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Deformation and Tribological studies of A356 Slag Reinforced Composites

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ABSTRACT: BF Slag is a major unwanted material during production of iron in the blast furance process. It comprises of oxides of iron, Al_2O_3 and silica along with some other minor constituents. Based on economics as well as environmental related issues, lot of efforts has been directed worldwide towards BF slag management issues i.e. of utilization, storage and disposal. In this paper an attempt has been made to reinforce the BF slag in aluminium silicon alloy A356, to prepare light weight composites. The hardness and compressive strength of the composites were determined as a function of the BF slag content. The best results were achieved with the aluminum composites with 5 wt. % slag.
Keywords: Blast furnace slag (BF slag), aluminium silicon alloy

1. INTRODUCTION

Metal Matrix composites (MMCs) are becoming beckoning materials for advanced aerospace and automobile and naval 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, BF slag is one of the most inexpensive reinforcement available in large quantities as solid waste by-product during melting of pig iron.

2.0 MATERIALS AND METHODS

2.1 Matrix Material

In the present work, A356 alloy (Al-Si alloy), supplied by M/s Synergies Dooray automotives limited, Visakhapatnam, and is used as matrix material.

Table 1: Chemical composition of A356 alloy, wt. %

Si	Mg	Cu	Ti	Zn	Fe	Al
6.5	0.4	0.05	0.06	0.03	0.09	Balance

2.2: Fabrication of Composites

In the present investigation, aluminium based metal matrix composites containing 5, 10 and 15wt% BF slag particulates of 125 µm were successfully synthesized by vortex method. The matrix materials used in this study was A356 alloy (Al-Si alloy) whose chemical composition was shown in table 1.

The fabrication of these composites was carried out by stir casting technique. The cylindrical fingers (20 mm Φ and 150 mm length) of A356 alloy were taken into a graphite crucible and melted in an electric furnace. After maintaining the temperature at 790 °C, a vortex was created using mechanical stirrer. The preheated slag particulates were added slowly in the vortex.. The molten metal was stirred at 600 rpm under nitrogen gas cover. The stirring was continued for about 5 minutes after addition of particles for uniform distribution in the melt, after casting, cast ingots of both alloy and composites were homogenized at 200 ^{0}C for 24hrs to get relieve the internal stresses and minimize the chemical inhomogenities which may be present in the cast condition.

2.3: Characterization of Composites

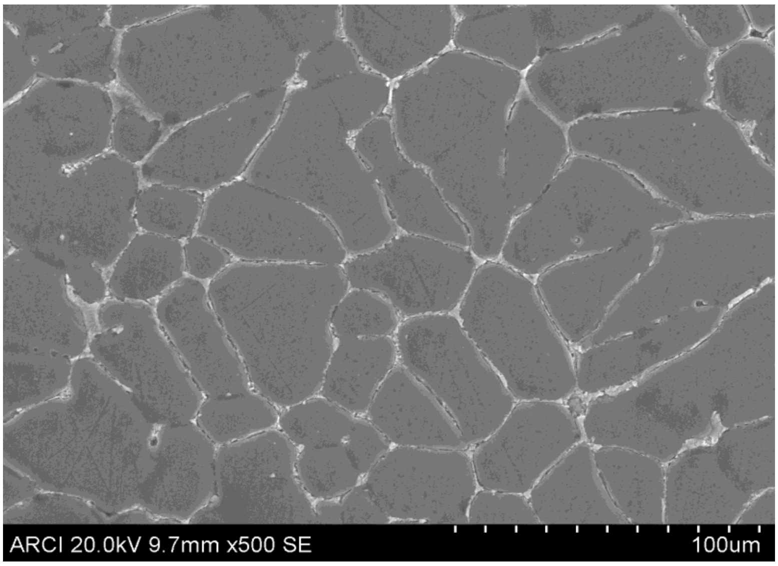
2.3.1: Metallography and Hardness tests

Scanning electron microscopy with 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 Vickers hardness tester. An average of 12 readings was taken for each hardness value.

