

Fabrication and Tensile Testing of Al6063 based Mono and Hybrid Composites

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Abstract— The Al based Metal matrix composites (MMC) are an important class of high performance advanced materials with potential engineering applications especially in the area of aerospace, defense and automotive industries. The advantages of Al based MMC over traditional alloys are high specific strength, improved stiffness and modulus, increased wear resistance, high temperature strength, low coefficient of thermal expansion and good damping capacity. In the present investigation cast Al6063 alloy was used as the matrix and silicon carbide (SiC) and Aluminium oxide (Al₂O₃) particles were used as reinforcement. The mono and hybrid metal matrix composite was fabricated using conventional liquid metal stir casting technique. By varying weight percent (5, 10, 15) of SiC, Al₂O₃ and (SiC+Al₂O₃) particles to the molten metal, while keeping all other parameters constant. The mono and hybrid composites are characterized mechanical properties.

Keywords— Metal Matrix Composites, Reinforcement (Al₂O₃, SiC and Al₂O₃+SiC), Casting, Tensile Strength, Density

I. INTRODUCTION

Aluminium alloys are used in advanced applications because of their combination of high strength, low density, durability, machinability, availability and the cost is also very attractive compared to competing materials. Composites are materials in which two phases are combined, usually with strong interfaces between them. They usually consist of a continuous phase called the matrix and discontinuous phase in the form of fibers, whiskers or particles called the reinforcement. Considerable interest in composites has been generated in the past because many of their properties can be described by a combination of the individual properties of the constituent phases and the volume fraction in the mixture.

Composite materials are gaining wide spread acceptance due to their characteristics of behavior with their high strength to weight ratio. The interest in metal matrix composites (MMCs) is due to the relation of structure to properties such as specific stiffness or specific strength. Like all composites, aluminum matrix composites are not a single material but a family of materials whose stiffness, density and thermal and electrical properties can be tailored. Composites materials have high stiffness and high strength, low density, high temperature stability, high electrical and thermal conductivity, adjustable coefficient of thermal expansion, corrosion resistance, and improved wear resistance. The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. When designed properly, the new combined material exhibits better strength than would each individual material.

II. DETAIL OF EXPERIMENT

A. Materials

Al 6063 was used as the matrix, aluminium oxide (Al₂O₃) and SiC as soft reinforcement. This matrix was used for thin-walled castings that demand high strength, such as castings for the general engineering.

Component	Mn	Fe	Mg	Si	Zn	Ti	Cr	Cu	others
Weight %	0-10	0-35	0.4-0	0.2-0.6	0-10	0-10	0-10	0-10	0.0-0.15

Table 1: Chemical Properties of Al 6063

It has very good castability and is suitable for sand, gravity die-casting, and high-pressure die casting. To produce composites, the stir casting technique was used. Particle size of 220 micron alumina and 200 micron particle sizes of silicon carbide were used in this composite. Reinforcement in varying amounts ranging between 5%, 10%, 15 wt. % was mixed with Al6063. The weight of the composite sample was measured with the help of an electronic balance.

B. Experimental Procedure

Our objective is fabrication and analysis of Al based SiC of aluminum alloy of grade Al6063 with addition of varying weight percentage composition of SiC by stir casting technique. So an experimental setup is made on which experiment is performed and samples will be prepared for characterization. These are some names of equipment which will be used in this experimental work:

1) Stir Casting Technique

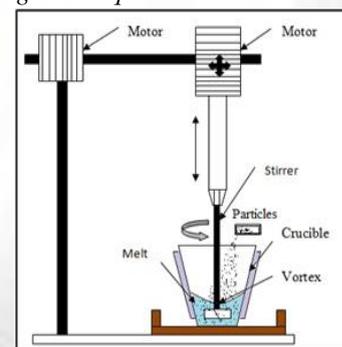


Fig. 1: Stir casting set-up

In this process, the matrix material will be heated in a resistance furnace to above its liquids temperature so that the metal is totally melted. The melt will be then cooled down to a temperature between the liquids and solidus points and kept in a semi-solid state. At this stage, the preheated particles are added and mixed. The slurry is again heated to a fully liquid state and mixed thoroughly. After mixer will be stirred and poured in mold to prepare samples & characterization of samples will be done.

2) Mechanical Tests

Mechanical Tests such as Tensile and Hardness were conducted as per the ASTM standards. In the present study, the tensile test was conducted to using a standard computer-interfaced UTM. The test was carried out at ambient temperature and in accordance with ASTM A370 standards. Tensile Test has performed on the material to check the Tensile Strength and percentage Elongation.

