



## Composite Material-Aluminium Silicon Alloy: A Review

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### ABSTRACT

From the last few years there has been a rapid increase in the utilisation of aluminium-silicon alloys, particularly in the automobile industries, due to their high strength to weight ratio, high wear resistance, low density and low coefficient of thermal expansion. Among the materials of tribological importance, Aluminium-silicon composites have received extensive attention for practical as well as fundamental reasons. Aluminium-silicon alloys and aluminium-based metal matrix composites have found applications in the manufacture of various automotive engine components. Compound work pieces are developed to combine favourable properties of different materials. Many composite materials are used in industrial production. Weight reducing in rapid moving parts of automobile engines such as Camshaft, Crankshaft, to a reduction of the weight and wear reduction purpose.

**Keywords: Composites, AISiC**

### I. Introduction

Generally ductile fractures occur with the sequence of nucleation, growth and coalescence of voids. It is very important to accurately understand the relationship between fracture behavior and microstructure for the purpose of alloy design. In aluminum alloys there is no ductile–brittle transition phenomenon observed in BCC metals. This provides a problem for improving the ductile fracture resistance when the yield strength is increased. The unstable fast fracture becomes frequent, even if it is a ductile fracture, because the strengthening lowers the level of toughness. This becomes a problem with large scale structures. In addition, fracture characteristics under the impact load seem to become also important, because the application to automobiles and vehicles will increase<sup>[1]</sup>.

Silicon reduces the thermal expansion coefficient, increases corrosion and wear resistance, and improves casting and machining characteristics of the alloy. When the Al-Si alloy solidifies, the primary aluminum forms and grows in dendrites or silicon phase forms and grows in angular primary particles. When the eutectic point is reached, the eutectic Al-Si phases nucleate and grow until the end of solidification<sup>[2]</sup>.

Aluminium alloy composites (AACs) are becoming potential engineering materials offering good combination of properties such as specific strength, specific stiffness, electrical and thermal conductivities, low coefficient of thermal expansion and wear resistance. In the automobile sector, Aluminum composites are used for making various components such as Camshaft, brake drum, cylinder liners, drive shaft etc. In aerospace industries, Aluminium composites are used in structural applications such as helicopter parts, rotor vanes in compressors and also in aero-engine parts [3]. The components, which are subjected to wear, are mainly due to sliding action, abrasiveness, erosion and corrosion. Extensive studies have been carried out to assess the Aluminium composites against various wear situations under varying environmental and tribo-conditions.

Composite materials offer the opportunity to adjust the properties of the units much better to its designated application as it would be possible for a mono phase work piece. Typical

property combinations are mechanical–chemical combinations for hard and chemically resistant units, Mechanical–optical combinations for a high wear resistance and a charming design or physical–biomedical combinations for fluid impermeability and food-safe surfaces [4].



Figure 1 Examples of Composite materials [4]

Aluminum composites are not a single material but a family. The matrix alloy, reinforcement material, volume and shape of the reinforcement, location of the reinforcement and fabrication method can all be varied to achieve required properties.

Effects of silicon in the Al-Si alloys are as follows [6]:

- i. Thermal expansion is reduced substantially by silicon.
- ii. Magnetic susceptibility is only slightly decreased by silicon.
- iii. The lattice parameter is decreased slightly by silicon.
- iv. Machinability is poor because of the hardness of the silicon.

In this review paper, it is reported on the strength, wear and manufacturing of composite materials also the future advancement and implementation scopes are described.

### II. LITERATURE SURVEY

In 2009, Suhael Ahmed. S [7] presented the Development and Characterization Of Al7075 Based Hybrid Composites. Aluminum based Metal matrix composites have been emerged as an important class of materials for structural, wear, thermal, transportation and electrical applications.

The cast composites will be subjected to a temperature of 530oC for two hours followed by quenching in air, water and ice. On quenching, the hybrid composites will be subjected to artificial aging at a temperature of 175oC for 2 to 10 hrs in steps of 2hrs. Metallographic studies both optical and SEM will be carried out on as cast and heat treated hybrid composites to assess the extent of distribution, nature of bond between the reinforcement and the matrix alloy. Mechanical properties as well as tribological and corrosion properties of developed hybrid composites will also be evaluated.

Srinivasa R. Bakshi, Di Wang, Timothy Price, Arvind Agarwal[8] in 2009, presented Microstructure and Wear properties of Aluminum/Aluminum–Silicon Composite coatings prepared by cold spraying. Particles impinging on a substrate will either rebound from the substrate or bond with the substrate depending on the material type and particle velocity on impact with the substrate. Cold spraying was used successfully to prepare 350–1200 μm thick composite coatings containing aluminum and aluminum–silicon alloy with a density of 98% or higher. The Al–Si particles were distributed uniformly in the aluminum matrix. Wear volume was found to be similar for Al and Al-Si coatings.

Manoj Singla, D. Deepak Dwivedi, Lakhvir Singh, Vikas Chawla[5] in 2009 shows that Development of Aluminium Based Silicon Carbide Particulate Metal Matrix Composite. In the present study a modest attempt has been made to develop Aluminium based silicon carbide particulate MMCs with an objective to develop a conventional low cost method of producing MMCs and to obtain homogenous dispersion of ceramic material.

