# CHARACTERISATION OF ALUMINIUM BASED METAL MATRIX COMPOSITE: A REVIEW

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***Abstract*: Aluminum metal matrix composites have better mechanical, tribological and physical properties in comparison to the conventional engineering materials and it has many applications in engineering fields. This paper gives the brief study of recent work over AMMC. This paper provides a brief knowledge of different types of reinforcements and its effects when these are added into aluminum metal matrix. this paper provides the suitable weight percentage ratio of reinforcement for optimum results and provides the mechanical, tribological and physical properties. This paper also provides the review of best fabrications techniques for producing the aluminum metal matrix composites (AMMC's). We find from this paper that AMMC's machining can be good by applying appropriate parameters.**

***Keywords*: Aluminium Metal Matrix Composites, Process, Reinforcement, Casting.**

## I. INTRODUCTION

There was a lot of reduction in properties of conventional engineering materials such as strength, hardness, toughness, density. Day by day, as our technology has been increases, the demand for metal matrix composites has been increases [1]. Because of the metal matrix composite has a light weight and strength, stiffness, toughness, hardness, density would be better than the conventional material. Therefore, aluminum metal matrix composites are used in Structural, aircraft, automobiles, aerospace industries [2].

Composite materials made up of two and more materials whose physical and chemical properties are different and do not dissolve among themselves. Composite is made up of two phases (i.e., Matrix & Reinforcement) [1, 2]. Matrix phase consists of equivalent lighter metals such as aluminum, titanium, and magnesium. It provides support for reinforcements. In fiber (reinforcement) phase, boron carbide (B4C), Silicon carbide (Sic), alumina (Al2O3) and graphite (Gr) are found in the forms of particulates, long and short fibers, the reinforcement is used to enhance the mechanical, Physical and tribological properties [1,2]. In metal matrix composites, matrix material is aluminum and reinforcement material are Graphite in the form of particles. The Graphite reinforcement are commonly used to improve the tribological & mechanical properties in AMMC's [3]. This paper reviews the various important factors like effects of various reinforcements, Physical, mechanical and tribological behaviors, machining of MMC and its applications.

### 1. SILICON CARBIDE (Sic) REINFORCED AMMC

**Fig. No. 1: Sic (Powder form)**

Md. Habibur Rahman et al. [4] experimentally investigated the Characterization of silicon carbide reinforced aluminum matrix composites using stir casting process. Aluminum metal matrix composites (AMMC'S) uses silicon carbide contents from weight of 0% to 20% prepared by stir casting process. The weight Content distribution of 20 % SiC shows the hardness and tensile strength in composites. It was note that the 20% Sic appeared to be optimum. After the experiment, the result shows that when the silicon carbide (Sic) reinforcement is mixed with the aluminum metal matrix, then the stiffness and tensile strength of the composite material increases.

Pavitra Ajagol et al. [5] explored the effect of Silicon carbide (Sic) reinforcement on microstructure and mechanical properties of Aluminum Metal Matrix Composites. Al-Sic composites containing weight fractions of Silicon carbide particles 5%, 10%, 15% are prepared with the use of stir casting process. Sic weight percentage increases the mechanical properties, hence silicon carbide weight percent is directly proportional to the mechanical properties. From investigation it is observed that if we increased the Sic contents in Aluminum metal matrix the porosity levels will be increases. SiC particles weight content of 15 % gives best results in mechanical properties.

Avinash Bhat et al. [6] experimentally explored that the manufacturing of novel composites AL6061 with 5% weight of silicon carbide (SiC) create composite by stir casting process. After experiment, the result revealed that composite Al6061 and 5 % weight contents of Sic has better wear properties as compared to the Al6061 metal matrix. As the load increases the wear rate is found to be higher in the Al6061 than in the Al6061-SiC and the wear rate also increases with increasing RPM when the load is constant.
B Siddhartha et al. [7] studied the result of silicon carbide (SiC) contents in mechanical characteristic and wear rate of aluminum metal matrix composites (AMMC's) by die casting process. it is observed that the inclusion of silicon carbide (Sic) particulates the aluminum metal matrix increases the mechanical characteristic like hardness, tensile strength of the composites. It has revealed that with the wear rate of 71**µm** found with Vicker hardness of 103.1 H. V and by using 30% SiC contents the tensile strength found 162.61 MPa. It is found that as the SiC content increases, the tensile strength, hardness will increase, and the wear rate will be lower at this time.

