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EVALUATION OF TENSILE AND COMPRESSION STRENGTH OF HYBRID COMPOSITE MATERIAL USING AL6061 ALLOY, FLY ASH AND MICA AS SECONDARY REINFORCEMENT

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Abstract- *This work reveals the evaluated results of some of the mechanical properties, such as tensile strength, compression strength, hardness and microstructure, of Aluminium alloy (Al6061) was reinforced with Fly ash as primary reinforcement and mica as secondary reinforcement for different ratios. The reinforcement of fly ash varied in the interval of 0%, 2%, 4%, and 6%. Keeping Mica as constant. Bottom pouring stir casting method is adopted for casting the composite materials. The test tokens were prepared according to ASTM standard (E8M-13A). The test was conducted and result was recorded. Tensile test, compressive test, hardness test and microstructure studies was evaluated and their results are recorded.*

Key words: Fly ash, Mica, Hybrid composite

1. INTRODUCTION:-

Composite material is the combination more than two distinguishable materials having different physical properties and chemical properties. The two phases of composite are Matrix phase, is a percolating soft phase, and Reinforcement phase. Matrix is, major part, responsible for binding the reinforcement materials firmly and transfers the load between the reinforcements. The matrix may be metal or non metal such as polymer. In general the reinforcements are in the form of fibers or particulates. Composites made out of aluminum alloy matrix gains significant attention because of their light weightiness and moderate moulding temperature. In recent times the hybrid composite has high demand due to their specific application in aerospace and automotive industries. Due the light weight, compared to the other structural metals, aluminum alloys plays a vital role in the designing of hybrid metal matrix composite material. Stirring speed of 800 rpm and furnace temperature of 820^{o} C is preferred [1]

2. Materials used:

2.1 Matrix: The matrix material used was Al6061 and whose constituents are shown in the table 1.

Table 1: Constituents of Al6061alloy

Element	%
Al	95.85 to 95.55
Mg	0.8 to 1.20
Si	0.40 to 0.80
Fe	0.0 to 0.7
Cr	0.04 to 0.35
Cu	0.15 to 0.40
Ti	0.0 to 0.25
Mn	0.0 to 0.15
Zn	0.0 to 0.25
remaining	0.05 each and 0.15 total quantity

Aluminium finds vast applications because of high strength to weight ratio, comfortable machine and it possesses good durability, ductility and malleability characters [2]. Al6061 is a most commonly used general

purpose alloys of Aluminum which exhibits good Mechanical properties and has low melting point of 710° C. It possesses good fluidity, solidification at constant temperature and great corrosion resistance.

2.2. Reinforcement material

2.2.1Fly ash:

Fly ash obtained from the thermal power plants and is a waste end product utilized to reinforce with aluminum matrix to enhance mechanical properties of the aluminum. The color of fly ash is tan to dark grey in color with a normal size of 50µm. When the temperature increases the matrix loses its strengths but the fly ash helps to retain the strength at that temperature. [3]

Table 2: Constituents of Fly ash.

Sl.No.	Component	Wt%
1	SiO2	40- 60
2	Al2O3	20-30
3	Fe2O3	4-10
4	CaO	5-30
5	LOI	0-3

2.2.2. Mica:

Mica is a group of sheet silicate mineral possessing properties such as inert, dielectric, elasticity and flexibility. In the present work, properly sieved mica of 53 micron size is used. Mica was heated before introducing in to the melt. It was added in the wt% of 2% and 6% with the fly ash of varying wt% of 2%,4% and 6%.

Table 3: Constituents of mica.