They show an oil fired tilting furnace has been used. The crucible material was graphite. Diesel was used as the fuel. A forced draft fan equipped with 2820-rpm motor has been used for supplying the required quantity of air. Scraps of Aluminium were preheated up to a temperature of 450oC and particles of silicon carbide up to a temperature of 1100oC in core drying oven. Crucible used for pouring of composite slurry in the mold was also heated up to 760oC. A new stir caster was developed to fabricate MMC.

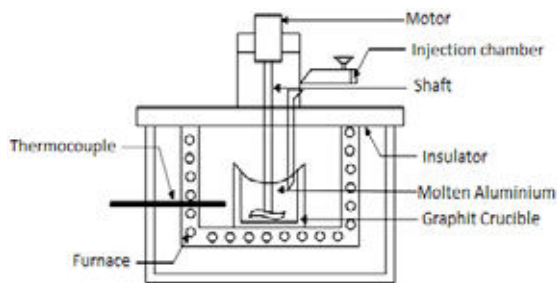


Figure 2 Setup for fabrication of composites[5]

The results of study suggest that with increase in composition of SiC, an increase in hardness, impact strength have been observed. The best results has been obtained at 25% weight fraction of 320 grit size SiC particles. Maximum Hardness = 45.5 BHN & Maximum Impact Strength=36 N-m.

In 2011, Thanut Jintakosol, Supreya Kumfu, Pisith Singjai[9] research on the Effect of Wear Tests on Silicon Carbide Nano wires/Aluminium Metal Powder Composites. The Various hard ceramic particle materials such as SiC, Al<sub>2</sub>O<sub>3</sub> are used extensively to reinforce aluminum matrices. The composites with 15% vol of SiC NWs show the best wear resistance, with a 76.95% decrease in wear rate compared to pure Al. It is therefore reported that SiC NWs/Al composites show improved wear resistance properties compared to single phase metal materials.

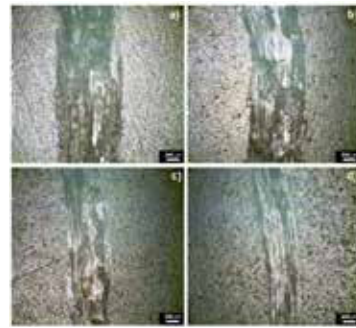


Figure 3 SiC per % volume of Aluminium

(a) 0% SiC (b) 5% SiC (c) 10% SiC (d) 15% SiC[9]

Neelima Devi, C, Mahesh.V, Selvaraj. N[12] in 2011 they represents in their research work for composite materials that Mechanical characterization of Aluminium Silicon Carbide Composite materials. Aluminium alloy materials or simply composites are combinations of materials. They are made up of combining two or more materials in such a way that the resulting materials have certain design properties on improved properties.

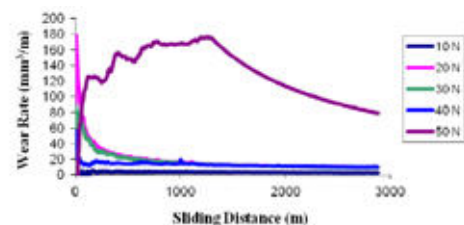


Figure 4 SiC 15% with Aluminium[12]

The maximum tensile strength has been obtained at 15% SiC ratio. This indicates that the Aluminium silicon carbide composite material is having less weight and more strength; it is very much useful in practical aerospace applications.

In 2011, Dunia Abdul Saheb[10] Presented Aluminum silicon carbide and aluminum graphite Particulate composites. To obtain a specific mechanical or physical property, the MMC should consist of fine particles distributed uniformly in a ductile matrix and with clean interfaces between particle and matrix. One of the problems associated with the infiltration route is the high volume fraction of the reinforcement which requires additional processes to dilute the content to the required levels. The best result has been obtained at 25% weight fraction of SiC particles. Maximum Hardness = 45.5 BHN.

Ramanpreet Singh, Er. Rahul Singla[11] in 2012 presented Tribological Characterization of Aluminium-Silicon Carbide Composite Prepared By Mechanical Alloying Aluminium Metal Composites are combinations of materials in such a way that the resulting materials have certain design properties on improved quality. Mechanical alloying is a unique process for fabrication of several alloys and advanced materials at room temperature. An effort has been made to study hardness and wear properties with varying weight fraction of SiC in particle reinforced MMCs developed with the help of mechanical alloying method of powder metallurgy technique.



Graph 4: Wear Rate V/s Sliding Distance (10% SiC)

Figure 5 Wear rate V/s sliding Distance (10% SiC)[11]

The abrasive wear resistance depends on the size of reinforcing elements as well as the size of abrasive particles. Smaller abrasive cause higher wear rate at smaller reinforcing particles than at larger ones and conversely.

### III. FUTURE WORK

From the above literature work, it is clear that the Aluminium-Silicon-Carbide has the higher strength, wear resistance, effective load carrying capacity, higher thermal stability and less weight compared to any mechanical materials. The future scope for this material is in Automobile application that manufacturing of Camshaft with Composite material. This helps in reduction of weight and wear of it. This improves the working life of Camshaft.

### IV. CONCLUSION

From literature review related to the AlSiC Composite material we have concluded that, the hardness of the Al-Si composite

increases with the increase in amount of silicon and also total elongation decreases with the increase of weight percentage of silicon. The amount of primary silicon increases with the increase in silicon amount. Yield strength and ultimate tensile strength increases with the increase of weight percentage of silicon.

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