## 2. ALUMINIUM OXIDE (Al2O3) REINFORCED AMMC

Mohammed Imran et Al. [8] I Observed that the Mechanical Behavior of Aluminum Metal Matrix Composite. Al7075-Al2O3 Composites Containing Weight ratio of 4%, 6%, 8% Aluminum Oxide Particles were prepared by Stir Casting Technique. The outcomes showed that presenting Al2O3 reinforcements in Aluminum (Al7075) matrix expands hardness and compression strength and 8 % weight Al2O3 reinforced aluminum metal matrix composites showed maximum hardness and tensile strength.
G. B. Veeresh Kumar et al. [9] Studies on Aluminum Metal Matrix Composites Al7075-Al2O3 carrying the filler contents up to 6% weight by using the liquid metallurgy technique. The uniform distribution of the aluminum particulates in matrix has been found by micro structural studies. It has been observed that the density of composites is found to be good from its base matrix. Increasing the filler content also increases the micro hardness of the composites and the hardness of Al7075-Al2O3 composites was found to be 60 -97 HN and 80 - 109HN.
Abhishek Kumar et al. [10] Found that the distribution of Al2O3 in the matrix investigated using the stir casting technique. The increases of weight fraction of Al2O3 with increase the stiffness of cast composites. Composites are found more than unchanged matrix metal Macrostructural observation tells us that electromagnetic stirring action produces small size cast metal matrix composites, and they have very good particle matrix interface bonding. It is observed that if the weight fraction of AL2O3 increases, the tensile of the cast composite also increases.
D. Sujan, Z. et al. [11] The experiment found that Al356 -Al2O3 composites were made using the stir casting technique. in this composite materials, Al356 alloy are found in powders forms, and it is mixed with aluminum oxide (Al2O3) particles of same size (400µm) in a weight fraction of 5%, 10%, 15%. It is observed that the wear rate decreases significantly with the addition of reinforcement particles.
Abhishek Kumar et al. [12] experimental investigation, Al 6351/Al2O3 metal matrix composite were fabricated by stir-casting economical route. Microstructure analysis revealed that stirring action generates metal matrix composites with tiny grain size and there is a superior interface bonding in matrix with respect to base metal, the increase in Al2O3 constituent toughness decreases. This is due to increase in brittleness between the Al6351 and Al2O3 interfaces.

## 3. BORON CARBIDE (B4C) REINFORCED AMMC

Gopal Krishna U B et al. [13]. studied that Al-B4C composites made up of different particle size 37µ, 44µ, 63µ, 105µ, 250µ distributions of reinforcements are produced by stir cast route. the experiment results found that the micro vicker's hardness for the particle size of 250µ AMCs was found to be maximum and found maximum hardness for 12 % weight in case of different weight percentages and 150 µ found in particle size reinforcement.
It is found that the maximum for 8 weight % in case of varying weight % of the reinforcement of 105µ size and aluminum matrix composites have maximum tensile strength for particle size of 105µ.
Daulat Kumar Sharma et cetera [14]. Experimental found that the boron carbide reinforcement in aluminum metal matrix composites (AMMC's) are using by the two-step melting process. It has observed that the two-step melting process and K2TiF6 increased the wettability. It is helpful for improvement of different weight percentages of particulate distribution in B4C reinforcement and in the hot-rolled and extruded aluminum metal composites, the particle distribution, interface bonding, tensile strength and yield strength are improved whereas elongation and porosity has decreases.
Arvind Kumar et al. [15] investigation the Al-B4C composites were produced by stir cast process and powder metallurgy method. It is observed that between the many fabrications process, the liquid metallurgical method is the most suitable method for fabrication of Al/B4C composite due to its innocence, low cost of manufacturing and it's enough flexibility. Microstructure study suggested that in stir casted Al/B4C Composite have uniform distribution of reinforcement in the matrix and found that the bonding between matrix and B4C are strong. It has been noted that the wettability of B4C below 1100 C is very difficult, it has been overcome by the using of flux in the melt. However, by powder metallurgy Al/B4C composite produced have less porosity and intermetallic compounds.
A. Senthil Kumar et al. [16] work deals with the preparation of Al6061/ B4C composites is attempted during this project work by powder metallurgy technique. Al6061/ B4C composites are prepared by varying zircon weight (0%, 3%, 6%, 9% & 12%). It is observed that the composite prepared with Zircon weight 5% reinforcement were obtained better characteristics. The results are found that maximum densification (92%) is achieved for the compacting load of 10000kg. if the amount of B4C in metal matrix part is increases, the hardness of Aluminum metal matrix composites is also increased. Density is decreased with increasing the quantity of the boron carbide (B4C) in the matrix part.

