

# Investigation and analysis for Mechanical Properties of Aluminium Silicon Carbide Composite

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**ABSTRACT:** In present scenario, different Metal Matrix Composites (MMCs) are being developed for potential applications in aerospace and automotive industries due to their superior strength to weight ratio, high temperature resistance, better corrosion and wear resistance. Among the developed MMCs, automotive industries are attracted towards the use of aluminum silicon carbide metal matrix composites. In the present work five different composition samples of Al-SiC composites with varying weight fraction of SiC (i.e. 5%, 10%, 15%, 20%, and 25%) were prepared by using stir-casting technique. Commercial aluminium and SiC powder (400 grit size) were used to prepare samples. Mechanical test included tension, compression and hardness test which were carried on Universal Testing Machine and Brinell hardness Tester respectively. In mechanical test analysis, tensile strength, compressive strength and hardness values were found to be maximum for Al-15% SiC.

**KEYWORDS:** Metal Matrix Composite (MMC), Aluminium, Silicon Carbide (SiC), Casting, Tensile strength, Compressive strength, Hardness.

## I. INTRODUCTION

Aluminium is the second-most plentiful element on earth and it became an economic competitor in the engineering applications as early as the end of the 19th century. Among the most striking characteristics is its versatility. The applications of aluminium and its alloys for the machine parts are more in the industry as compared to other metals alloys. Aluminium alloys are preferred engineering material for automobile, aerospace, structural application. In present scenario, different Metal Matrix Composites (MMCs) are being developed as an alternative material to metals alloys for potential applications in aerospace and automotive industries due to their superior attributes. The Major attributes of MMCs which differentiate it with metal alloys are enhanced tensile and compressive strength, improved hardness, high temperature resistance, better corrosion and wear resistance.

Among the developed MMCs, automotive industries are attracting towards the use of aluminum silicon carbide metal matrix composites. In the present study an attempt has been made to develop aluminium based silicon carbide particulate MMCs by stir casting method to investigate the mechanical properties of the Al-SiC composites.

The objectives of this research work are outlined as follows:

- Fabrication of commercial aluminium based metal matrix composite reinforced with Silicon carbide by low cost stir casting technique.
- Mechanical characterization of Al-SiC composites.

## II. METHODOLOGY

In order to prepare the Al-SiC samples, Commercial aluminium rod measuring 4 ft length having cross section of 5 cm x 2 cm and SiC powder (400 grit size) was purchased from the open market. The weight of Aluminium cut piece and SiC powder was measured on weighing scale. Fig 1 shows the weighing of commercial aluminium and SiC powder by Digital weighing scale.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016



**Fig 1 Weighing of SiC and Commercial Aluminium on Weighing Machine**

Aluminium and SiC was taken in different proportion for the preparation of Al-5% SiC, Al-10% SiC, Al-15% SiC, Al-20% SiC and Al-25% SiC respectively. For making Al-SiC composite, a coal-fired furnace was made in-house in the workshop of SRMSCET Bareilly. The furnace was prepared by using 12 gauge MS plate of 1.5 m length and 450 mm width.

Firstly, coal of furnace was fired with scrap wood. Weighted Aluminium was put in the graphite crucible. Particles of silicon carbide are preheated up to a high temperature  $350^{\circ}\text{C}$  for one hour in muffle furnace. Weighted Aluminium samples were also preheated up to a temperature  $350^{\circ}\text{C}$  in the coal furnace. Then silicon carbide powder was poured in to crucible furnace. This composite slurry (Commercial Al and SiC powder) was heated in furnace crucible to approx  $900^{\circ}\text{C}$ . Manual mixing of melted composite slurry was done by a thick steel stick for approx 30 minutes continuously. The resultant molten mixture was then used for sand casting. Fig 2 shows the melting and stirring of Al and SiC particles.

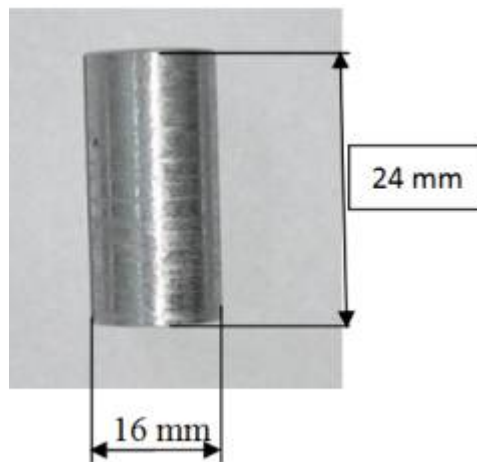


**Fig 2 Manual Stirring of Composite Slurry in Crucible of Coal Fired Furnace**

Tensile, compressive, hardness and wear test specimens were prepared for all sample materials by sand casting technique. For this purpose different patterns were made. These patterns were used in sand casting to make casted components. These casted components were further used to make standard test specimens. Fig 3, Fig 4 and Fig 5 shows the prepared tensile, compressive and hardness test specimen respectively.



