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STUDY OF MECHANICAL BEHAVIOUR ON ALUMIN IUM 6061 MATRIX COMPOSITES REINFORCED WITH Al2O3 AND B4C PARTICALS AND FRACTOGRAPHY STRUCTURE

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Abstract -Al6061 alloy is a wrought alloy with the main alloying constituent's magnesium (Mg) and silicon (Si). The Al6061 alloy has great qualities at ambient temperature and good at wet ability, but it has poor high-temperature behaviour. Furthermore, by adding conventional reinforcements to make composites, it is important to develop the mechanical behaviour of aluminium metal matrix composites. Usually stir casting involves addition of ceramic particles into the softened melt in the crucible. In this study, Al6061- Al_2O_3-B_4C composites are produced by novel dual stir casting in which particulates are mixed homogeneously with melt by mechanical stirring in two stages and solidification takes place with the suspended particles. These novel two stages of mixing of ceramic and oxide particulates improved the wet ability of these reinforcements with the matrix material.

***Key Words*:** Aluminium, Al_2O_3, B_4C, Tensile, Hardness, Impact, Fractography.

1. INTRODUCTION

Metal–matrix composites (MMCs) are Appealing materials in achieving Mechanical properties as: hardness, Young's modulus, yield strength and ultimate tensile strength due to reinforcement particles into the matrix. Aluminum-matrix composites Due to its improved physical and mechanical properties, AMC has become increasingly use in the automate, army, auspice, and electrical industries. Example, 6061Al-alloy is supposedly used in e-applications such as transport and skyscrapers where High Class mechanical properties are achieved allying tensile strength, hardness etc., are achieved. Materials such as Sic, Al_2O_3, B_4C, TiB_2, ZrO_2, SiO_2 and graphite are being used as reinforcements to improve the properties of such alloy. Reinforced Particles usage is exponentially increasing in such industrial activities to ramp up quality Products such as pistons, cylinder heads, connecting rods etc.

Composites that forms heterogeneous structures which meet the requirements of specific design and function, imbued with desired properties which limit the scope for classification. However, this lapse is made up for, by the fact new types of composites are being innovated all the time, each with their own specific purpose like the filled, flake, particulate and laminar composites.

Ceramic matrix composites (CMC) are used in applications where resistance to high temperature and corrosive environment is desired. CMCs are strong and stiff but they lack toughness (ductility). Ceramics in general are characterized by high melting points, high compressive strength, good strength retention at high temperature, and excellent resistance to oxidation.

The melting point, physical and mechanical properties of the composite at various temperatures determine the service temperature of composites. Most metals, ceramics and compounds can be used with matrices of low melting point alloys. The choice of reinforcements becomes more stunted with increase in the melting temperature of matrix materials.

The number of cycles increases, the life of the component decreases. Compared with the unheated sample, the hot-extrusion heat-treated sample has a longer life. Compared with cast samples, extruded samples have a longer life. In terms of hot casting and extrusion, these compounds have a longer fatigue life compared to base alloys. Among all the materials studied, these compounds have the longest fatigue life.

The mechanical properties of MMC after hot rolling did not significantly improve the presence of grain cracks and shrinkage. The properties of these materials can be optimally utilized, making MMC an appropriate choice of secondary processes for enhanced. The low porosity level below 3.6% in AA 6063 synthetic materials was developed and also had tensile strength, productivity intensity and increased hardness value with an increase in the flexibility of Al volume percentage and breaking of falling flexibility. The aging treatment leads to a slight improvement in the tensile strength of synthetic materials. SIC is used as consolidation from 30 to size beads with sodium tetra hydration. Thereafter, the microscopic structure survey is carried out by the DATGG software control microscope. Plasticizers are not badly affected in these integrated materials. Improving the performance of AL 6063, which can be achieved when 9 and 12% SICs are used as amplification. The treatment of aging improves awakening durability and strength. Ductility is not negatively affected by these composites. The strength enhancement of Al 6063 is achieved when 9% and 12% of SiC is used as reinforcement. Aging treatment improves not only strength but also fracture toughness.

Further, research survey reveals that there is no much work conducted on the use of alumina and boron carbide as reinforcement to develop aluminium based composites. Major aim in this research is to develop Al6061 alloy with Al_2O_3 and B_4C composites by novel two-stage stir casting technique. The developed composites are evaluated for their microstructural characterization and mechanical properties.

2. Experimental Details

In the present work, Al6061 alloy with constant wt % Al_2O_3 and varying wt % B4C particles are chosen into account as a base matrix and reinforcement respectively.