## 4. FIBER REINFORCED AMMC

Khalil et al. [17] revealed that the current developments on bamboo fiber based reinforced bio composites. Bamboo fibers reinforcement was used in composite as the bamboo fiber, which is stronger than the other fibers were used as raw material in product designing and used for generating high quality sustainable products.

Jun Liang et al. [18] studied the surface metallization of the carbon fiber rope for improvement the surface properties like wear scratches, resistance to corrosion strength etc. It is also observed that the tensile strength of the composite material is greater than the matrix material, and the strengthen result of the carbon fiber rope are greater than carbon fiber bundle. It is found that the high temperature aluminum liquid creates the carbonization of the carbon fiber and surface damage, and it is also decreasing the strength of the carbon fiber.

E. Abhilash et al [19] it deals with that metal matrix composites are manufacturing from carbon fiber performance and aluminum alloys by the utilization of squeeze infiltration process. This process has shown the enhancement in the hardness and in aluminum matrix composites billet found lesser toughness in radial plane than axial plane. The microstructure study acquired for the squeeze cast matrix alloy are found better than the die cast matrix alloy. fiber matrix bonding and better wettability is existing by squeeze infiltration process. It is found that the density (2.47 g / cc) of the aluminum metal matrix is lesser than the matrix material density (2.7g / cc).

Anil Kumar et al [20] observed that the tensile strength of Aluminum glass fiber reinforcement (GFRP) plastic material has very low ductility and has the highest quality. Before failure, it does the least elongation show in its length. When composite is prepared then the properties have significant changes like the tensile strength becomes highest in individual materials as well as all the composites and the Composite Glass Fiber Reinforcement Plastic (GFRP) has higher elongation compare with the unlike pure GFRP. This shows that improvement in ductility is taking place.

Jan clause et al [21] Studied of integral aluminum- fiber reinforcement plastic (FRP)-structures produced by high pressure die-casting. It was found that using the previous mold tool increases tensile force twice and sample manufacture gives low tensile force. It is found that the tensile strengths show up to 73% strength of the glass fiber reinforcement plastic (GFRP) structures. It is suggested that through a difference in pressure the tensile strength can be increased. The process enables the production of integrated transition structures between the less weight material aluminum and glass fiber reinforcement plastic (GFRP) without significant loss of strength.

Mathivanan Periasamy et al [22] investigated that the impact strength execution of aluminum glass fiber reinforced sandwich panels is find out in comparison with change in aluminum fiber volume fraction, thickness fraction and orientations in layers of glass fiber reinforcement plastic (GFRP) Sandwich laminates have both energy values higher in comparison of monolithic aluminum. It is revealed that bi-directional cross ply hybrid laminate damage resistance than unidirectional hybrid laminate (UDHL) and exhibit better impact performance. It has been observed that if the fiber volume and aluminum thickness fraction increase, then the specific cracking and performance energy also increased.

## 5. ZIRCONS (Zr) REINFORCED AMMC

P. Saritha et al. [23] investigated the Al-7075 - Zircon composites containing (0%, 1%, 2%, and 3%) weight of zircon are prepared by utilization of stir casting process. It is revealed that mechanical properties of composite i.e., tensile strength and hardness are improved with increasing percentage of Zirconium in the Al-Zr Composites. It gives the mechanical behavior of aluminum metal matrix composite. From all four composite specimens 97%Al+3%Zr hardness is maximum. From all four composite specimens 97%Al+3%Zr Tensile strength is Maximum.

B.Vijaya Ramnath et al. [24] investigated the hardness, tensile and flexural of Aluminum metal matrix composites reinforced with fly ash and zircon sand. It is observed that the specimen which carries 1% zircon sand & fly ash has high hardness & tensile strength. From wear resistant test it is found that the specimen which carries 1% Zircon sand & fly ash has higher resistance in comparison with other specimens. It is found that the best value of ultimate tensile strength is found at 1% of zircon sand in Aluminum metal matrix composites.

