

# **A Review on Fabrication and Property Analysis of AL LM-25/SiC Composite by Using Stir Casting Method**

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**ABSTRACT:** Aluminum MMC's are widely used in various applications because of their higher mechanical and physical properties when compared with their base Al alloy. This review paper focuses on the change in mechanical properties of various Al/SiC composites fabricated by using stir casting method. Effect of SiC reinforcement in different AL alloys on mechanical properties like hardness, tensile strength, wear test, percentage elongation, residual stress measurements are discussed in detail. For this purpose various reinforcement of SiC with different weight percentage and different particle sizes are considered along with Al alloys. Variations in process parameters of stir casting are also made and taken into consideration.

**KEYWORDS:** Al/SiC, Al LM-25, Hardness, MMCs, Tensile Strength, Wear Resistance.

## **I. INTRODUCTION**

A metal matrix composite (MMC) is a composite material with a mixture of two or more constituent parts, one being a metal, other material may be a different metal such as a ceramic or organic compound. If three materials are present, it is called as hybrid composite. The unique characteristics of the composite materials for the specific requirements make these materials more popular in a variety of applications like aerospace, automotive and structural components, resulting in savings of material and energy. Metal matrix composites (MMCS) have become an important class of materials for structural, wear, thermal, transportation and electrical applications. This is due to their ability to exhibit superior strength-to-weight and strength-to-cost ratio when compared to equivalent monolithic commercial alloys. The strength of the composites depends on the amount, arrangement and type of reinforcement in the resin.

Aluminium-based particulate reinforced metal matrix composite has high class of performance material for which it is used in aerospace, automobile, chemical and transportation industries because of its improved strength, high elastic modulus and increased wear resistance over conventional base alloy. To improve different properties of the main material, such as wear resistance, hardness, fatigue resistance, friction coefficient, thermal conductivity and others, reinforcement is used. As from recent studies, MMCs have found a lot of application in automobile industry for the production of brakes and parts of engines and in aerospace industry for the production of structural components, as well as in electrical and electronic industry and in many other applications Composite materials which main constituent part is a metal are called Metal Matrix Composites (MMCs). The other compounds may be metals too, ceramics or even organics. They are well known for their excellent thermo-physical and mechanical properties..

## **II. OBJECTIVES**

The main objective of this review paper is to discuss the effect of reinforcement of SiC on the properties of AL alloys when composite material is fabricated by using Stir casting method.

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## III. PROPERTIES OF MATERIAL

### 3.1 Properties of Al-LM25

Property	Tensile Stress (N/mm <sup>2</sup> )	Elongation (0%)	Brinell Hardness Number	Specific Gravity	Freezing Range (°C) Approx
Value	130-150	2	55-65	2.68 gm/cc	615-550

**Table-1: Properties of Al-LM25**

### 2.1 Properties of SiC

Property	Density	Poisson's Ratio	Modulus of Elasticity	Tensile Strength	Hardness
Value	3.1 gm/cc	0.19	476 GPa	310 MPa @ R.T.	2800 Kg/mm <sup>2</sup>

**Table-1: Properties of SiC**

## IV. STIR CASTING

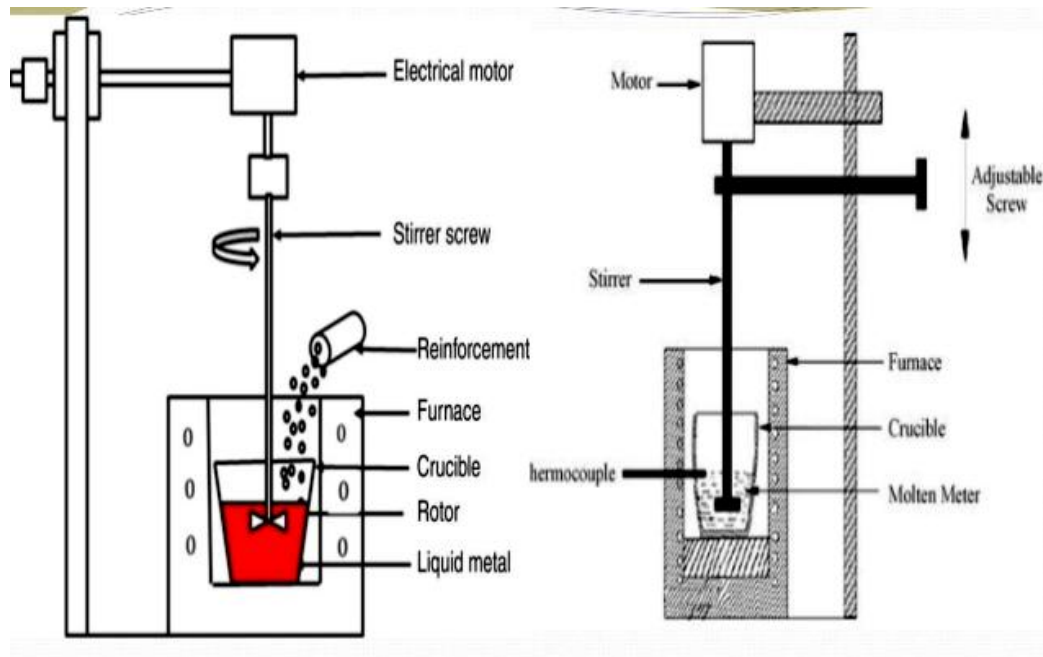
Stir casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring. Stir casting is the simplest and the most cost effective method of liquid state fabrication. Conventional stir casting is having various developments when compared with conventional stir casting. This development makes stir casting more efficient, economical which opens the many ways in research work related with composite materials. Among the different manufacturing processes available for discontinuous metal matrix composites, stir casting is generally accepted, and currently practiced commercially.

