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Effect of Graphite and AL_2O_3 Reinforcement on Al6061 based Metal Matrix Composite

Jeevan Gowda G
Research Scholar,
Department of Mechanical Engineering,
Vivekananda Institute of Technology,
Bangalore, Karnataka, India.

Abstract **- Aluminium based composite are getting a vast scope nowadays because of its properties and availability. In the present work, Graphite and AL_2O_3 reinforced composite are prepared using stir casting technique for varying wt.% (Graphite 3% and AL_2O_3 3%, 6% & 9%). Micro structural study has been carried out on prepared composites, which reveals a good distribution of particles in to the matrix. Hardness and tensile properties were also determined; with the addition of reinforcement the properties are improved compared to the parent metal alone. Based on the evaluation 6% AL_2O_3 and 3% Graphite gives a better result as compared to other composition.**

Keywords: ***Graphite, AL_2O_3, Composite , Aluminium, Reinforcement, stir casting;***

1. INTRODUCTION

Composite, as the name itself indicates it is a combination of two or more material, which are non reactive and of different phase, that don't makes a homogeneous mixture that is where it stands different than alloying. The research on composites are not from few days it is from few decades, but still the process parameters are not optimised and a huge numbers of reinforcement are available which still keeps this field in higher altitude. And composites provide a better alternative to conventional material as it constitutes different material, it has its own contribution over the properties. There are so many methods to prepare metal matrix composite like powder metallurgy, stir casting, extrusion etc. Among which stir casting will be easier and economical way to produce composites.

Cu coating on particles like SiC contributes better bonding between the reinforcements and matrix [Mohan Vanarotti et al., (2014)]. Using halide salts wettability can be increased and cover flux results in decreased contact angle and surface tension forces [G.L Rajesh et al., (2014)]. Inert gasses can also be used to prevent the formation of oxides [J. Jebeen Moses et al., (2014)]. Addition of some materials like fly ash to aluminium matrix improves the hardness, wear resistance, stiffness etc., when the reinforcement is more than 15% the tensile strength is reportedly decreasing [Rohatgi et al., (1997)]. The grain also has its own impact on material properties, lower grain size results in higher mechanical properties [K.R. Ravi et al., (2008)]

2. COMPOSITE PREPARATION

In our work, stir casting technique is used to prepare the composites. The procedure used is the required amount of aluminium is weighed and placed in crucible, temperature was preset to 710^0c, and once the temperature is attained, same temperature is maintained for 10minutes to confirm complete molten state of the metal, hexacholoroethane tablets are used for degassing. The corresponding wt.% of reinforcement is weighed and preheated to 400^0c to remove moisture. And the mould is also preheated to minimise casting defects. Now after achieving complete liquid state the melt is stirred at 300-400 RPM to create vortex and preheated reinforcement along with magnesium and coverall is introduced while stirring, coverall helps in preventing oxidation and magnesium to improve wettability. After stirring for 10 minutes the slag is removed and the melt is poured in to the permanent moulds. Further, solidified preforms are machined to required ASTM standards and tested for different parameters.

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Figure 1: Alumina Particle

Figure 2: Granite Particle

3. TENSILE STRENGTH

The tensile tests were carried out at a constant speed in Universal testing machine of 100KN capacity. The specimen prepared as per ASTM standard E08 and having dimensions of gauge length of 30mm and diameter 10mm, with a grip distance of 15mm and diameter 15mm.

Table 1: Results of Tensile Test

Sl NO	NOMENCLATURE	TENSILE STRENGTH (MPa)
1	Al6061 + 0% reinforcement	392
2	Al6061 + 3% Graphite + 3% AL2O3	403
3	Al6061 + 3% Graphite + 6% AL2O3	407
4	Al6061 + 3% Graphite + 9% AL2O3	378