The Al6061 alloy with 15 wt. % Al_2O_3 and 0 to 9 wt. % of B_4C particles were produced by two step stir casting method. Al6061 is a creamy, weight to strength and highly malleable metal. Its facade is dependent on roughness of the surface and silvery to dull gray ranges form. It is non ferrous and non magnetic nature. Also it is soluble in convinced forms of water, in alcohol it is insoluble. The major alloying elements are Magnesium and silicon constituents of Al6061 which is a precipitation hardening alloy. Al6061 is good weldability and exhibits superior mechanical properties.

Commercially 6061Al alloy is available in different grades such as 6061- O, 6061-T6 and 6061-T651. It is commonly utilized aluminum alloy for general usage. While Al_2O_3 and B4C particles were enforced as reinforcements. The Al_2O_3 and B_4C particles with micron size particles were present study Fig. 1 (a-b) is indicating the SEM micrograph and energy dispersive spectrographs of Al_2O_3 particles and Fig. 2 (a-b) is indicating the SEM micrograph and energy dispersive spectrographs of B_4C particles used in the current investigation.

2.1. Analysis of Hardness

The hardness test is a mode of calibrating the hardness of materials on a microscopic range. Micro hardness is calculated applying Vickers hardness tester, as displayed in Figure 3.4. The precision diamond indenter is pressed toward material with a load of 5 kgf to 30 kgf. The microscopically deliberate slit length and adapted load are used to estimate the hardness value.

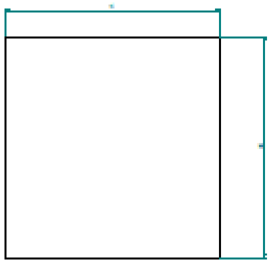


Fig. 1: Hardness specimen as per ASTM standards

2.2. Impact Test Measurements

Charpy Impact Test more familiar as the Impact Charpy test, it is a standardized immense strain rate test that clinch the amount of energy absorbed by a material during failure. This engrossed toughness is allowance of the notch toughness of a peculiar material, distribute as a tool for studying the temperature-dependent ductile-brittle evolution. It is widely applied in industry because of its ease of preparation and implementation, and its ability to obtain results quickly and inexpensively. The downside is that some results are comparable.

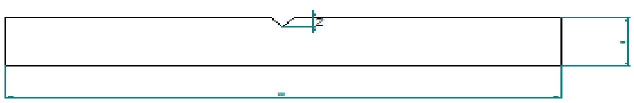


Fig. 3: Charpy impact test specimen ASTM E384

2.3. Tensile Test Measurement

A computerized shortened tensile tester was used for tensile testing to examine the mechanical behavior of composites. The size of sample used in the tensile study according to the ASTM E8 standard Integral length of sample =99mm Gauge length =37mm, Gauge diameter = 6mm, Gripping length=29mmt, otal diameter=10mm

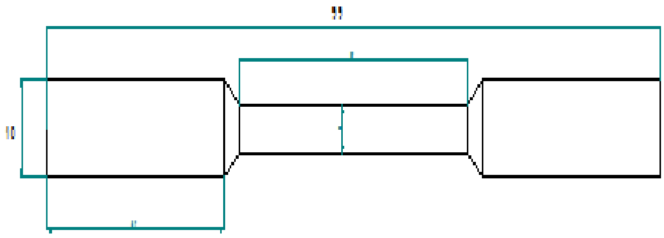


Fig. 2: Tensile test specimen as per ASTM E8

Table-1: Displaying the hardness Measurement results of as cast 6061Al, with inclusion of 9 wt% of Al_2O_3 particulates and 0 , 3, 6 and 9 wt% of B_4C to 6061Al before ageing.

SL No.	Sample ID Al6061+15% Al_2O_3	Vickers Hardness Value for 1Kg Load Indent 1	Sample 2	Sample 3	Sample 4	Sample 5	Avg
1	Al6061	70	75	72	73	69	71.8
2	Al6061+15% Al_2O_3	77.5	78.2	79.1	79.6	78.2	78.8
3	3%B_4C	85.6	84.2	83.9	84.7	83.8	84.4
4	6%B_4C	87.5	88.4	88.7	88.9	89.2	88.5
5	9%B_4C	88	89.6	90.2	88.2	89	89

Graph-1: Displaying the deviation in hardness of 6061Al+Al_2O_3 wt%15 and B_4C 0, 3, 6, and 9 wt% of particulates before ageing.