Its advantages are in its simplicity, flexibility and applicability to large scale production and, because in principle it allows a conventional metal processing route to be used, and its low cost. The liquid metallurgy technique is the most economical among all the available routes for metal matrix composite production, it allows very large sized components to be fabricated and is able to sustain very high productivity rates. The cost of preparing composites materials using a casting method is very low compare to that of competitive methods and for high volume production it is projected that costs will fall to one-tenth of total cost. Stir casting of MMCs involves melting of the selected matrix material, followed by the introduction of a reinforcing material into the melt, obtaining a suitable dispersion through stirring.

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**Fig-1: Stir Casting Machine**

## V. LITERATURE REVIEW

Balasubramanian et al. [2015] fabricated metal matrix composite with matrix material as a AA 6063 and reinforcement material as sic with different weight % of 0, 5, 10, 15 by using stir casting method. Hardness for the specimens with 0, 5, 10, 15 % of SiC found 55.8, 64.17, 71.93, 86.07 kgf/mm<sup>2</sup> respectively. Tensile strength for the specimens with 0, 5, 10, 15 % of SiC found 140.94, 165.97, 180.61, 175.25 N/mm<sup>2</sup> respectively. When he compared properties like hardness, tensile strength and wear resistance of composite material with matrix material AA 6063 he found that the properties of composite material increases with increase in weight percentage of sic. [1].

J. Jebeen Moses et al. [2014] in his studies fabricates aluminum metal matrix composite with matrix material AA 6061 and SiC as a reinforcement material with wt. % of 0, 5, 10, and 15 by using stir casting method. When he compared hardness and tensile strength of composite material with matrix material AA 6061, properties increased as the wt. % of SiC increases. Hardness of the material increases up to 133.33% as compared with unreinforced AA 6061 while UTS increases up to 65.2% as compared with unreinforced AA 6061 alloy [2]

David Raja Selvam. J et al. [2013] used stir casting method for the fabrication of aluminum metal matrix composite. He used AL 6061 as a matrix material and SiC as a reinforcement material wt. % of 7.5 and 10 along with fly ash constant wt. % 7.5. After conducting different property tests like hardness, tensile strength, thermal co-efficient. of expansion, he found that reinforcement materials enhances the properties of matrix material as the wt. % increases. Ultimate tensile strength of the material increases from 173 Mpa to 213 Mpa as the wt. % of Sic increases with constant fly ash wt. %. Thermal co-efficient. of expansion of Sic & fly ash composite is  $3.25 \times 10^{-6}/^{\circ}\text{C}$  while Thermal co-efficient. of expansion of AL 6061 is  $23 \times 10^{-6}/^{\circ}\text{C}$ . Micro hardness increase from 69.53 HV to 78.8 HV while macro hardness increases from 49.4 BHN to 57.21 BHN [3].

Ajay Anand et al. [2015] found improvement in properties when he fabricated an aluminum metal matrix composite by using stir casting method. He used AL 6061 as a matrix material and formed a composite by reinforcing SiC in it with wt. % of 2, 4, 6 and 8. His results show that hardness, tensile strength and compression strength increases

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with increase in wt. % of SiC. Hardness of the materials with 0, 2, 4, 6 and 8 wt. % of SiC found 65, 66.3, 67.6, 68.8 and 67.8 respectively. Compression strength of the materials with 0, 2, 4, 6 and 8 wt. % of SiC found 496.71, 775.72, 781.08, 693.06 and 656.23 Mpa respectively. Tensile strength of the materials with 0, 2, 4, 6 and 8 wt. % of SiC found 147.504, 143.383, 142.736, 152.866, 136.320 Mpa respectively. Hardness is highest at 6%, compression strength is highest at 4%, and tensile strength is highest at 6% [4].

