Journal of Material Science and Mechanical Engineering (JMSME)
Print ISSN: 2393-9095; Online ISSN: 2393-9109; Volume 2, Number 1; January-March, 2015 pp. 1-3

http://www.krishisanskriti.org/jmsme.html

Effect on Characteristic of Aluminum Metal Matrix Composite by Silicon Carbide Reinforcement

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Abstract—*The Metal Matrix Composites are made by dispersing through reinforcement of material into metal matrix. These are prepared by casting, although selection by to technical challenge exists with casting technology. Within the matrix to obtaining such homogeneous distribution of reinforcement is a challenge itself, and it affects directly on the quality and property of composite.*
In this work the composite material is developed by reinforcing of Silicon carbide in Aluminum metal by different weight percent ratio and followed by stir casting fabrication technique. Hardness and Tensile Strength of prepared composite has been evaluated. The distribution of SiC particle in the Al matrix revealed by microstructure observation.

1. INTRODUCTION

The Metal matrix composites are combination of two or more than two different materials including metal, intermatallic compound or next step dispersed phase of metal matrix. To achieve optimum combination of properties it has produced by controlling the morphology of constituent. The properties of Constituent's phase, its relative amount, dispersed geometry including particle shape and size along with orientation in matrix.[1,2]

The application of Aluminum metal matrix has widely in daily life. In the case of advantage, rather than unreinforced material, better to reinforced particle in aluminum containing Light weight, improved stiffness, greater strength and high specific module, High thermal conductivity, low thermal expansion coefficient, tailored electrical properties, increasing wear resistance, improved damping capacity and increase in wear resistance. The incorporation of reinforcement constituents has been formed in mono filaments or continuous fiber, short fiber, particles. Now days the strongest exploration of wide use of AMCs are Automotive application such as brake disk, engine piston, Aerospace, Thermal management area and industrial product. [3]

Aluminum can be manufactured by powder metallurgical formation, semi solid process and liquid state processes (stir casting, squeeze casting, infiltration etc.). Generally ceramic particle like silicon carbide (SiC), boron carbide (B_4C), graphite and alumina (Al_2O_3) and non metallic particles are used as reinforcement of Aluminum metal matrices. In terms to metal matrix composite, the reinforcement includes Whisker, fibers as well as particles. In metal matrix composite to develop fiber commonly used are SiC, B_4C, Al_2O_3, graphite. Mainly these are used as whiskers. Whiskers and silicon nitride continuous fibers are under development are potential full candidate for future MMCs. The others whisker materials include are MgO-Ni, MgO, NiO &TiB_2. Particulates are considered as common reinforcement with metal matrices. The most important role considered under particulate reinforcement include alumina, silicon carbide, Zirconia (ZrO_2), Titanium carbide & Thoria (ThO_2) and boron carbide, boron nitride, silicon nitride etc.

The aluminum alloy composite materials consist of high stiffness, high strength, and more corrosion and wear resistance, more thermal stability and more fatigue life. The aluminum alloy material are found unique capacity in field to design material we required as per own property.

When applying load physically to composite, the load has been transferred to reinforcement followed to dispersed reinforcements bounded with matrix. To obtain the high strength composite the strong interface between matrix and reinforcement is highly required. These strong interfaces have been obtained during casting by mutual dissolution or reaction. To achieve good wettability, reinforcement is necessary during casting. [4]

The aim of this study is to observe the effect of silicon carbide reinforcement in aluminium matrix composites on hardness, tensile strength and microstructure aspect in different chemical composition.

2. EXPERIMENTAL CONFIGURATION

2.1 Material

Aluminum is used as base material and SiC has been used as reinforcement particle to prepare the composite for this study. The chemical composition of Al used are prepared is given in table 1.

Table 1: Chemical Composition of AMC (wt %)

Element	Percentage (Current)	Percentage Ref[16]
Al	99.7	99.62
Fe	0.115	0.01
Si	0.117	0.19
Cu	0.0007	0.01
Mg	0.0033	0.01
Sn	0.0022 0.0041	
Ni	>>0.0005	0.01
Cr		
Mn		

2.2 Preparation of composites

The fabrication of AMC was done by stir casting process incorporation to SiC reinforcement. Aluminium was melted in furnace on temperature of 760^0 C. The aluminum containing all the above chemical specification composition will get melt on this temperature. On the another hand the SiC particle has been preheated on temperature of 800^0C for two hour has been mixed with molten liquid of Al. now the stirring has been done for duration of 10-13 min. Now the melted material was poured into mould and keeps it for solidifying. Now the desired dimension of sample has taken for test performance.

