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Research Paper

Analysing the mechanical behavior of A6061/SiC/B_4C/Flyash composite fabricated through stir casting

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Abstract

Alloys of Aluminium are prominently used in automobiles, aerospace and ship building industries because of their high strength to weight ratio. The aim of this work is to manufacture the particulate reinforced metal matrix composite (PRMMC) materials by using Aluminium 6061 and reinforcing Boron Carbide, particles of silicon and fly ash. The study helps to fabricate an optimized composite material through the best methodology which is identified at the end of the experimental studies which is going to be carried out. This study helps the current researches carried on the nano-composite materials and PRMMC. In this paper, the Aluminium 6061 and its reinforcements are discussed and it gives a methodology to select the optimized method. The specimens fabricated by stir casting are analyzed and categorized according to their mechanical behavior by conducting mechanical tests. The Micro-structure of the specimen is examined by scanning electron microscopy (SEM) and spectrum analysis is done to the reinforcement distribution percentage.

1. Introduction

Composites are materials formed by combining constituents at macroscopic level. The constituents do not dissolve into one another. The materials used for reinforcement are embedded in the matrix of the base material. Steel reinforced concrete is an example of composite. In the present era the producing nano composites and PRMMC is the present scenario between the research scholars and the scientist. The aluminium 6061 is the base materials and the SiC/B_4C/Graphite/Fly ash is selected as the reinforcements. Stir casting technique is followed here to produce the composite material and optimize the strength and its mechanical behaviour [1-5]. Stir casting is a process commonly used to fabricate composite materials. In this method, the reinforcements are added to the molten matrix materials during continuous stirring. The Illustration of stir casting is shown in figure 1. The metal matrix in molten state along with the reinforcements is cast into the required shape by casting method [1-3]

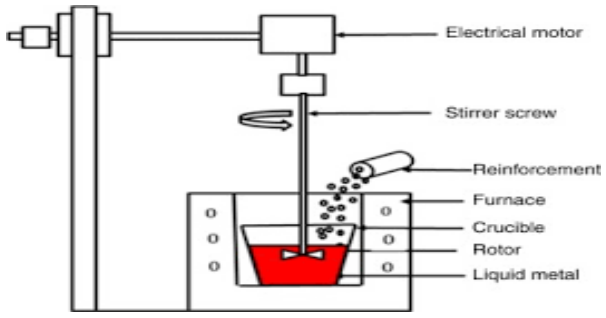


Fig. 1: Stir casting

2. Experimental Method

An empty crucible is placed in the furnace and the temperature is raised gradually till 750°C. Weighted amount of Aluminium 6061-O is loaded into the hot crucible for melting. Required quantities of reinforcements B4C/SiC/Fly ash powder are weighed on the weighing machine. Reinforcements are heated for 40 minutes at a temperature of 485°C. The aluminium turns into molten state at 650°C. After five minutes the foam powder is added which forms a foam layer of contamination on liquid surface which to be removed. Temperature is gradually raised upto 795°C [6-8]. At this temperature, stirring process is initiated and continued for five minutes. A speed controller is used to gradually increase the stirrer rpm upto 300. During the process of stirring, the preheated reinforcements are added to the molten aluminium. Reinforcements are dispensed physically with the help of conical hopper a measurement of 10%, 15%, 20 %.(i.e., Al 6061 with 90%, 85%, 80%). The reinforcements are added at a 0.5gm/sec flow rate. Stirrer rpm is then gradually reduced and stopped finally. The prepared mould is preheated to 500°C so that the composite is maintained in molten state throughout the pouring process. The Molten metal matrix composite from is poured into the mould. Care should be taken in pouring the molten composite into at a uniform rate to avoid the gas from trapping in the casting. Figure 2 shows the pouring of the molten composite into the mould. This process is continued for all the three specimens [1-3].