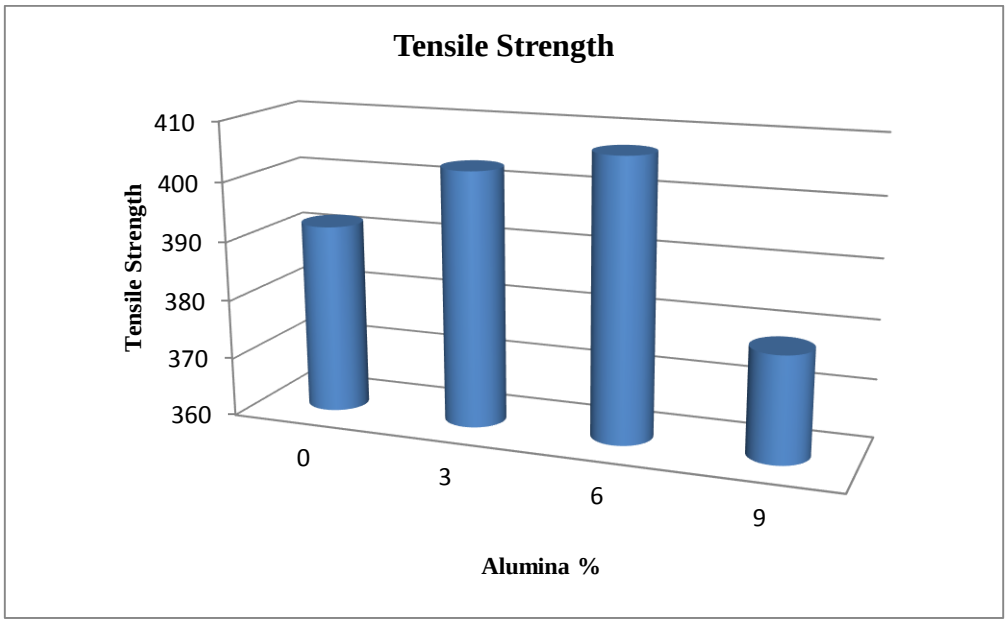

Figure 3: Variation of Tensile Strength with reinforcement %

4. HARDNESS

Hardness is the resistance to plastic deformation (e.g., a local dent or scratch). Thus, it is a measure of plastic deformation.

The Hardness of the composites samples were measured using a Leitz, Brinnel hardness measuring machine with a load of 100 N. The specimen prepared as per ASTM standard and the dimension of the specimen is 19X19 mm.

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Table 2 : Results of hardness test

Sl NO	NOMENCLATURE	LOAD (N)	BHN
1	Al6061 + 0% reinforcement	250	53
2	Al6061 + 3% Graphite + 3% AL2O3	250	58
3	Al6061 + 3% Graphite + 6% AL2O3	250	64
4	Al6061 + 3% Graphite + 9% AL2O3	250	69