III. RESULT AND DISCUSSION

The Table 2, shows the results of tensile test as follow:

Sr. No.	Nomenclature	Area (mm ²)	T.S. (MPa)	% E.L.	Density (Kg/m ³) ($\times 10^{-3}$)
1.	Al 6063+ Sic- 5%	122.375	89	8.0	2.524
2.	Al 6063+ Sic- 10%	119.839	86	6.1	2.543
3.	Al 6063+ Sic- 15%	239.252	89	6.2	2.517
4.	Al 6063+ Al ₂ O ₃ 5%	124.147	108	6.6	2.533
5.	Al 6063+ Al ₂ O ₃ - 10%	123.949	101	5.2	2.533
6.	Al 6063+ Al ₂ O ₃ - 5%	120.811	86	7.7	2.509
7.	Al 6063+ Al ₂ O ₃ + Sic 5%	123.358	102	4.4	2.593
8.	Al 6063+ Al ₂ O ₃ + Sic 10%	120.617	82	3.4	2.616
9.	Al 6063+Al ₂ O ₃ + Sic 15%	116.563	135	9.1	2.674

Table 2: Tensile test, Elongation and Density Result:

Tensile tests were performed on the composites produced in accordance with the specification. The samples for the test were machined to round specimen configuration with 6 mm diameter and 30 mm gauge length. The test was carried out at room temperature using an universal testing machine operated at a strain rate. Three repeat tests were performed for composite composition to guarantee reliability of the data generated.

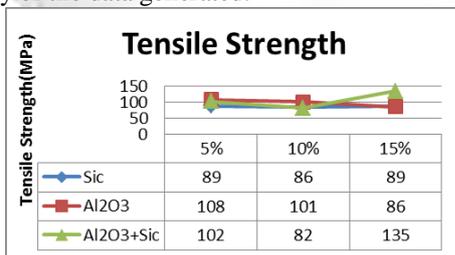


Fig. 2: Tensile test

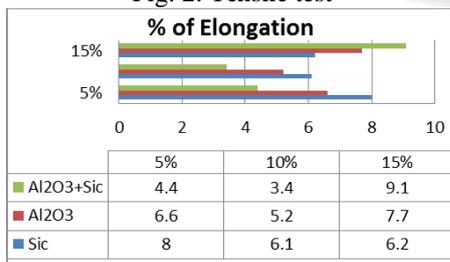


Fig. 3: Elongation

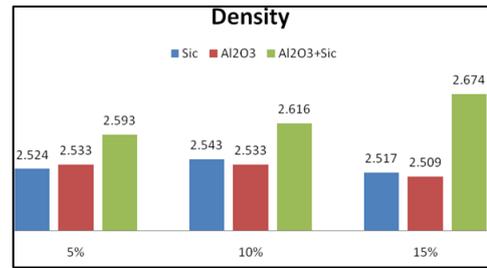


Fig. 4: Density

The samples were machined to get dog-bone specimen for the tensile test. The shape and dimensions of the tensile specimen. The computer-interfaced UTM (Universal Testing Machine) was used for the tensile test. The loads at which the specimen has reached the yield point and broken were noted down. The extensometer was used to measure the elongation.

IV. CONCLUSION

In this research work, Al 6063/Sic/Al₂O₃ composites are fabricated using the stir-casting technique and the mechanical behavior of the metal matrix composites were studied. The following important observations can be noted:

- 1) It appears in this study that Tensile Strength starts increases with increase in weight Percentage of Sic and Decrease with increase of percentage of Al₂O₃. The best result of tensile strength has been obtained at 15% weight of Sic+Al₂O₃.
- 2) Density and Elongation of Al 6063 with silicon carbide (Sic), Alumina (Al₂O₃) varies with the weight Percentage of Al₂O₃ and Sic. The best result of density and elongation has been obtained at 15% weight of Sic+ Al₂O₃.

REFERENCES

- [1] L.F. Mondolfo, Aluminium alloy: Structure and properties, Butterworth and Co ltd, London, (1976) 253.
- [2] T.P.D. Rajan, R.M. Pillai, B.C. Pai, K.G. Satyanarayana, P.K. Rohatgi(2007). "Fabrication and characterization of Al-7si-0.35 Mg/fly ash metal matrix composites processed by different stir casting routes" Journal composites Science and Technology 67, pp. 3369-3377.
- [3] Mitesh Kumar and Ashok Kumar Mishra(2014). "Mechanical Behavior Of Al 6063/Mos₂/ Al₂O₃ Hybrid Metal Matrix Composites" International Journal of Scientific and Research Publications, Volume 4, Issue 12.
- [4] Girisha.H.N, Dr.K.V.Sharma.(2012) " Effect of Magnesium on strength and microstructure of Aluminium Copper Magnesium alloy" International Journal of Scientific & Engineering Research, Volume 3, Issue 2.
- [5] Chennakesava Reddy and Essa Zitoun(2010). "Matrix Al-alloys for silicon carbide particles reinforced metal matrix composites" Indian Journal of Science and Technology, vol. 3 No. 12 (Dec 2010).