Fig. 2: Molding Process

3. Results and Discussions

The sample I, II, III is prepared by stir casting process by adding the reinforcement in different proposition i.e., weightages as mentioned in table 1. They are then molded to form the composite sample. The prepared samples are shown in figure 3. These prepared samples are machined for the mechanical properties testing and the SEM (Scanning Electron Microscope) analysis [10-11]. The SEM images of the prepared samples are shown in figure 4-6 respectively. The tensile and hardness values of the aluminium 6061 'O' and the three prepared samples are given in table 2.

Table 1: The Samples are mixed in the following ratios

Reinforcements	Sample-I	Sample-II	Sample-III
Silicon carbide (Sic)	5.2%	5.7%	5.7%
Boron carbide (B4C)	5.15%	6.1%	6.1%
Graphite	3.1%	3.5%	3.5%
Fly ash	4.1%	4.5%	4.5%

Fig. 3: Specimens

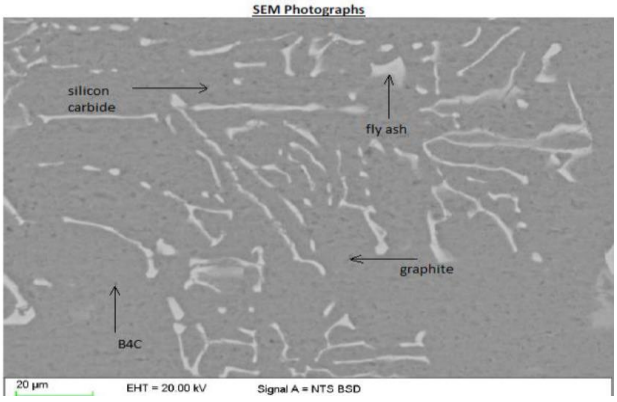


Fig. 4: SEM Image Sample-I

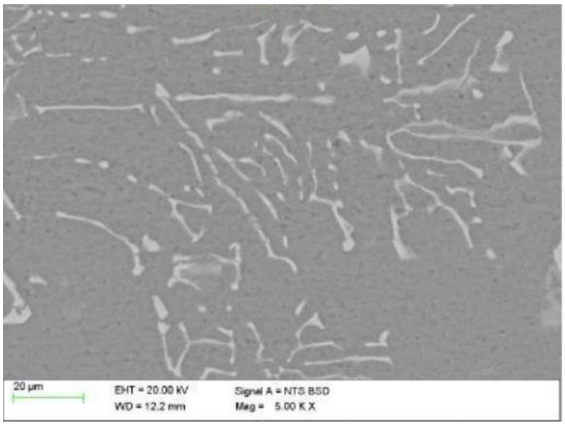


Fig. 5: SEM Image Sample-II

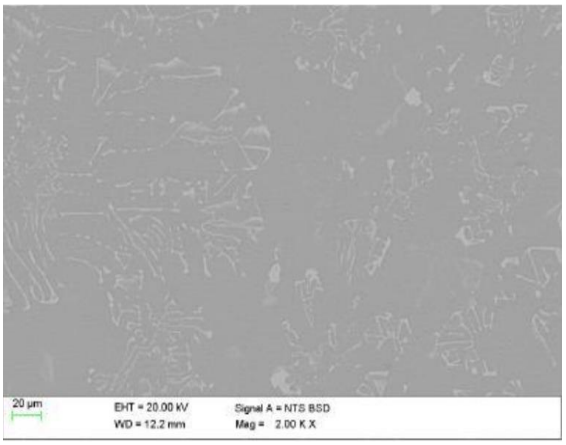


Fig. 6: SEM Image Sample-III

Table 2: Mechanical test results

Test	**Aluminium 6061 O**	**Sample I**	**Sample Ii**	**Sample Iii**
Tensile (Mpa)	110	111	99	118
Hardness (Brinell) Bhn	33	43	45	46

Figure 7 and 8 shows the comparison of the tensile strength and hardness of the Al6061 'O' and the three prepared samples.