2.3 Experimental testing

To getting better visual impact it is compulsory to get better finishing surface of sample. Samples were polished with emery paper finest grade of 1,2,3,4 by keeping rotation of 90^0 in direction of top to bottom, left to right, bottom to top and followed by right to left. Then now proceed on revolving wheel for cloth polish with mix of alumina power and water. The alumina power of 10 µmm were been taken.

Microstructure of composite prepared presence of SiC in Al was observed. Etching agent was used for surface clean vision and keeping corrosion free surface according to sample. Optical microscope was been used for visual impact at magnification of 200X.

Hardness testing has measured in Vickers hardness THV-1M Automatic testing machine. A diamond indenter which has designed in conic angle of 136^0 , applied load varying from 1 to 100 Kgf. The Vicker's hardness (H_V) is calculated by

$$H_V = \frac{P}{\frac{d^2}{2}\sin \alpha/2} = \frac{1.8544\ P}{d^2}$$

Tensile measurement has been performed using by computerized INSTRON 8000 series tensilo meter by applying tensile force.

3. RESULT AND DISCUSSION

3.1 Microstructure

The interface characteristics of grain bonding reflect in composite material property after reinforced. The visual interface of microstructure was observed.

Fig. 1: Typical Microstructure of Al-SiC

From Analysis of microstructure, it has been observed that particle wettability has been increased. This is due to the variation of contact time of SiC in liquid of Aluminum.

3.2 Hardness

The micro hardness of composite material has measured which reflects the property of resistance of material against surface indentation. It shows the interface bonding strength between composite matrix and reinforced particles.

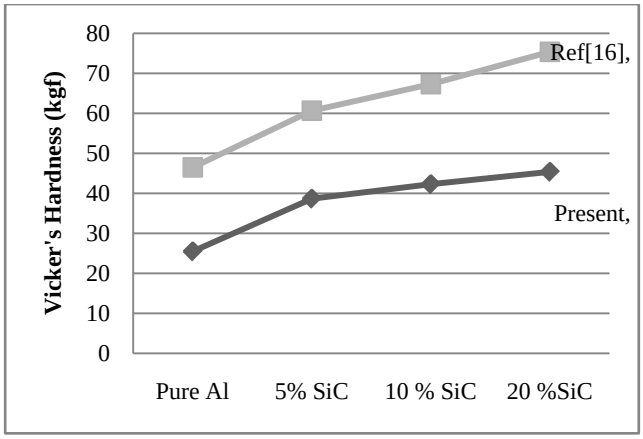

Fig. 2: Hardness with respect to wt % of SiC

The Fig.2 shows the nature of matrix over continue increasing tendency. The increasing of wt % of SiC enhancing the hardness rather than Pure Al.

3.3 Tensile strength

The Fig. 3 showing the relation between tensile strength with respect to increasing wt % of SiC of developed composite.

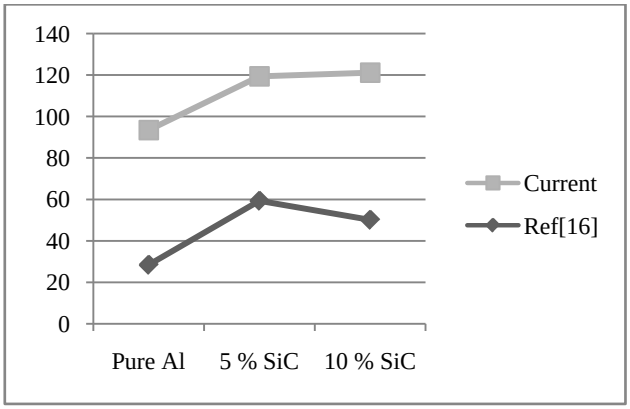

Fig. 3: Tensile strength with respect to wt % of SiC

From the tensile test result, it is observed that the tensile strength of aluminum matrix composite has been greater than unreinforced aluminium due to increase of SiC wt % and maximization of strong bond phenomena in Al matrix. The continuity increases in tensile strength has been obtained with respect to increasing wt % if SiC.

4. CONCLUSION

This present work fabrication has been successfully done using stir casting .The effect of SiC contents has analyzed and extending behavior of mechanical properties and microstructure. The distribution of SiC in AMC was fairly homogeneous. The Sic particle' distribution was observed to be intra granular. It has refined to the grains of alloy matrix and was properly enhanced in bondation in matrix. Interfacing of AMC and SiC particle was clean without the presence of pores, voids and reaction products. As well as it has enhance micro hardness .Increasing in SiC contents shifted the fracture mode from ductile to brittle. Due to unique composition in content of weight percent in metal the activeness of hasten tensile strength has been observed

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