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Testing and Characterization of Silicon Carbide Reinforced Aluminium Matrix Composites

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Abstract: ***The aim of this research work is to study about the casting of aluminium matrix composite with varying weight percentage of silicon carbide and the mechanical properties, wear characteristics. Aluminium matrix composites of varying Sic content (5%, 10%and 15%) is prepared by stir casting process. Brinell hardness, tensile strength, and impact strength of the prepared composites are. The results showed that introducing Sic reinforcements in aluminum (Al) matrix increased hardness and tensile strength and 15 wt. % Sic reinforced AMC showed maximum hardness and tensile strength. Microstructural test is also performed.***

Keywords: Metal matrix composites, stir casting, Hardness test, Tensile test, Impact test

1. Introduction

Metallic matrix composites are combinations of two or more different metals which come under different categories of base metal. Metal matrix composites are produced by controlling the configuration of the reinforcement to achieve optimum combination of physical, chemical and mechanical properties. Properties of the composites depend on the properties of the constituent phases, their relative amount, dispersed phase geometry including particle size, shape and orientation in the matrix. AMCs materials than unreinforced materials such as-greater strength and high specific modulus, improved stiffness, light weight, low thermal expansion coefficient, high thermal conductivity, tailored electrical properties, increased wear resistance and improved damping capabilities. Reinforcing constituents can be incorporated within the matrix in the form of particles, short fibers, continuous fibers or mono filaments. Now it is used in aerospace, thermal management areas, industrial products, automotive applications such as engine piston, brake disc etc. AMCs can be manufactured by liquid state processing (stir casting, infiltration, squeeze casting etc.), semisolid processing and powder metallurgical route. Usually non metallic and ceramic particles like silicon carbide (SiC), alumina (Al2O3), boron carbide (B4C), graphite etc. are used as reinforcements in AMCs. When loads are applied externally to the composites, metal matrix transmits loads to reinforcement sand then loads are carried by dispersed reinforcements bonded with the matrix. Strong interface bond between reinforcements and matrix is required to obtain high strength of composites. The aim of this study is to observe the effect of SiC reinforcements in Al matrix composites on, tensile strength, wear resistance and impact strength.

1.1 Materials

Aluminium was used as matrix material and SiC particles were added as reinforcement material to prepare composites in this study. The chemical composition of Al used as matrix material is given in table 2. Wettability is the tendency of one fluid to spread on, or adhere to, a solid surface in the presence of other immiscible fluids To increase the wettability of SiC particles in the molten Al, 1 wt. % of magnesium (Mg) was added to molten aluminum during casting. SiC particles of mesh size -190/+240 (particle size is below 75μm and above 60μm) and ribbon shaped Mg were used.

Table 2: Composition of Al used as matrix material wt (%)

Mg	Si	Cu	Zn	Fe	Ti	Mn	Cr	Al
1.0	0.6	0.24	0.24	0.78	0.16	0.14	0.15	Balance

1.2Prepration of Composites

SiC reinforced AMCs were prepared by stir casting process. Al was melted in furnace and when the temperature of the liquid Al reached at 750°C, Mg was added in the melt. Heat treated SiC particles were added in molten metal through funnel at 730°C. Silicon carbide particles were preheated at 800°C for about two hours. An electrical resistance furnace assembled with graphite impeller used as stirrer was used for stirring purpose. After SiC addition, the liquid metal-reinforcements mixture was stirred for 10 minutes at a rpm of 510. Finally composites were poured in preheated metal moulds at 672°C. The melt was allowed to solidify in the mould.

Table 3: Variation of density

S.No.	Material	Experimental Result
1	Al	2.6 g/cm^3
2	Al+5%SiC	2.65 g/cm^3
3	Al+10%SiC	2.69 g/cm^3
4	Al+15%SiC	2.75 g/cm^3

Figure 1: Stir Casting

Figure 2: Samples of Composites (12cm.x12cm.each)

2. Experimental Design

Table 1: Experimental Design

S.No.	Experimental Work	Equipment
1	Casting of AMC's	Stir Casting
2	Hardness Testing	Rockwell hardness testing Machine
3	Tensile testing	Universal testing Machine
4	Impact testing	Izod Impact testing machine

Experimental Analysis

2.1 Hardness

The resistance of materials against surface indentation is termed as hardness. Table 4 shows the Brinell hardness values of AMCs containing varying wt. % of SiC reinforcements. The table shows that addition of SiC particles in Al matrix composites enhances the hardness of AMCs when compared with unreinforced Al.