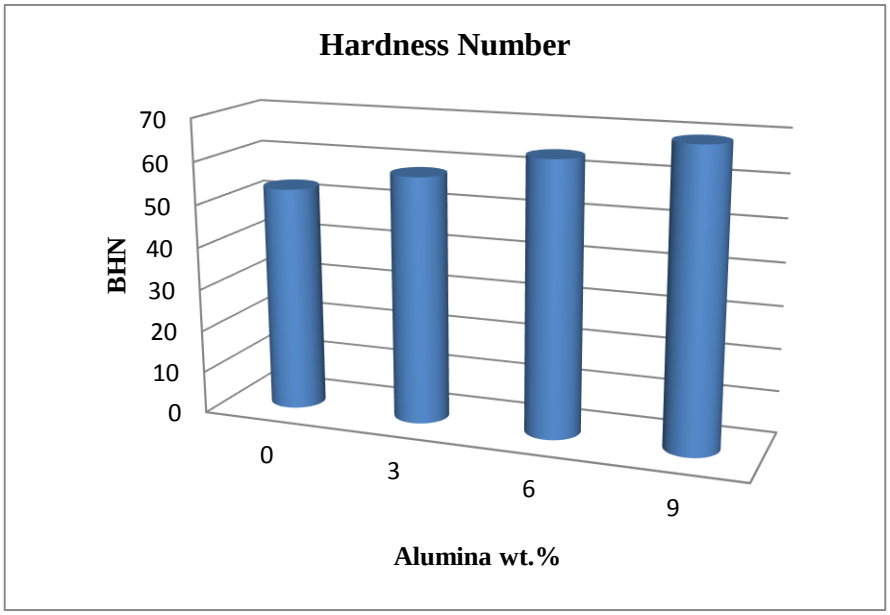

Figure 4: Variation of BHN with reinforcement %

The hardness of the composite material increases monotonically by significant amounts as the reinforcement's particles content increases. As the AL2O3 reinforcement contents increased from 3% to 9% by weight with 3% Graphite constant, the hardness is increased by 30%. The percentage of increase in hardness as a variation of different reinforcement is shown in the table 1.

The scanning electron microscope (SEM) is a type of electron microscope that images the sample surface by scanning it with a high- energy beam of electrons in a raster scan pattern. The electrons interact with the atoms that make up the sample producing signals that contains information about the samples surface topography, composition and other properties such as electrical conductivity.

5. SCANNING ELECTRON MICROSCOPE

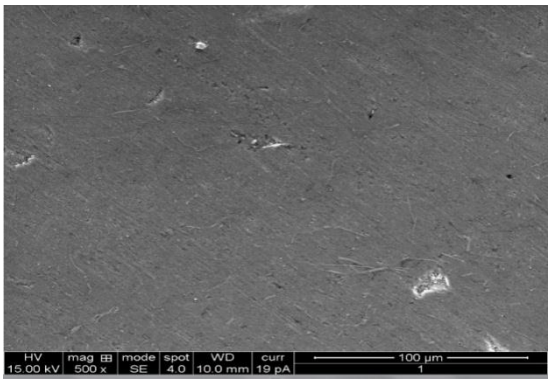

Figure 5: AL6061+3%Graphite+3% AL2O3

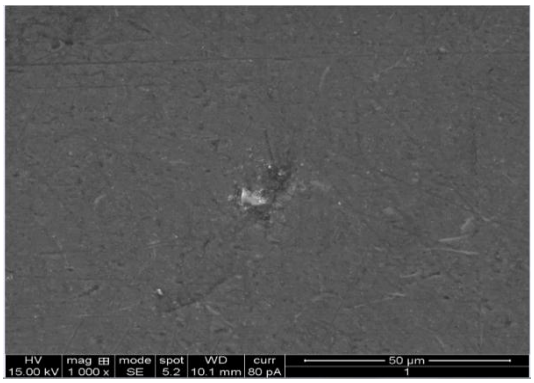

Figure 6: AL6061+6% Graphite +3% AL2O3

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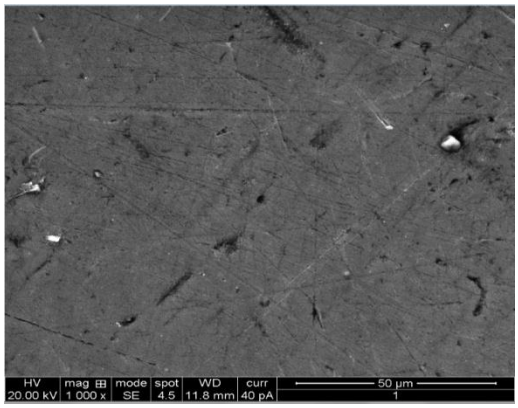

Figure 7: AL6061+3% Graphite +9% AL2O3

SEM images reveals the distribution of particles, it shows a fair distribution of particles in to the matrix, white colour dots shows the presence of AL2O3 and black patches shows the presence of graphite.

CONCLUSION:

- Using stir casting particulate metal matrix composite can be produced successfully
- Addition of reinforcement particles with the aluminium increases the mechanical property and gives a better result.
- Addition of 6% alumina with 3% Graphite in aluminium improves the hardness by 30 % and tensile strength is also increased.
- SEM images shows a good distribution of reinforcements
- For 9% alumina with 3% Graphite reinforcement there is a drop in tensile strength which may be due to the clustring of reinforcements as seen in SEM images (Figure 7)

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