**Fig 3 Al-Sic Composite Tensile Test Specimen**



**Fig 4 Prepared Standard Compression Test Specimen**

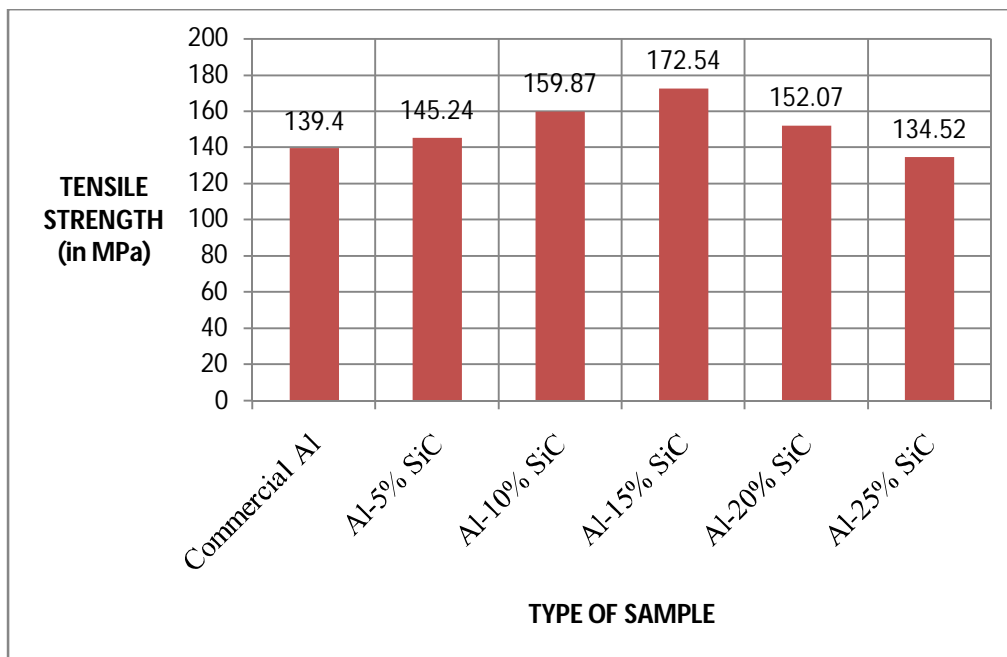


**Fig 5 Hardness Test Specimen**

Mechanical test includes tension, compression and hardness test which were carried on Universal Testing Machine and Brinell Hardness Tester respectively. Preparation of samples, tensile test, compression test and hardness test were carried out in the workshop of Mechanical engineering department of S.R.M.S. College of Engineering and Technology, Bareilly.

**III. RESULTS AND DISCUSSIONS**

Tensile test of the entire prepared specimen were carried out on UTM. Initially for commercial aluminum, tensile strength was measured as 139.40 MPa which is 4.2% less than Al-5% SiC composite. It is clear from Fig 6 that the composite sample with 15% SiC gives the maximum tensile strength i.e. 172.54 MPa. If the SiC percentage (5%) is increased further in the composite then there is reduction of tensile strength



**Fig 6 Ultimate Tensile Strength of All Samples**

Compression test of the entire prepared specimens were also carried out on UTM. . Maximum compressive strength value was found to be 322.85 MPa for Al-15% SiC composite material. The results of compression test are shown in Fig 7.

Hardness test was carried out on Brinell Hardness Tester. On each sample specimen, four impressions were made by steel indenter ball and diameter of each impression was predicted by brinell microscope. Average value was taken to calculate the Hardness value in BHN. The maximum value of hardness was found to be 87.1 BHN for Al-15% SiC composite. Fig 8 shows that the addition of SiC up to 15% in Al which increases the hardness value of the prepared composites and if SiC is added over 15%, hardness value decreases.

