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Research Article

Studies of Mechanical Properties of Aluminium metal matrix alloy with Silicon Carbide

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Abstract

A composite material contains matrix phase (metal) and reinforcement phase (SiC); combined together and produce the material with better properties than conventional materials. The reinforcement is added in the bulk material to increase its strength and stiffness. To meet the objectives the composite material was fabricated by varying the SiC weight fraction (5%, 7%, and 9%), while other parameters keep constant. For all grades of material, an increasing trend in the shear and tensile strength was found with the increase in SiC weight %. During the test, the fracture mode was found to be ductile in nature. During tensile test, the elongation of the material was found to decrease from 7% to 9% SiC weight percentage increment. This may be because of non-uniform mixing of the SiC in the matrix phase or generation of pore or cracks with SiC increment which was earlier validated with the microstructure analysis.

Keywords: *Aluminum alloys, silicon carbide, shear test, tensile test.*

1. Introduction

The Metal Matrix Composite (MMC) made up from two phase continuous and discontinuous. The continuous phase is in the form of the matrix which consist metal itself. While, discontinuous phase also called reinforcement is present in the form of whiskers, fibers or particles. Considerable research interest in this field has been increasing because of their high volume to weight ratio. They have the wide range of applications like in aircraft, bicycle, automobile and space shuttle. In combination, MMC provides the properties which are not possible to achieve with conventional material. These properties can be increased in strength and stiffness or else other.

In the same direction, a modest attempt has been made in the present work for increase in the yield, shear and tensile strength of the composite material. Three different grades of Al alloy was chosen for the analysis and SiC at three varying weight % (5%, 7% and 9%) was added to the melt of all three grades. The fabrication step involved for Al/SiC MMC development are already explained in the previous work. Hardness test was also done in the previous work and the results were found to be satisfactory. The hardness value was increasing with the SiC weight % increment (Kundu, P. *et al,* 2013). The present work is the extension of the previous work and hardness and tensile test was done cast material. Current paper is organized in four sections. Results obtained from tensile and shear test are presented in section 2 & 3 respectively. Section 4 concludes the paper.

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2. Tensile test

The computer interfaced 50 ton Universal Testing Machine (UTM) was used for the tensile testing (Fig. 1). The samples used for testing are of dog-bone shape made by machining as shown in Fig. 2. The hydraulic pressurized system was used for loading of the specimens. The load reading at yield point and broken point was noted down (Reddy *et al*, 2010). The elongation was measured by the extensometer. The load-deflection curve was also obtained with the help of computer attached to the machine. Fig.3 shows the load-deflection curve for Al 6063/SiC MMC with 5% weight percentage.

Fig. 1. 50 Ton Universal Testing Machine

Fig. 2. Specimen used for tensile testing

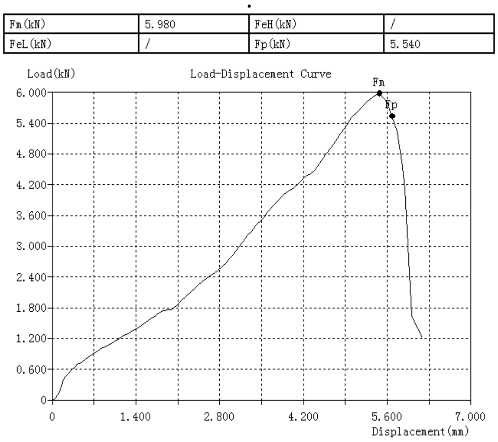

Fig. 3. Load deflection curve for Al 6063/SiC MMC with 5% SiC weight percentage (Tensile test)

During the experiment, extensometer gives the elongated length. For calculation of the % elongations following calculations were made:
Al 6063 with 5% SiC was considered for the demonstration of the % elongation calculation. The specimen has the diameter of 10 mm and area of 80.08 mm^2. Percentage elongation can be defined as:

$$\text{Elongation (\%)} = \frac{\text{Elongated Length} - \text{Gauge Length}}{\text{Gauge Length}} \times 100 \qquad (1)$$

where, Gauge Length = $(5.65) \times A^{1/2}$ = 50.0 mm and elongated length from the experiment was found 51.6 mm. Percentage elongation for this case can be calculated as:

$$\frac{51.6-50.0}{50.0} \times 100 = 3.2\%.$$

Table 1 Results obtained from tensile test

Material	Ultimate Tensile Strength (MPa)	Yield Stress(MPa)	Elongation (%)
Al6063+5% Sic	74.7	49.9	3.2
Al6063+7% Sic	120.1	75.4	10
Al6063+9% Sic	117.7	75.4	6.8
Al6066+5% Sic	133.1	98.8	2.4
Al6066+7% Sic	123.9	91.2	3.2*
Al6066+9% Sic	122.6	94.4	2.4
Al6351+5% Sic	112.6	95.3	1.8*
Al6351+7% Sic	107.4	92.4	0.8*
Al6351+9% Sic	118.4	96.6	1.6

*Sample broke near the gauge mark

Table 1 shows the various results obtained from the tensile test. The yield and ultimate tensile strength were found to be in ascending order of Al6063, Al6066, and Al6351. With the increase in the SiC weight percentage, both the properties were found to be increasing. Whereas, elongation % was increasing from 5% to 7% and decreasing from 7% to 9% SiC weight percentage for all the grades of Al alloy. This may be because of increase in the crack and porosity with SiC weight % increment which is already explained in previous work with the help of microstructure analysis.

3. Shear Test

Machine used for the tensile test is used for shear test also (Fig. 1). The jig used for the shear test is shown in Fig. 4. The results obtained from the shear test are shown in Table 2. In shear test also, increase in shear strength of the specimen was found with SiC weight %. Like the tensile test, Fig. 5 shows the load-displacement curve for the shear test.

Fig. 4. Jig Used For Shear Test

Table 2 Results obtained from Shear test

Material	5% Sic	7% Sic	9% Sic
Al 6063	107.2	94	97.8
Al 6066	120.9	110.9	119.4
Al 6351	119.5	114.4	126.6

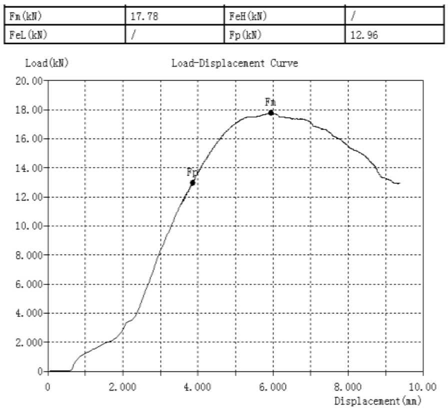

Fig. 5. Load deflection curve for Al 6063/SiC MMC with 5% SiC weight percentage (Shear test)

Conclusions

In the present work, the shear strength, yield strength and ultimate tensile strength of three different grades of Al alloys were calculated. All three properties of Al/SiC MMC were found in ascending order of Al 6063, Al6066 and Al 6351. The fracture mode was found to be in ductile nature for all three grades. In addition, the shear strength, yield strength, and ultimate tensile strength were found to be increasing with SiC weight %. During tensile test, the elongation of the material was found to decrease from 7% to 9% SiC weight percentage increment. This may be because of non-uniform mixing of the SiC in the matrix phase or generation of pore or cracks with SiC increment which was earlier validated with the microstructure analysis.

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