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Determination of Mechanical Properties of Aluminium Based Composites

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ABSTRACT : Metal matrix composites (MMCs) have been reported to offer isotropic properties with substantial improvements in strength and stiffness relative to those of the unreinforced material. Modem Technology aims at high physical and mechanical properties, the weight & the cost must be low and it should have isotropic properties. The above requirements are developed through metal matrix composites, which are not achievable with monolithic alloys. Review literatures reveal that the particle reinforced MMCs (Hybrid MMCs) exhibit reasonable increase in physical and mechanical properties.

Keyword : Mchanical Properties, Composites, Aluminium Composites.

I. INTRODUCTION

The present work deals with the fabrication and Mechanical Testing of a hybrid composite with the following constituents.

* Aluminium 6061 Matrix
* Silicon Carbide particulate reinforcements
* E-glass fiber reinforcements.

The compositions of the above materials were varied in the following manner:

Aluminium 6061+2% SiC

Aluminium 6061+4% SiC+2% Eglass

Aluminium 6061+6%SiC+4% Eglass

Aluminium 6061+8%SiC+6%Eglass

The fabrication employed was liquid metal vortex technique. Silicon carbide particle size ranged from 15-30 microns. E-glass of the fiber added ranged from 3-5mm. The two reinforcements were added to the Aluminium powder to form the hybrid composite. The castings were machined to standard dimensions as suggested by ASTME. These specimens were tested for the following specifications undar standard test conditions.

* Tensile and compressive properties (yield strength, Young's modulus ultimate tensile strength, fracture strength).
* Hardness (Brinell and Rockwell).

The tensile tests were conducted in a 2- TON Tensmeter. The compression tests were conducted in a 40-TON Universal Testing machine. The hardness tests were conducted in the suitable hardness testing apparatus by choosing appropriate scales of loading and measurement.

The Aluminium and 2% Silicon carbide composite fabricated with the same technique. The results obtained were also compared with that for Aluminium.

The test revealed marked increase in the tensile and compressive strengths and an appreciable increase in the hardness with respect to the base composite as well as Aluminium.

II. SCOPE OF THE PRESENT INVESTIGATION

The popular use of Aluminium and its alloys in the automobiles and aerospace industries gives a clear indication of the desirable properties possessed by these materials. But the technology has progressed there has been a need to fabricate materials with these properties enhanced. The arena of advanced materials has made open to us limitless avenues of achieving these desired charectoristics in materials. Thus to achieve specific properties we can choose from an array of composites materials, each tailor made to satisfy specific needs.

The work that is planed aims to fabricate a material that has enhanced properties of the popular Aluminium 6061 as well as the Aluminium-Silicon Carbide MMC.

The work planned also aime at encouraging future work in this vastarena of hybrid composites. Hybrid composites as we know have in their store immense potential for future research and development.

III. EXPERIMENTAL PROCEDURE

The experimental procedure adopted in the presented work consisted of the following three phases,

Phase 1: Fabrication

It was decided to fabricate with the following compositions,

Aluminium 6061, 2% Silicon Carbide.
Aluminium 6061, 4% Silicon Carbide, 2% E-glass.
Aluminium 6061, 6% Silicon Carbide, 4% E-glass.
Aluminium 6061, 8% Silicon Carbide, 6% E-glass.

In accordance with the above proportions, appropriate quantities of Aluminium 6061, Silicon carbide power and E-glass fibers were weighed.

Initially the weighed Aluminium 6061 ingots for a particular composition was placed inside a Graphite crucible and melted in a muffle furnace. The temperature of the furnace was made to reach 800°C. Aluminium melts at 660°C. The superheat was given to ensure liquid state of Aluminium 6061 during mixing and pouring. Along with this operation simultaneously, Silicon Carbide powder corresponding to that particular composition was perheated upto 500°C in a furnace and the split metal die where the final mixture would be poured was also preheated to prevent sudden cooling of the melt which causes brittleness. The molten state Aluminium 6061 in the crucible was taken out of the furnace and the preheated Silicon Carbide was poured into the crucible. After this the proportionl quantity of E-glass that was weighed prior to this was also added to the mixture. Immediatety the mixture in the crucible was placed below an electric stirrer and stirred to effect the liquid metat vortex mixing technique. When stirred and mixed to a satisfactory extent the mixture with Aluminium still in molten form was poured into the dies by loosening the clamps.