Table 4: Brinell hardness of SiC reinforced AMCs

Sample	Brinell Hardness No.
Al+0%SiC	68.5
Al+5%SiC	74.6
Al+10%SiC	84.3
Al+15%SiC	97.5

2.2. Tensile strength

Tensile test is performed to check the tensile strength of composite material. The standard size of specimen is shown in figure 3. From the tensile test results, it is observed that the tensile strength of AMCs is more than unreinforced Al. Tensile strength increases in AMCs can be attributed due to the applied tensile load transfer to the strongly bonded SiC reinforcements in Al matrix, increased dislocation density near matrix-reinforcement interface, and grain refining strengthening effect.

With the increase of wt. % SiC, porosity also increases but increase of strength due to strong interfacial bond helps to improve the tensile strength of AMCs. The decrease of tensile strength for 10 wt. % SiC reinforced AMC is due to the effect of sorting out of SiC particles in tensile test specimens.

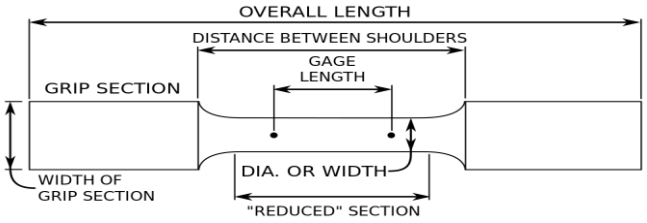

Figure 3 Standard size of specimen according to ASTM

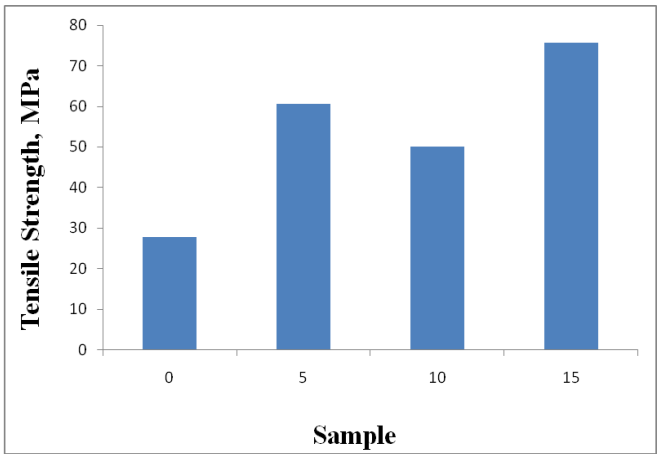

Chart 1: Tensile strength of SiC reinforced AMCs

2.3 Impact Test

Impact testing is an ASTM standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific height (constant potential energy) and then released. The arm swings down hitting a notched sample, breaking the specimen. Impact strength is calculated by dividing impact energy in J (or ft-lb) by the thickness of the specimen. The test result is typically the average of 5 specimens. ISO impact strength is expressed in kJ/m^2. Impact strength is calculated by dividing impact energy in J by the area under the notch.

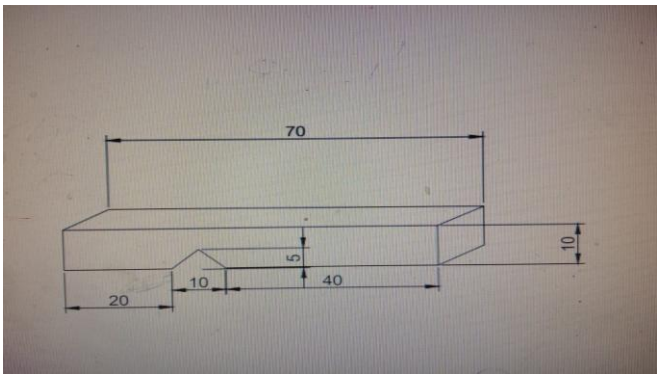

Figure 4: Standard size of Specimen according to ASTM

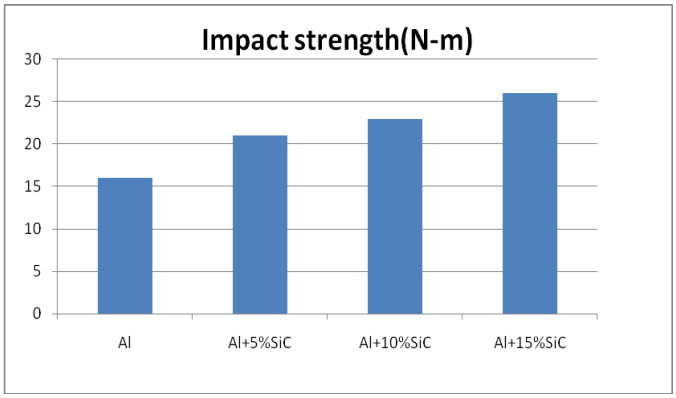

Chart 2: Impact strength of SiC reinforced AMCs

3. Conclusions

In the above study we found that by increasing the percentage of SiC the mechanical properties of aluminum matrix composites have increased.

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