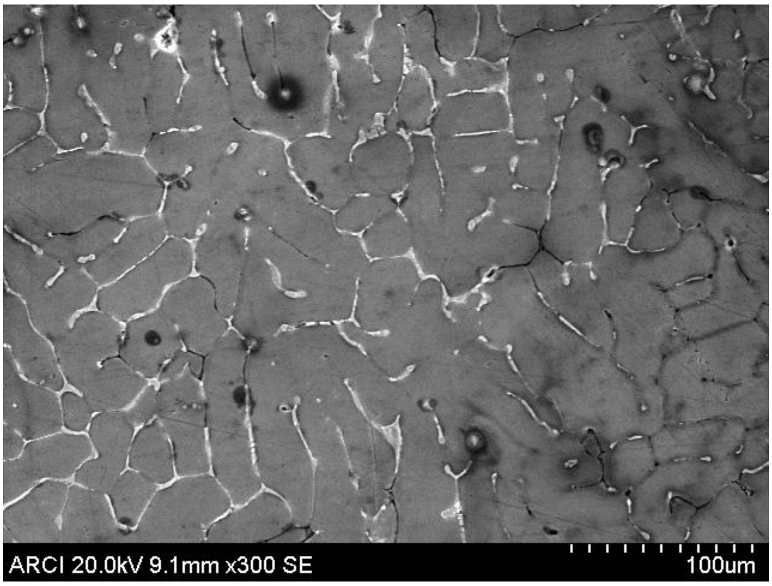
3 RESULTS AND DISCUSSION

a. Microstructures and EDS of alloy and composites

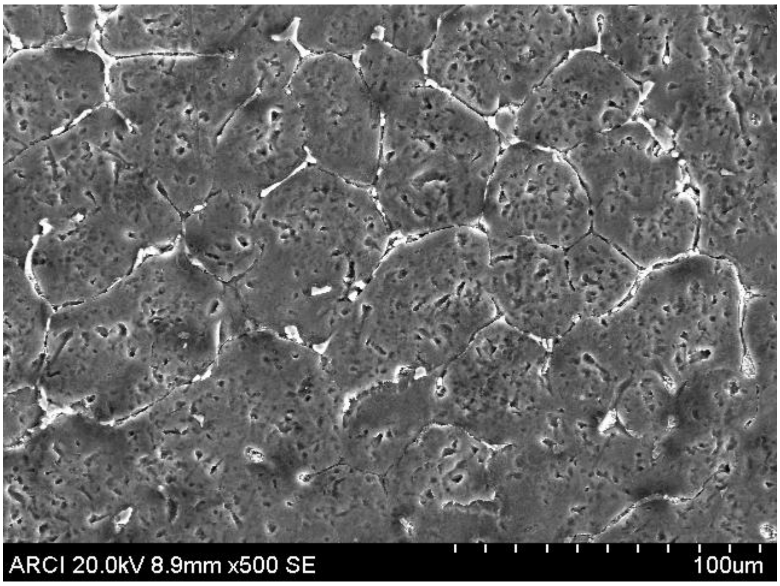
Figure 1 (a-d) shows the SEM and optical micrographs of alloy and composites, it is evident from the microstructures that interdendritic regions (IDRs) were formed, and also the distribution of slag particulates was uniform throughout. Similarly, the reinforcement phase shows only the constituents, such that no contamination has occurred. Since, perfect shielding of nitrogen gas is maintained, traces of oxygen is not seen either with the matrix or the reinforcements



(a)



(b)



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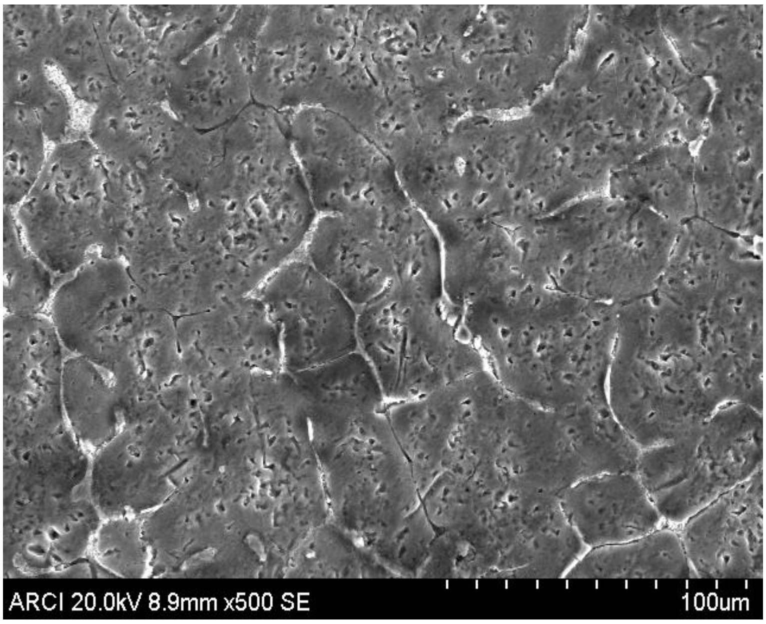

(d)

Figure 1: (a) A356 base at 100X **(**b) A356 –5% COMPOSITE at 100X (c) A356 10% COMPOSITE at 100X (d) A356 –15% COMPOSITE at 100X

4. CONCLUSIONS

[1]. A356/BF slag 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 FA/SiC particles and matrix phase.
[4]. 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 nitrogen gas was maintained during the mechanical stirring while reinforcement addition.
[5]. The hardness of the composites increased with increasing the amount of FA/SiC than the base alloy.

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