A similar approach was adopted for all the other compositions and corresponding castings were obtained.

Phase 2: Machining

The casted materials had to be machined for performing the Tensile and Compressive tests along with Hardness tests. The dimensions to be machined for had to be in accordance with the ASTME standards for the individual tests.

Phase 3: Testing

The testing phase consisted of the following three parts
Tensions tests
Compressive tests
Hardness tests

IV. TENSION TESTS RESULTS

Material	*UTS N/mm (Mpa)*	*Yield Strength N/mm*	*Youngs Modulus Gpa*	*% Elongation*
Al+2%SiC Al+4%SiC+	305.61	197	79	10.2
2% Eglass Al+6%SiC	307.53	209	80.5	9.372
4% Eglass Al+8%SiC	309.53	214	82	9.4018
6% Eglass	310.937	217	83.5	8.4982

V. COMPRESSION TESTS RESULTS

Composition	*Fracture Strength N/mm*	*Yield Strength N/mm*	*% Reduction in Length*
Al+2% SiC Al+4% SiC +Length	861.86	716.3	65
2% Eglass Al+ 6% SiC	874.35	718.87	57.5
4% Eglass Al+ 6% SiC+	880.6	717.5	55
6% Eglass	880.6	719.2	62.5

VI. HARDNESS TESTS

Composition	*Brinell Hardness (BHN)*	*Rockwell Hardness (RHN)*
Al+ 2%SiC Al +4%SiC+2%	71.1	123.5
Eglass Al+6%SiC +4%	72.08	125.5
Eglass Al+8%SiC+6%	79.08	126.3
Eglass	85.688	127

VII. CONCLUSION

The following conclusions have been drawn from results obtained.

Conclusions based on the tensile and compression test results.

The material that has been fabricated is observed to have acceptable values of critical parameters such as Ultimate Tensile Strength, Yeild Strength, Young's Modulues and Hardness and have shown an overall improvement in the various material properties when compared to those of Aluminium 6061. It can be safely stated that with the increase in the reinforment compositions, there have been notable improvements in the essential properties.

Conclusions on Tensile Properties

The graph shows the ultimate tensile strength compared between Aluminium 6061 and the materials fabricated. The graph indicates a steady improvement gained by the materials.

The reason for the improvement can be stated as follows:

The fracture of a specimen occurs with the movement of dislocations.

The grain boundaries restrict the movement of these dislocations.

When the reinforcements are added, the particulate reinforcements from nuclei which results in greater number of grain formation. Thus the movement is restricted further, which results in greater strength. Also, the addition of fibers as reinforcements share the applied load and with the fundamental definition of reinforcements (reinforcement shares the applied load and thus increase the strength.) Thus the observation in the overall increase of the tensile strength is aptly justified and explainable.

Comparison between Aluminium 6061 and the composite fabricated.

Evaluation of Mechanical properties of Aluminium based hybrid Composites

PRPPERTY	***Al 6061***	***Hybrid Composite***
UTS (N/mm^2)	270-290	305-310
Yeild strength (N/mm^2)	180	197-217
Young's Modulus	70	79-83.5

Conclusions on Hardness properties

The addition of the reinforcements has resulted in a steady increase in the hardness. The addition of Silicon Carbide, which is ceramic in nature, could have caused the increase, as ceramics are generally hard. The following table is relevant.

Hardness type	***Aluminium 6061***	***Hybrid Composite***
BRINELL	65-85	75-85
ROCKWELL	115-120	123-127

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