Sl.No.	Component	Wt%	Sl.No.	Component	Wt%
1	Silica (SiO_2)	45.57 %	**7**	Phosphorus (P)	0.03 %
2	Alumina (Al_2O_3)	33.10 %	**8**	Sulphur (S)	0.01 %
3	Potassium Oxide (K_2O)	9.87%	**9**	Magnesia (MgO)	0.38 %
4	Ferric Oxide (Fe_2O_3)	2.48%	**10**	Loss on Ignition (H_2O)	2.74 %
5	Sodium Oxide (Na_2O)	0.62%	**11**	Moisture at 100°C	0.25 %
6	Graphite Carbon (C)	0.44%	**12**	Titanium Oxide (TiO_2)	Trace s

Table 4: wt% of matrix and reinforcements and matrix

Sl. No.	Specimen ID	% of Aluminum Al6061	% of Mica	% of Fly ash
1	A1	100	0	0
2	A2	98	0	2
3	A3	96	0	4
4	A4	94	0	6
5	B1	98	2	0
6	B2	96	2	2
7	B3	94	2	4
8	B4	92	2	6
9	C1	96	4	0
10	C2	94	4	2
11	C3	92	4	4
12	C4	90	4	6

3. Methodology of casting:

The composites were fabricated by stir casting process which enhances uniform distribution of reinforced particulates. Stir casting bottom pouring (gravity pouring) method is economical. The aluminium was melted at constant 800°C and with the stirring speed of 800 rpm was maintained. Fly ash and mica is heated for one hour at 400°C before introducing in to the furnace. The stirrer is used to create a vortex in the molten matrix and the preheated reinforcement materials are slowly admitted into the molten matrix. Degassing chemical was added to eliminate liberated gas during melting and a small quantity of Magnesium (Mg-0.5-0.6%wt) was added to enhance good wetability [4]. Stirring was continued for 10min after the introduction of reinforcement into the molten matrix . The entire mixture was poured in to the preheated mould. The cast was removed after complete solidification and machined according to ASTM E8/E8M-2009 standard [5] as shown in fig1.

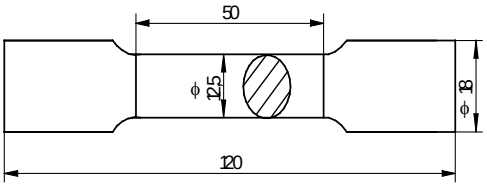

Fig:1 Tensile test specimen ASTM-E8

4.0 TESTING OF SPECIMENS:

4.1 Tensile test.

Fig 2: Universal testing Mechine

Tensile test was conducted after the successful completion of casting and machining of test specimens using computer interfaced UTM. The test token was machined according to ASTM specification. The Tensile load was applied until the specimen, fixed in UTM, break and corresponding values was recorded. Maximum tensile strength of 260.779 N/mm^2 was obtained for the combination of 2wt% of mica and 4wt% of Fly ash along with Al6061 matrix. The test result reveals that the increase in wt% of mica decreases tensile strength.

Fig: 3 Tensile test specimen after the test.

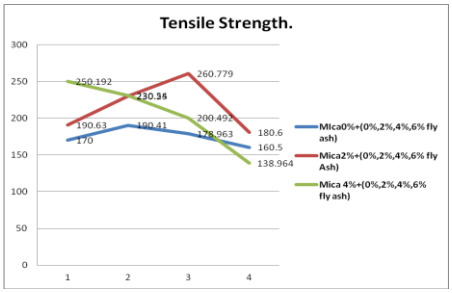

Chart -1: Tensile strength for various combinations of matrix and reinforcement

4.2 Compression Test.

Compression test was conducted to evaluate the compressive strength of the material

Fig4: Compression test specimen

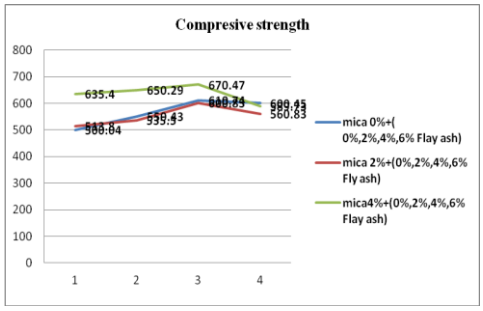

Chart -2: Compressive strength for various combinations of matrix and reinforcement

The maximum compressive strength of 670.47 N/mm^2 was obtained for the combination of Mica4% and fly ash 4% remaining Al6961 matrix beyond that ratio the compressive strength falls due to the increased percentage of Fly ash and Mica.

