Fabrication Of 4-Stroke Two Wheeler Piston Using FA/Sic Particles Reinforced Composites

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Abstract: **Experiments have been steered under laboratory condition to assess the mechanical characteristics of the composites with aluminium matrix alloy, reinforced with silicon carbide (SiC) and Flyash. This has been possible by fabricating the samples through usual stir casting technique. Scanning electron microscopy was used for microstructure analysis. Chemical characterization of both matrix and composites was carried out by using Energy Dispersive x-ray Spectroscopy. Density, hardness, tensile and compression studies were carried out on both the alloy and composites. Improved hardness and compression properties were observed for all the composites. Interestingly improved tensile properties were observed for all the composites than alloy. Dispersion of ceramic particles in aluminium matrix improves the hardness of the matrix material and also the mechanical behavior of the composite.**

Keywords: **Aluminium Alloy, (Sic) and Flyash, Energy Dispersive X-Ray Spectroscopy.**

I. INTRODUCTION

Metal Matrix composites (MMCs) are fetching attractive materials for advanced aerospace and automobile structures because of their properties can be tailored through the addition of selected reinforcements [1, 2]. In particular particle reinforced MMCs have found special interest because of their high specific strength and specific stiffness at room or elevated temperature. Normally micron sized ceramic particles are used as reinforcement to improve the properties of the MMCs. Ceramic particles have low coefficient of thermal expansion (CTE) than metallic alloys, and therefore incorporation of the these ceramic particles may exist interfacial mismatch between matrix and reinforcement. This phenomenon may be higher for high ceramic particle concentration. Among various dispersoids used, fly ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants. Fly ash particles are classified into two types, precipitator and cenosphere.

II. EXPERIMENTAL

2.1. Fabrication of composites

In the present investigation, aluminium based hybrid metal matrix composites containing 5 and 10 wt% SiC and Flyash particulates of 70μm were successfully synthesized by quagmire method. The matrix materials used in this study was Al-zinc alloy. The synthesis of these composites was carried out by stir casting technique. The stirring was continued for about 120seconds after addition of particles for uniform distribution in the melt. Still, the melt with reinforcement was in stirring condition the same was poured into mould and the samples were homogenized .

2.2 Characterization of Composites

2.2.1 Metallography and Hardness tests

Scanning electron microscopy ((Model: SEM – Hitachi S-3400N - Japan) with EDAX energy dispersive X-ray spectroscopy (EDS) was used in order to evaluate the morphological changes and the elemental analysis of the alloy and the composites. The hardness of the alloy and composite was evaluated by using Leco Vickers hardness tester (Model: LV 700- USA). An average of ten readings was taken for each hardness value.

2.2.2 Density and Porosity tests.

The density of the alloy and composites was measured by the Archimedes drainage method by using the following equation:

$$\rho_{MMC} = (m) / ((m-m_1) \text{ X } \rho_{H2O})$$

Where ρ_{MMC} is the density of the composite, 'm' is the mass of the composite sample in air, 'm_1' is the mass of the same composite sample in distilled water and 'ρ_{H2O}' is the density of distilled water (at 293K) is 998 kg/m^3.

Theoretical density calculations, according to the rule of mixture were also used to determine the densities of the composites. This was obtained from the below equation.

$$\rho_c = V_r\, \rho_r + (1-V_r)\, \rho_m$$

Where ρ_c is the density of the composite, Vr is the weight ratio of reinforcement, ρ_r is the density of reinforcement and ρ_m is the density of the unreinforced alloy. The porosity of the test materials were also calculated from the following equation.

Porosity (%) = (1- (measured density / calculated density)) X 100

III. RESULTS AND DISCUSSION

3.3.1 Microstructures and EDS of alloy and composites

Figure 1 (a-d) shows the micrographs of particles, and composites varying with wt. percentages. We can observe that, addition of particles in the alloy, i.e. by increasing the content by weight percent the increased percentage content can be seen clearly by using the microscope, fig (c) shows the microstructure of the alloy and whereas the figures b and d shows the addition of the particles to the alloy, difference in the microstructures was noticed clearly.

