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Fabrication and Characterization of Silicon Carbide Reinforced Aluminium Matrix Composites

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Abstract: ***The purpose of this work is to study about the mechanical properties and wear characteristics of as cast silicon carbide (Sic) reinforced aluminum matrix composites (AMCs). AMCs of varying Sic content (5%, 10% and 15%) were prepared by stir casting process. Vickers hardness, tensile strength, and impact strength of the prepared composites were analyzed.*** **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. Micro structural observation revealed clustering and non-homogeneous distribution of Sic particles in the Al matrix. Porosities were observed in microstructures and increased with increasing. % of Sic reinforcements in AMCs. Pin-on-disc wear test indicated that reinforcing Al matrix with Sic particles increased wear resistance***

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

1. Introduction

Metallic matrix composites are combinations of two or more different metals, intermatallic compounds or second phases in which dispersed phases are embedded within the metallic matrix. They are produced by controlling the morphologies of the constituents to achieve optimum combination of 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 [1, 2]. AMCs have found wide applications in our daily life. There are some advantages in using particles reinforced 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. Interface bond is formed by reaction or mutual dissolution during casting. Therefore, good wetting of the reinforcements is necessary during casting. 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

2. Experimental

2.1 Materials

Aluminium was used as matrix material and SiC particles were added as reinforcements to prepare composites in this study. The chemical composition of Al used as matrix material is given in table 1. 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 -200/+250 (particle size is below 75µm and above 55µm) and ribbon shaped Mg were used.

Table 1: Composition of Al used as matrix material wt (%)

Elements	Fe	Si	Mn	Cu	Mg	Al
%	0.15	0.20	0.01	0.01	0.01	Balance

2.2Prepration 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 500. Finally composites were poured in preheated metal moulds at 670°C. The melt was allowed to solidify in the mould.

Figure 1: Samples of Composites

3. Experimental Testing

3.1 Hardness

The resistance of materials against surface indentation is termed as hardness. Table 2 shows the Vickers 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 2: Vickers hardness of SiC reinforced AMCs

Sample	Vicker Hardness
Al+0%SiC	24.50 ± 0.35
Al+5%SiC	38.65 ± 1.78
Al+10%SiC	42.20 ± 2.42
Al+15%SiC	45.40 ± 1.02

3.2. Tensile strength

Fig.1 shows the relation between tensile strength and wt. % of SiC reinforcements of fabricated composites. From the tensile test results, it is observed that the tensile strength of AMCs is greater than unreinforced Al. Increase of tensile strength 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. In a composite containing strong matrix with strong interface, the crack has to propagate across both matrix and inforcements. With the increase of wt. % SiC, although porosity increases but increase of strength due to strong interfacial bond contributes to enhance the tensile strength of AMCs. The decrease of tensile strength for 10 wt. % SiC reinforced AMC is due to the effect of segregation of SiC particles in tensile test specimens.

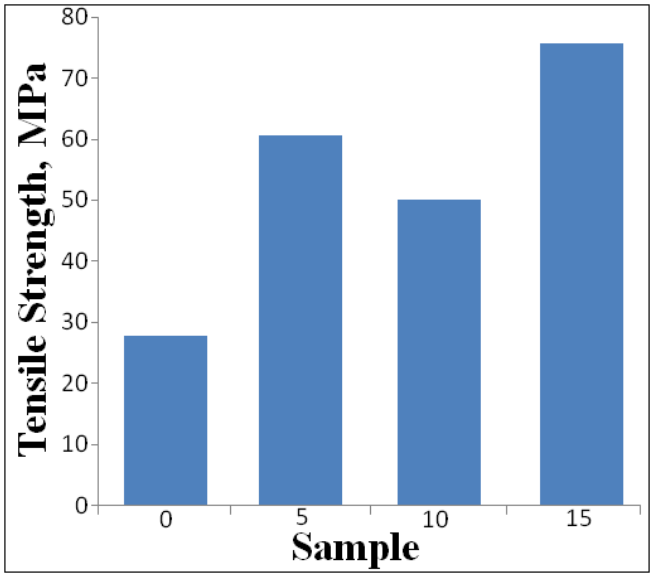

Chart 1: Tensile strength of SiC reinforced AMCs

3.3 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.

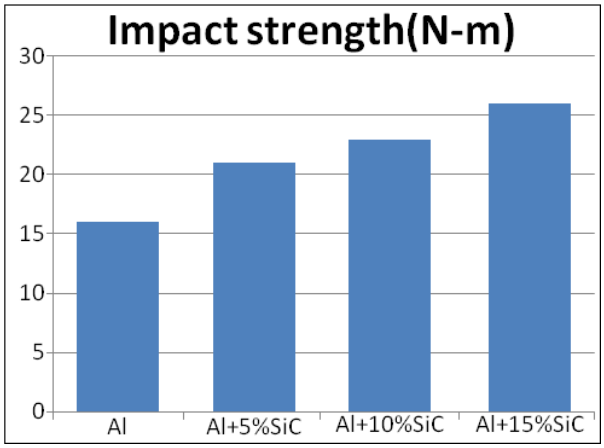

Chart 2: Impact strength of SiC reinforced AMCs

4. Conclusions

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

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