4.3 Hardness Test.

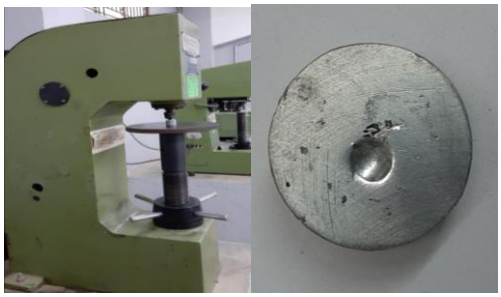

Fig:5 Brinell Hardness testing Machine and Specimen

Brinell hardness test was conducted and with the combination of 2% mica plus 4% fly ash with 94% Al6061 hardness of 63 BHW was observed and recorded.

4.4 Microstructure

Appearances of small pits are due to oxidation of surface by the etchants or may be by the grinding of the surface. Fig-7 shows the proper distribution of matrix and reinforcement. It indicates inter metallic precipitates in a matrix of aluminium solid solution. No porosity or segregation was seen. In the Fig-8 thread like boundaries are due to fine particles of fly ash reinforcements added with matrix.

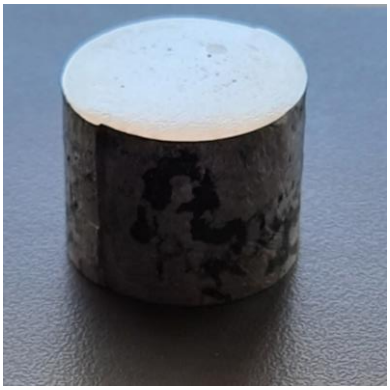

Fig-6: Microstructure test test specimen

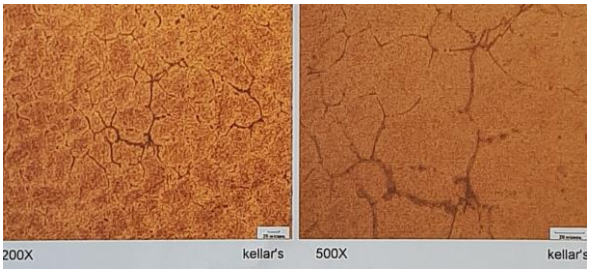

Fig: 7 Micro structure of 0% mica +0% fly ash+ 100% Al6061

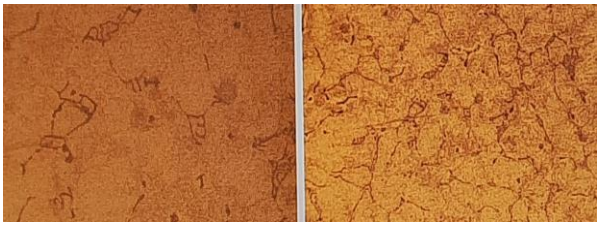

Fig: 8 Micro structures of 4% mica +4% fly ash+ 92% Al6061

Conclusion: The Al6061 matrix is material is reinforced with different wt% of Mica and Fly ash by stir casting bottom pouring method of casting under normal room temperature environment. Tensile test, compression test, hardness test and microstructure study was conducted. From the test result it was found that addition of fly ash and Mica in the ratio of wt% of 4% each shows good improvement in compressive strength also hardness of 63 BHW. With 2% mica plus 4% fly ash with 94% Al6061 shows good tensile strength. Beyond which the compressive and tensile strength decreases. Also the microstructure image shows that the reinforcements are

uniformly distributed in the matrix and there is no agglomeration or voids were found.

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