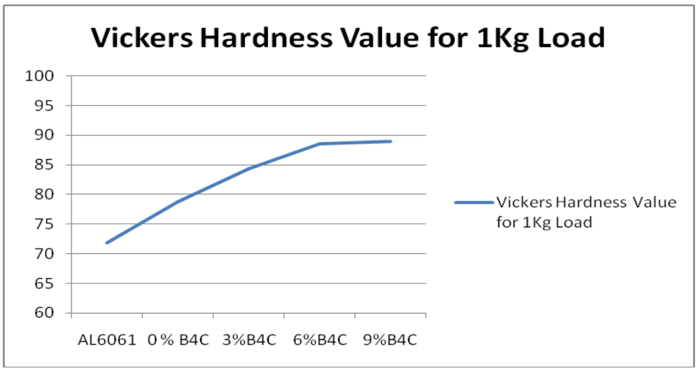
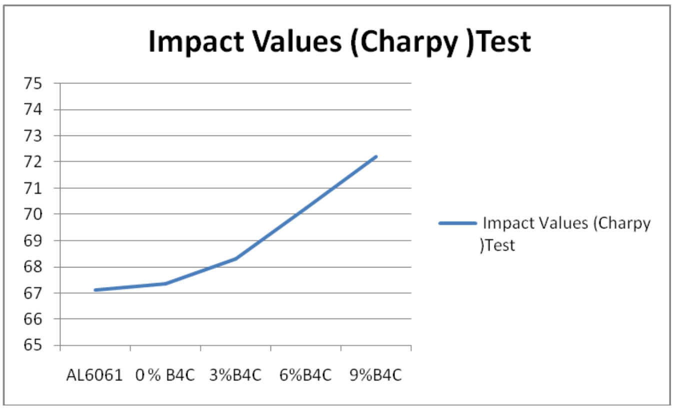


Table-2: Displaying the Impact analysis conclusion of as cast 6061Al+15% Al_2O_3, with conclusion of 3, 6 and 9 wt% of B_4C particulates to 6061Al before ageing.

SL No.	Sample ID	Impact Values (Charpy)Test			
	Al6061+15% Al2O3	Sample 1	Sample 2	Sample 3	Avg
1	AL6061	66.6	68	67.5	67.1
2	AL6061+15%AL2O3	69.4	68.36	65.59	67.34
3	3%B4C	68.21	69.01	68.01	68.32
4	6%B4C	70.24	70.54	70.21	70.23
5	9%B4C	72.4	71.8	72.3	72.2

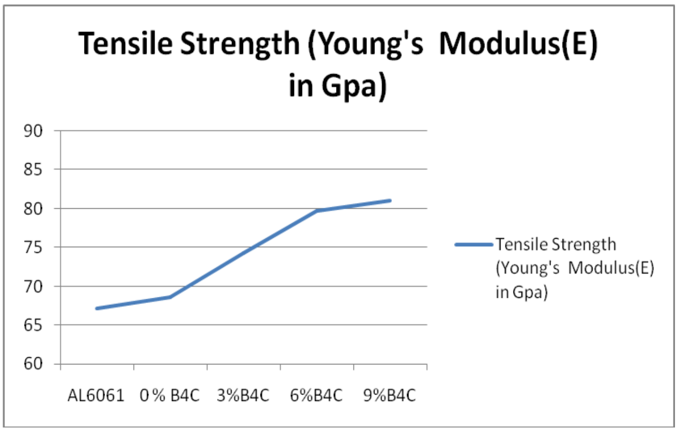


Graph-3: Displaying the deviation in Impact Test of 6061Al+Al_2O_3 wt%15 and B_4C 0, 3, 6, and 9 wt% of particulates before ageing.

Table-3: Displaying the tensile test conclusion of as cast 6061Al+15% Al_2O_3, with adding of 0, 3, 6 and 9 wt% of B_4C particulates to 6061Al before ageing.

SL no.	Al6061 +15% Al2O3	Young's Modulus(E) in Gpa	Proof Stress 0.2% in Mpa	Ultimate Tensile Stress in Mpa	% Elongation	% Strain at UTS	Stress at Break in MPa	% Strain at Break
1	AL6061	67.12	121.34	130.45	17.08	12.56	101.83	20.67
2	0 % B4C	68.57	126.65	139.54	17.20	13.45	102.32	25.78
3	5%B4C	74.23	132.98	146.85	17.87	24.56	103.52	34.63
4	6%B4C	79.73	138.23	152.75	18.40	30.64	96.84	56.97
5	9%B4C	80.98	143.54	161.97	19.65	32.98	88.45	45.89

Graph-2: Displaying the divergence in Young's Modulus of 6061Al+Al_2O_3 wt%15 and B_4C 0, 3, 6, and 9 wt% of particulates before ageing.