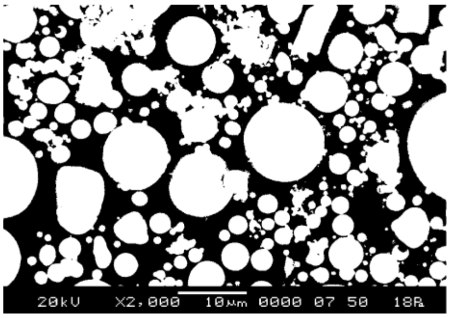

Figure a

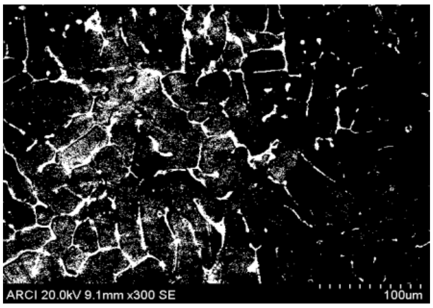

Figure b

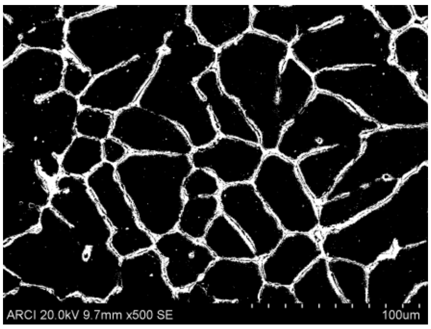

Figure c

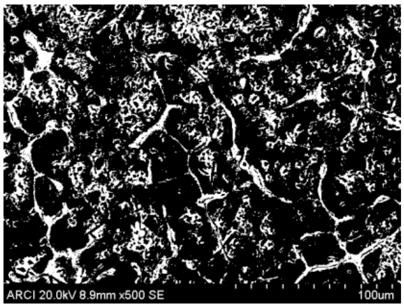

Figure d

Figure 1: (a) SEM Micrograph of particles (b) 5% composite at 100X (c) base at 100X (d) 10% composite at 100X

3.3.2 *EDS analysis*

The EDS spectrum of the alloy shows the presence of Al, Cu and Mg in the matrix phase, figure 2, and silicon and carbon constituents on the reinforcement, figure 2. which were present in the fly ash. The matrix does not show any increment in Cu and Mg concentration reveals that the dissolution of the reinforcement is restricted to its vicinity. Similarly, the reinforcement phase shows only the constituents, such that no contamination has occurred. Since, perfect shielding of argon gas is maintained, traces of oxygen is not seen either with the matrix or the reinforcements. An average of six readings was taken on the matrix, free from particulates.

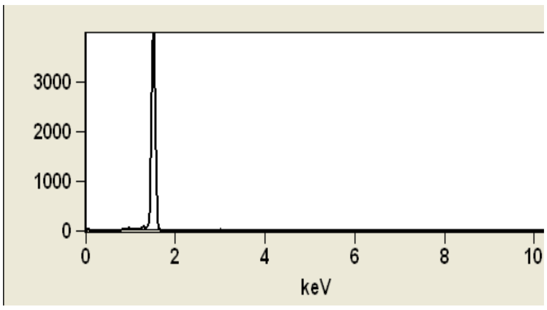

Figure 2 EDS spectrum on the particulate

3.3.3. XRD analysis

The XRD analysis shows the presence of alumina (Al_2O_3), mullite ($3Al_2O_3 \cdot 2SiO_2$) and silica (SiO_2) shown in figure3 .

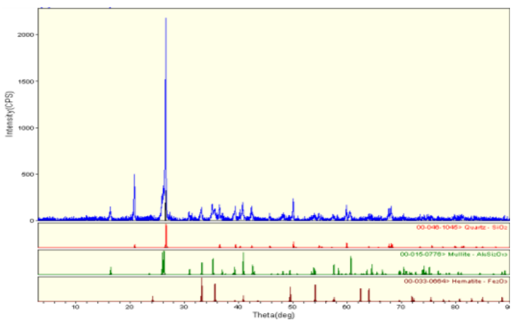

Figure 3 XRD

3.3.4. ***Density and Hardness studies***

The average theoretical and measured density values of the alloy and its respective composites were given in table 2. It was observed that the addition of particles into the alloy matrix significantly decreases the density of the resultant composites in compare to the base alloy.

Table.2 Theoretical and measured densities of alloy and composites

S. No	Specimen	Density (g/cm3)	
		Theoretical	Measured
1.	Alloy	2.71	2.71
2.	5% FA/SiC composite	2.59	2.54
3.	10% FA/SiC composite	2.50	2.45

The density of the composites decreases with increasing the percentages of particulates, as shown in table 2. With 10%, the density of composite decreased to 2.45 g/cm3 compared to the density of the alloy 2.71 g/cm3. The measured densities, however, were lower than that obtained from theoretical calculations. The extent of deviation increases with increasing reinforcement content. This can be attributed to the increase in porosity with fly ash content as shown in table2.

The hardness of a material is a physical parameter indicating the ability of resisting local plastic deformation. The hardness was increased from 86 VHN for alloy to 110 VHN for composite 1 and 115 VHN for composite 2 with 10 % reinforcement respectively. This could be due to the presence of particulates which consists of majority of the alumina and silica which are hard in nature and also due to presence of hard SiC particles. This is also confirming the result reported by Hassan, S. F *et al.* and Ma, NG *et al*. [3, 4].

Figure 4 Casting and machining of piston

Figure 5 final part of piston

IV. CONCLUSIONS

1. composites were produced by stir casting route successfully.
2. There was a uniform distribution of particles in the matrix phase.
3. From the SEM figures, it clearly shows that there were no voids and discontinuities in the composites; there was a good interfacial bonding between the particles and matrix phase.
4. The density of the composites decreases with increasing the percentages of particulates compared to the density of the alloy 2.71 g/cm3.
5. The measured densities were lower than that obtained from theoretical calculations. The extent of deviation increases with increasing reinforcement content.
6. From the EDX analysis of composites shows that no oxygen peaks were observed in the matrix area, confirming that the fabricated composite did not contain any additional contamination from the atmosphere. This might be due to a shield of argon gas was maintained during the mechanical stirring while reinforcement addition.

7. The hardness of the composites increased with increasing the amount of FA/SiC than the base alloy.

V. ACKNOWLEDGMENTS

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