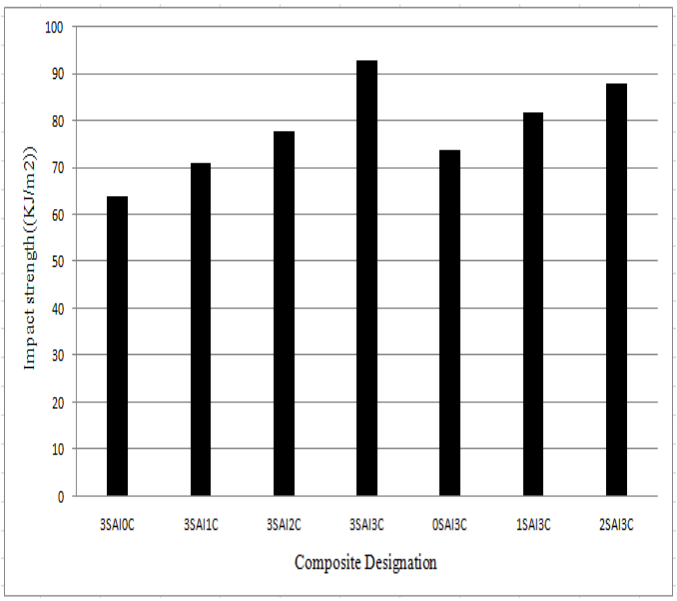
➢ *Effect of Impact strength on Sic & Co powder filled Al 6061 Composites*

An impact test gives the value of toughness of the material that is capability of a material to absorb energy before rupture in joules due to sudden and dynamic application of the load. The Izod impact test is a standard test of the determination of impact strength [5].

In this work, the Izod impact test is carried out on two samples of each composition. Finally, the mean of two values of impact strength is considered as impact strength for that composition. The table 3 shows the impact strength of all the fabricated MMC. The figure 3 shows the bar chart for the average value of impact strength for all the fabricated MMCs.

Table 3 Impact strength of the fabricated MMCs

Composite Designation	Sample1 (KJ/m^2)	Sample 2 (KJ/m^2)	AverageImpact strength (KJ/m^2)
Al/Sic/CoMMC (3SAl0Co)	58	70	64
Al/Sic/Co MMC (3SAl1Co)	79	63	71
Al/Sic/Co MMC (3SAl2Co)	82	74	78
Al/Sic/CoMMC (3SAl3Co)	87	99	93
Al/Sic/Co MMC (0SAl3Co)	72	76	74
Al/SiC/Co MMC (1SAl3Co)	89	75	82
Al/Sic/CoMMC (2SAl3Co)	82	94	88



Bar Chart of Average Value of Impact Strength for All MMCs

From the Table 3 and figure 3 it was revealed that as the % wt of SiC and Co content increases, the impact strength of MMCs also increases. It is due to the excellent wettability property of cobalt and SiC particles with the aluminium 6061 alloy at the interface. The excellent wettability property of cobalt and SiC particles with the aluminium 6061 alloy at the interface increase the bonding between reinforce particles and matrix which further increase the capacity of absorbing the energy before fracture i.e. impact strength [4]. Also, the particulates control the transfer and distribution of load from one place to another place in the MMCs [6]. which further increase the impact strength. The Maximum impact strength is achieved with 3SAl3C MMC i.e MMC with 3%wt of SiC, 3%wt of Co because 3SAl3C MMC have more %wt of particulates among the all fabricated MMCs. So it will offer more capacity to absorb energy before rupture.

IV. CONCLUSION

➢ *The Following Conclusion have been Drawn from Present Research Work*

- For the weight wt. % of Sic-Co in aluminum matrix the Tensil Strength of the MMC is increase with the increasing of the Sic-Co reinforcement and maximum at 3 wt.%.of Sic-Co particulate.
- For the weight wt. % of Sic-Co in aluminum matrix the Impact strength of the MMC is increase with the increasing of the Sic-Co reinforcement and maximum at 3 wt.%.of Sic-Co particulate.

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