Hemanth Rajat et al [25] Studied Al6061 Zircon (Zr) Aluminum metal matrix composites preparation with the use of stir-casting technique. Composites using Al6061 as a matrix reinforced with zircon particulates. The reinforcements are distributions in weight of zircon 0%, 3%, 6%, 9% and 12%. The optical micrographs of composites show the uniform distribution of Zircon. The tensile strength of the composite is found high in the Al6061 metal matrix composites at 9% of Zircon in comparison to base metal Aluminum alloy. It is increases with increase in reinforcement with zircon 9% and decreases with below contents of reinforcement. The best value of tensile strength is found at 9% of zircon (Zr).

## 6. FLY ASH REINFORCED AMMC

M Ravichandran et al. [26] experimental Investigated that AA6061- fly ash composites with 0%, 3%, 6%, and 9% weight are produced by using the stir casting process. The tensile strength is increased up to 6 % weight and then decreased in AA6061 matrix & compressive strength of the matrix composite are increased far as 6 % weight of fly ash and then decreased in AA6061 matrix. It is observed that the hardness of the composite are increases up to 9% weight by the addition of the fly ash contents in the metal matrix.

Shankar et al. [27] studied various techniques and particle size of Aluminum metal matrix composites reinforced with fly ash contents. It is observed that the Mostly stir casting was preferred by several researchers in case of the production cost. it is an economical and environmentally friendly solution because it reduces the Production cost.

Raghunath Palanichamy et al. [28] Studied that the fly ash particles are reinforced with Aluminum metal matrix for improvement of mechanicals & physical characteristics. It has found that frictional coefficient and wear of composites material are influenced

within the reinforcement contents, speed of sliding and load exerted. Tensile strength, compression strength and hardness are increased with increasing the percentage of fly ash content.

**7. GRAPHITE REINFORCED AMMC**

S. Sathish kumar et al. [29] experimental investigated that Al7075 graphite composites of dry sliding wear behavior is determined by the utilize of Pin on disc tool. In which liquid casting technique was used. The coefficient of friction is decreased by insertion of graphite particulates and come to minimum at 8% weight graphite. It was note that the 8% graphite appeared to be optimum. It is noted that the wear rate of composites is reduced by insertion of graphite contents and come to a minimum value of 8% weight graphite content.

J.Pradeep Kumar et al. [30] studied that AA5083 aluminum alloy are successfully reinforced with different percentage of weight in magnesium and graphite with the help of situ stir casting technique. It is revealed that the ultimate tensile strength of the material reduces with increases of 14% reinforcement contents for every 2% addition of Graphite. it is found that the rate of corrosion is decreases with increase in Graphite contents addition. it is also observed that after the tensile testing pure AA5083 developed a rugged surface.

Gyanendra Singh et al. [31] studied that the fabrication of aluminum graphite composite material by use powder modular method. It is noticed that the mechanical characteristics of Aluminum metal matrix composites are increases when % of Graphite is increases. The composite materials usually divided into superior characteristics with comparison to the characteristics of matrix material alone. The aluminum strength of the aluminum graphite composite metal was found very well.

Rohit Sharma et al [32] investigated that Graphite based Aluminum metal matrix composites are manufactured by using the stir-casting method, it was found that the addition of graphite content, the results give the decrease in the thermal expansion of the composite. hardness decreases with the increases in graphite, but Hardness increases with the increase in silicon carbide. Reinforced material such as graphite has shown the better results pertaining to tensile strength in comparison to the Silicon carbide.

## II. CONCLUSION

This paper has provided us brief knowledge of different types of reinforcements and aluminum metal matrix composites. The paper also provides a literature review on methods of fabrication of aluminum metal matrix composites. This process is a difficult work due to the variations of reinforcement in matrix material. These types of review revealed the views, experimental and theoretical results obtained, and conclusion are make over the years by different investigators in the streams of MMC's. Various researchers and industries have helped in conduction of various studies, with the help of this paper our knowledge has enriched about the processing of aluminum metal matrix composites and their mechanical and physical properties.

(1) The observations revealed the stir casting method is very economical and easy method for fabrication of AMMC's.

(2) Solid-state and powder processing techniques result in an improvement in the hardness, tensile strength, compressive strength of Al-SiC composites when adding 5% to 30% weight of SiC particles.

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