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(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

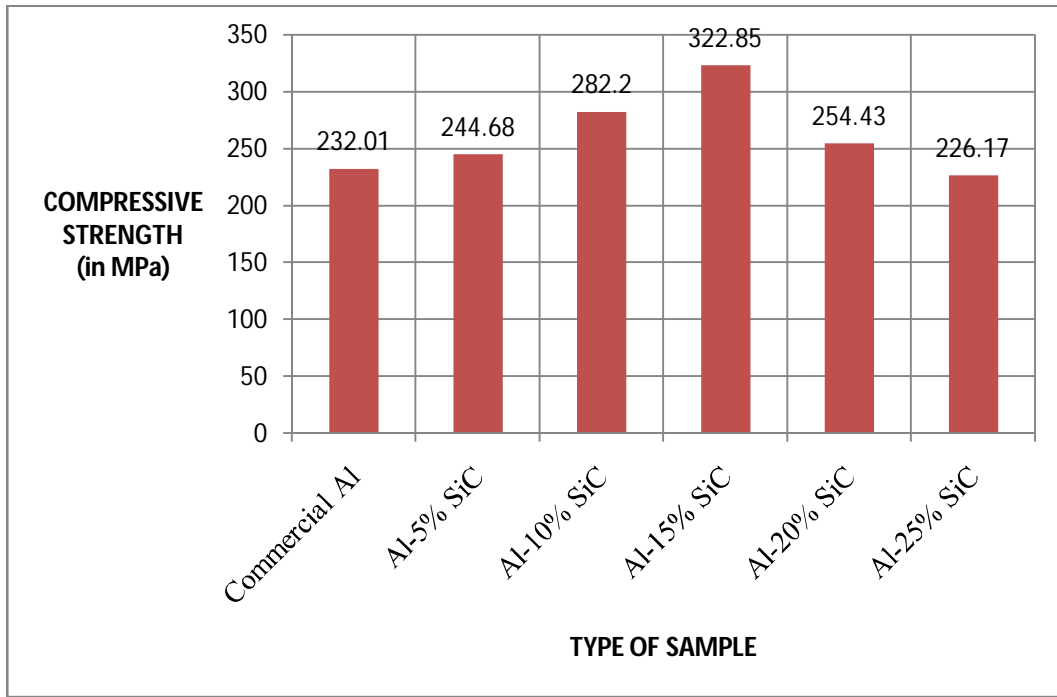


Fig 7 Compressive Strength of All Samples

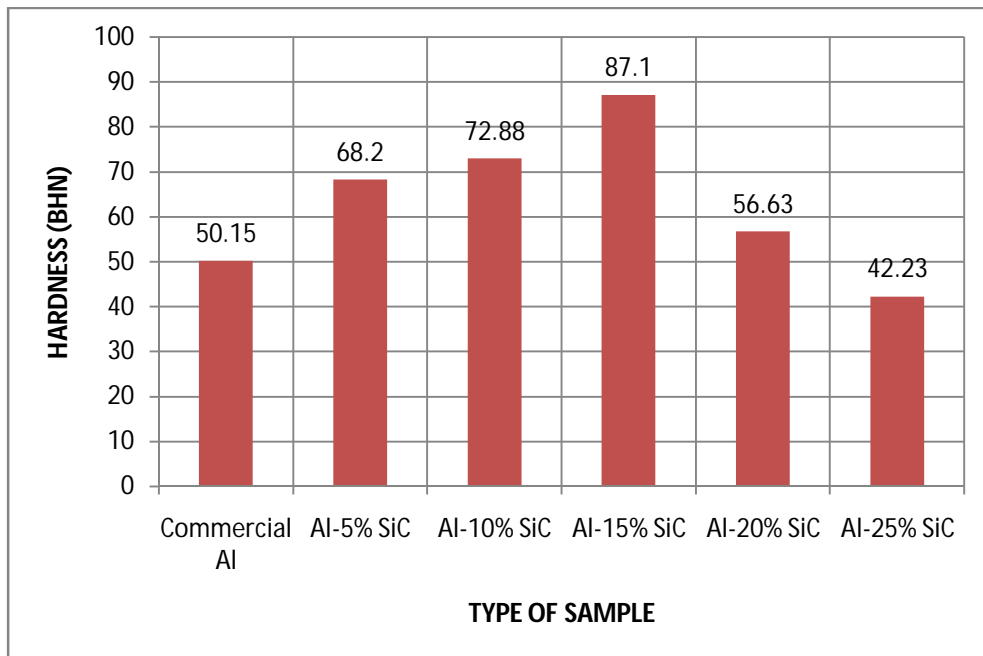


Fig 8 Hardness of All Samples

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Vol. 5, Issue 9, September 2016

## IV. CONCLUSIONS

The experimental investigation of mechanical properties has led to the following specific conclusions:

1. Successful fabrication of Al-SiC metal matrix composites with the reinforcement of SiC was made possible using stir casting method.
2. It was observed that commercial Aluminium without addition of SiC had strength of 139.4 MPa in tension and 232 MPa in compression. But with the addition of SiC (5%, 10% and 15%) the strength increases to 145.24 MPa, 159.87MPa, 172.54 MPa in tension and 244.68 MPa, 282.20 MPa, 322.85 MPa in compression respectively. Further, when the SiC was added beyond the 15% (i.e. for Al-20% SiC and Al-20% SiC), tensile as well as compressive strength of composites decreases.
3. The hardness value for commercial aluminium was measured as 50.15 BHN. The hardness values were found to increase (68.2, 72.88 and 87.1 BHN) with addition of SiC (5%, 10% and 15%) respectively. But with the addition of SiC over 15%, large decrease in hardness values (34.98 % and 25.42 %) was observed for Al-20% SiC and Al-25% SiC respectively.