Scanning Electron Microscope (SEM)

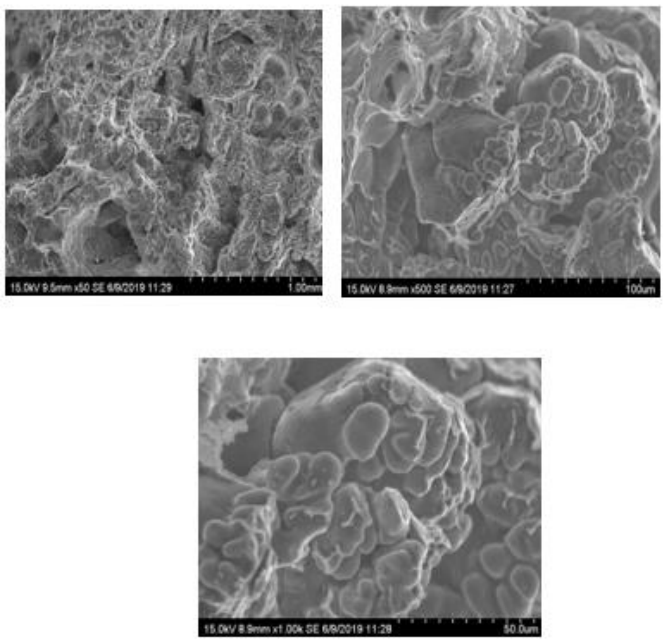


Fig -3: Tensile Fractography

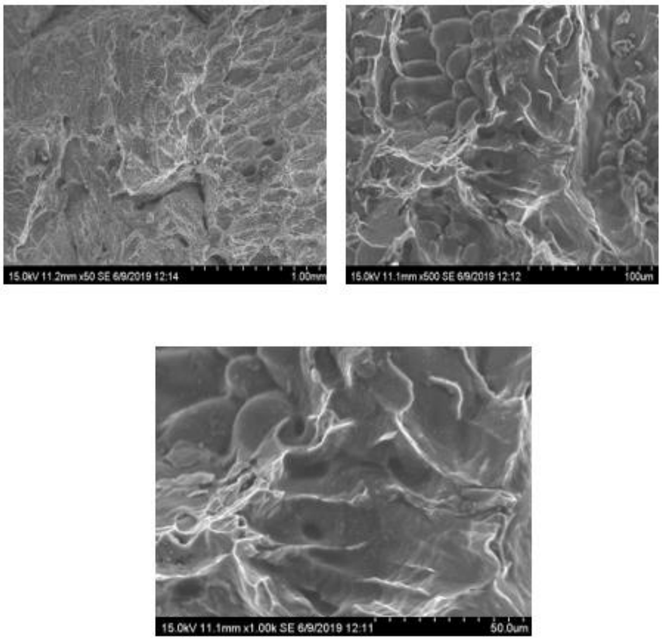


Fig -4: Impact Fractography

3. CONCLUSIONS

Current status of course on the mechanical properties of 6061AlAl_2O_3/B_4C metal matrix compounds among beyond precipitation hardening are as follows.:

•Aluminum stationed metal matrix composites bear act successfully fabricated by electric resistance furnace approach by two step inclusion of reinforcement

combined along preheating of particulates.
•With the help of stir casting technology, Al6061alloy with Al_2O_3 and B_4C composites with changing 3 and 9wt. percent of B_4C and constant 15 wt. percent of Al_2O_3 were successfully fabricated.
•UTS, and YS, % elongation, Hardness, impact strength, and Fractography behaviors were determined micro structurally.
•Composite SEMs produced by the polishing method show that Al_2O_3 / B_4C particles are fairly evenly distributed in the 6061Al metal matrix. The microstructure of the composite contains essential Al dendrites and process silicon, and Al_2O_3 / B4C particles are separated from the dendrite region.
•6061AlAl_2O_3 / B_4C composites are harder than 6061 alloys. As the weight percentage of the reinforcement increases, so does the hardness of the composite.
•After heat treatment, the hardness of the composite also increases as the weight% of the reinforcing material increases.
•It is also observed that the tensile strength increases with increasing Al_2O_3/B_4C weight ratio, and that the aged composite tensile strength and yield strength are higher than that of the after heat treated compound.

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