M.A. Hassan et al. [2014] fabricated aluminum metal matrix composite by using stir casting method with AL 6063 as a matrix material and SiC as a reinforcement wt. % of 10, 20, 30, 40 and 50. He conducted different property tests like hardness test, tensile test, compression test and impact test. He concluded that properties of the material increases with increase in wt. % of SiC. Tensile strength of the material increases from 131.23 Mpa to 194.60 Mpa. Compressive strength of the material increases from 103.70 Mpa to 167.15 Mpa. Impact strength of the material increases from 140.09 KJm<sup>-2</sup> to 250.37 KJm<sup>-2</sup>. Hardness of the material increases from 39.78 BHN to 56.46 BHN [5].

Dinesh M. Pargunde et al. [2013] used Al [98.41%] as a matrix material, SiC as a reinforcement material with wt. % 5, 10, 15, 20, 25 and 30 for fabrication of aluminum metal matrix composite by using stir casting method. He conducted hardness test and corrosion test on composite material and matrix material and concluded that properties of the material increases up to 25 wt. % of SiC later increase in wt. % of SiC decreases the properties of the material. Hardness of the material with 0, 5, 10, 15, 20, 25, 30 wt. % of SiC found 30.80, 39.33, 40.40, 42.40, 43.60, 44.80 and 41.60 respectively. Impact strength of the material with 0, 5, 10, 15, 20, 25, 30 wt. % of SiC found 10.67, 22.67, 24.00, 27.33, 31.33, 35.33 and 32.00 respectively. Corrosion resistance of the material with 25 wt. % SiC found highest and it is 4.88822 mm/month. The result of the experiment shows that the composite material with 25 wt. % SiC has greater properties among the all compositions [6].

B. P. Samal et al. [2013] fabricated aluminum metal matrix composite by using stir casting method. This fabrication includes AL as a matrix material along with SiC wt. % 10 as a reinforcement and Mg wt. % 3 as a wetting agent. He conducted different property tests like hardness test, tensile test, yield strength, UTS, elastic modulus and % elongation. From these tests he concluded that reinforcement increases the properties of the matrix material as well increase in wt. % of reinforcement increases the properties. Yield strength of the composite (AL-Mg 3 wt. %) found 91 Mpa and 136 Mpa of the composite (AL-Mg 3 Wt. %, Sic 10 Wt. %). Tensile strength of the composite (AL-Mg 3 wt. %) found 224Mpa and 293Mpa of the composite (AL-Mg 3 Wt. %, Sic 10 Wt. %). Elastic modulus of the composite (AL-Mg 3 wt. %) found 62Gpa and 77Gpa of the composite (AL-Mg 3 Wt. %, Sic 10 Wt. %). % elongation of the composite (AL-Mg 3 wt. %) found 21.25 and 6.7 of the composite (AL-Mg 3 Wt. %, Sic 10 Wt. %). Yield strength, Ultimate tensile strength and Elastic modulus increased by 49%, 31% and 24% respectively. The % elongation decreased by 68% shows up to 6% [7].

Satyanarayan et al. [2015] fabricates aluminum metal matrix composite by using stir casting method. For this purpose he took AL LM-25 as a matrix material and SiC as a reinforcement material with wt. % of 3, 6, and 9. He conducted property tests like hardness test, tensile test, and wear test on composites and matrix material. As a result he found increment in properties of material as the wt. % of SiC increases. Hardness of the materials with 0, 3, 6 and 9 wt. % of SiC found 60.3, 73.3, 76.27 and 77.27 respectively [8].

## VI. PROPOSED WORK

Metal matrix composites can be easily replaced with the matrix material for this purpose Metal matrix composites must be fabricated with various combinations of matrix material and reinforcement materials. Metal matrix composites found to be important in various applications due to their properties because of this research in this particular area is very necessary and important. From this review paper it is seen that there are various combinations of matrix material and reinforcement which can be fabricated and studies can be conducted on properties of this Metal matrix composites, so that replacement for the conventional materials can be done and obtain improved applications with better life of applications

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## VII. CONCLUSION

Most of the Aluminum alloys support the reinforcements of the material and due to these reinforcement properties of the matrix material increases up to some extent some of the alloys supports reinforcements up to 50% of its weight percentage but increase in properties is limited up to some weight percentage.

As far as the recent study of composite material manufacturing is concerned stir casting is most effective and efficient in all the conditions such as cost, simplicity of operation, distribution of reinforced particles etc. Stir casting is superior over all methods available for manufacturing of composite materials. Stir casting method is suitable up to 30 weight percentage of reinforcement material.

## VIII. SUMMARY

Stir casting is found very useful in fabrication method for AL/SiC composite as far as cost and effectiveness is concerned. Properties of the matrix material can be easily increased by increasing weight percentage of reinforcement.

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