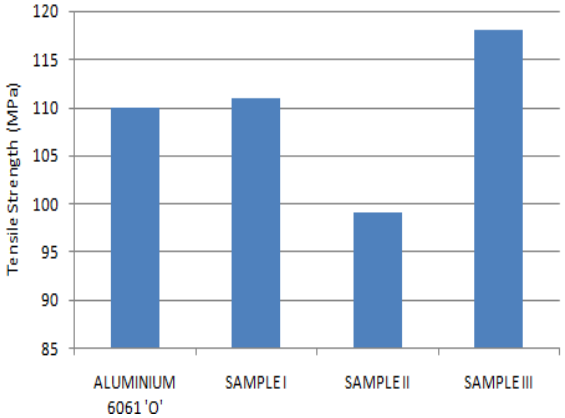


Fig. 7: Comparison of the Tensile strength

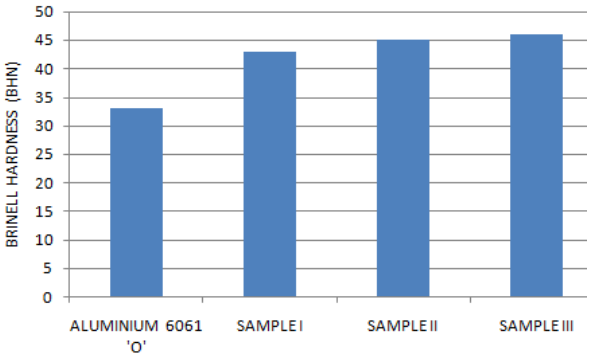


Fig. 8: Comparison of the Brinell hardness

The Chemical composition of 10% SiC composite obtained by EDAX is given in table 3 and 4.

Table 3: Chemical composition of the composite of' 10 %w Al-SiC/B4C/Fly ash

S.No	Elements	Weight%
1.	$CaCO_3$	20.19
2.	SiO_2	7.65
3.	MgO	0.87
4.	Al	60.69
5.	Cu	2.40
6.	B	5..20

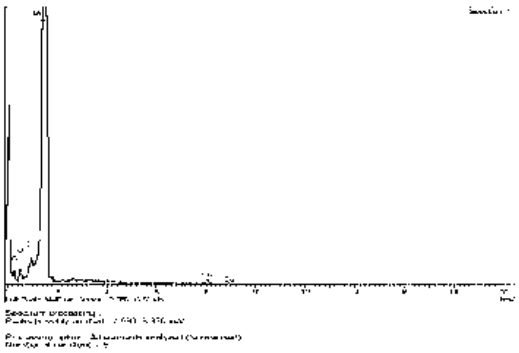
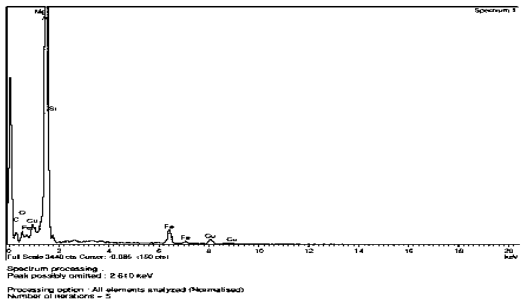


Table 4: Chemical composition of the composite of 10 %w Al-SiC/B4C/Fly ash

S.No	Elements	Weight%
1.	$CaCO_3$	26.15
2.	SiO_2	10.20
3.	MgO	0.67
4.	Al	47.37
5.	Cu	2.38
6.	B	8..20
7.	Fe	5.03



4. Conclusion

The particulate reinforced metal matrix composites (PRMMC) were produced by stir casting. The fabricated specimens are analyzed and categorized according to its mechanical behavior by conducting tensile and hardness tests. The physical structure was performed through optical microscopy (OM) and scanning electron microscopy (SEM) and finding the distribution percentage by using spectrum analysis.

- The comparison graphs shows the gradual difference between the three specimens and also the taken results do not give 100% significant result because the composition ratio of the specimen, corrosion and wear behavior and the machining parameters should also be considered to justify the method and conclude it.
- In this study, experimental results show that the stir casting method gives a positive result in terms of tensile strength and hardness.

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