## REFERENCES

- [1] Elwin L. Rooy "Introduction to Aluminum and Aluminum Alloys", ASM Handbook Volume-2, pp.17-38
- [2] Pradeep K. Rohatgi, "Metal-Matrix composites", Defence Science Journal, Volume 43, Issue 4, October 1993, pp 323-349.
- [3] Atul Kumar, Dr.Sudhir Kumar and Dr.Rohit Garg, "A Review Paper on Stir Casting of Reinforced Aluminum Metal Matrix Composite", International Journal of Advance Research in Science and Engineering, Volume 4, Special Issue (01), August 2015.
- [4] Nikhilesh Chawla and Yu-Lin Shen, "Mechanical Behaviour of Particle Reinforced Metal Matrix Composites" Advanced Engineering Materials, Volume 3, 2001, pp 6.
- [5] C. Sun, M. Song, Z. Wang, Y He, "Effect of Particle Size on the Microstructures and Mechanical Properties of SiC-Reinforced Pure Aluminum Composites", Journal of Materials Engineering and Performance, Volume 20(9) (2011), pp 606-1612.
- [6] I.N. Popescu, S. Zamfir, V.F. Anghelina, C.O. Rusanescu, "Processing by P/M route and characterization of new ecological Aluminum Matrix Composites (AMC)", International Journal of Mechanics. Volume 3(4)(2010),pp 71-80.
- [7] Manoj Singla, D. Deepak Dwivedi1, Lakhvir Singh and Vikas Chawla, "Development of Aluminum Based Silicon Carbide Particulate Metal Matrix Composite", Journal of Minerals & Materials Characterization & Engineering, Vol. 8, No.6, 2009, pp.455-467.
- [8] G. B. Veeresh Kumar1, C. S. P. Rao, N. Selvaraj and M. S. Bhagyashekar, "Studies on Al6061-SiC and Al7075-Al2O3 Metal Matrix Composites", Journal of Minerals & Materials Characterization & Engineering, Vol. 9, No.1, 2010,pp.43-55.
- [9] Neelima Devi. C, Mahesh.V and Selvaraj. N, "Mechanical characterization of Aluminium silicon carbide composite", International Journal of Applied Engineering Research, DINDIGUL, Volume 1, No 4, 2011.
- [10] Daljeet Singh, Harmanjit Singh, Som Kumar and Gurvishal Singh, "An Experimental investigation of Mechanical behavior of Aluminum by adding SiC an Alumina", International Journal on Emerging Technologies, volume 3(1), pp 178-184(2012)
- [11] Mr. Amol D. Sable1 and Dr. S. D. Deshmukh, "Preparation of Metal-Matrix Composites By Stir casting Method", International Journal Of Mechanical Engineering and Technology, Volume 3, Issue 3, September - December (2012), pp. 404-411.
- [12] B. P. Samal, S. C. Panigrahi and B. Sarangi, "Use of Modified Stir Casting Technique to Produce Metal Matrix Composites", International Journal of Engineering and Technical Research, ISSN: 2321-0869, Volume-1, Issue-9, November 2013.
- [13] Rajeshkumar Gangaram Bhandare, Parshuram and M. Sonawane, "Preparation of Aluminium Matrix Composite by Using Stir Casting Method", International Journal of Engineering and Advanced Technology, ISSN: 2249 – 8958, Volume-3, Issue-2, December 2013.
- [14] Shubham Mathur and Alok Barnawal, "Effect of Process Parameter of Stir Casting on Metal Matrix Composites", International Journal of Science and Research, Volume 2 Issue 12, December 2013.
- [15] Pradeep R, B.S Praveen Kumar and Prashanth B, "Evaluation of Mechanical Properties of Aluminium Alloy 7075 Reinforced With Silicon Carbide and Red Mud Composite", International Journal of Engineering Research and General Science, Volume 2, Issue 6, October-November, 2014
- [16] Satyanarayan, Dominic Roystan, M.Shreesaravanan, Balaguru and C.Devanathan, "A Study on Mechanical Properties of Aluminium LM25-SiC Composites Fabricated Using Stir Casting Technique", International Journal of Advanced Research Trends in Engineering and Technology, VolumeII, Special Issue XXII, February 2015.