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Investigation of Macro Properties on AA 6082 - Hybrid Metal Matrix Composite

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Abstract: ***The present study deals with the investigation of effect of reinforcement (B_4C+ZrO_2+graphite) particles on mechanical properties of aluminum alloy (Al6082) composites, fabricated by Stir casting method. The MMC specimens were prepared by varying weight percentage of the reinforced particles 0% B_4C & 0% ZrO_2 ,1% B_4C & 2% ZrO_2, 2% B_4C & 4% ZrO_2, 3% B_4C & 6% ZrO_2 and 1% graphite respectively and keeping all other parameters constant. The various mechanical properties had been analyzed for the fabricated MMC's. During metal matrix investigation shows higher tensile value obtained at Sample C (ZrO_2 4% +2% B_4C+ Gr 1%). The higher hardness value was obtained at Sample D (3% B_4C, 6% ZrO_2 & 1% graphite), due to higher weight percentage of reinforcement enhanced the properties of this metal matrix composites. For impact test, Sample A had higher impact strength.***

Keywords: AA6082; Crucible casting; Zirconium oxide Hybrid composite

I. INTRODUCTION

Composite material is a material composed of two or more distinct phases (matrix phase and reinforcing phase) and having bulk properties significantly different from those of any of the constituents. Many of common materials (metals, alloys, doped ceramics and polymers mixed with additives) also have a small amount of dispersed phases in their structures, however they are not considered as composite materials since their properties are similar to those of their constituents (physical property of steel are similar to those of pure iron) . Favorable properties of composites materials are high stiffness and high strength, low density, high temperature stability, high electrical and thermal conductivity, adjustable coefficient of thermal expansion, corrosion resistance, improved wear resistance etc.

A. Metal Matrix Composites (MMC_S)

Automobile manufacturers are responding to demands for greater fuel efficiency through use of alternate materials such as metal matrix composites (MMCs). Parts made of MMCs offer significant weight savings while maintaining if not improving performance as compared with conventional materials. Over the last decade, MMCs have made slow but steady progress toward mainstream utilization in the automobile industry. To meet the demands of less fuel consumption, less pollution and more efficiency standards and to maintain competitiveness, automobile producers are seriously considering alternate materials in the design of their products. Advanced materials, such as metal matrix composites (MMC) appears a promising way to achieve significant improvements in performance.

II. OBJECTIVES

A. Objectives of Work

The requirement of composite material has gained popularity in these days due to their various properties like low density, good wear resistance, good tensile strength and good surface finish. The present study deals with the investigation of effect of reinforcement (B4C+ZrO2) particles on mechanical properties of aluminum alloy (Al6082) composites, fabricated by Stir casting method. The Hardness strength will also be taken into consideration. For the achievement of the above, an experimental set up is prepared where all the necessary inputs will be made. The composite has to be prepared by crucible casting technique and has to be analyzed various mechanical properties.

TABLE I AA 6082 COMPOSITION

Alloying Element	Al	Cr	Cu	Fe	Mg	Mn	Si	Ti	Zn
Wt (%)	95.2 – 98.3	0.0 - 0.25	0.0 - 0.1	0.0 – 0.5	0.6 - 1.2	0.4 - 1.0	0.7 - 1.3	0.0 – 0.1	0.0 - 0.2

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B. Applications of 6082 Aluminum

Aluminum alloy 6082 is used in the same applications as 6082 aluminum. It is also used in: Road transport, Rail transport, Extreme sports equipment Source.

III. CASTING PROCESS

The aluminum metal matrix composite materials are the combination of two or more constituents in which one is matrix and other is filler materials (reinforcements). Aluminum metal matrix may be laminated, fibers or particulates composites. These materials are usually processed through powder metallurgy route, liquid cast metal technology or by using special manufacturing process. The processing of discontinuous particulate metal matrix material involves two major processes (1) powder metallurgy route (2) liquid cast metal technology.

A. Crucible Casting

In this project we have used sand mold casting for produce the requirement size. Sand casting, also known as sand molded casting, is a metal casting process characterized by using sand as the mold material. It is relatively cheap and sufficiently refractory even for steel foundry use. A suitable bonding agent (usually clay) is mixed or occurs with the sand. The mixture is moistened with water to develop strength and plasticity of the clay and to make the aggregate suitable for molding. The term "sand casting" can also refer to a casting produced via the sand-casting process. Sand castings are produced in specialized factories called foundries. Over 70% of all metal castings are produced via a sand-casting process.



Fig. 1 Casted samples and Specimen.

TABLE II
Weight Percentage And Mass Fraction

Table 2.1. Sample Composition of Percentage

Sample	AA 6082 (%)	ZrO_2 (%)	BORON CARBIDE (%)	Graphite (%)
A	100	0	0	0
B	96	2	1	1
C	93	4	2	1
D	90	6	3	1

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Table 2.2 Sample Composition of Mass Fraction

Sample	AA 6082 (gm)	ZrO_2 (gm)	BORON CARBIDE (gm)	Graphite (gm)
A	600	0	0	0
B	576	12	6	6
C	558	24	12	6
D	540	36	18	6

IV. RESULT AND DISCUSSION

A. *Hardness Value*

TABLE III
Hardness Value

S. No	Material	HRB
A	Al6082-100%	62
B	2%-ZrO_2 + 1% B_4C +1%Gr Remaining Al-6082	65
C	4%-ZrO_2 + 2% B_4C +1%Gr Remaining Al-6082	68
D	6%-ZrO_2 + 3% B_4C +1%Gr Remaining Al-6082	71

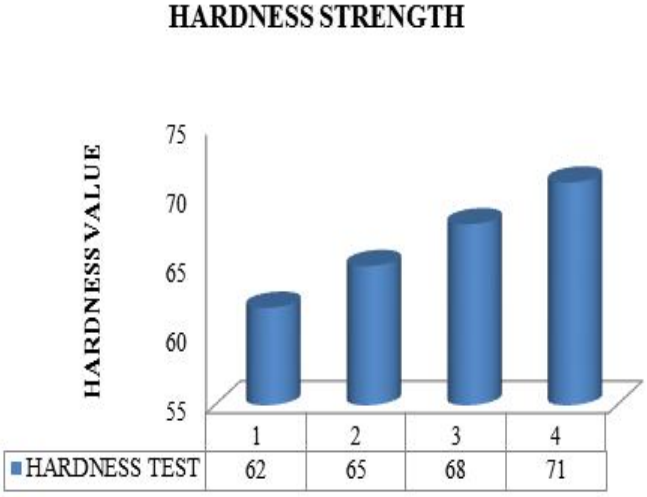


Fig. 2 Ratio Vs Hardness Strength

B. *Impact Value*

TABLE IV
IMPACT VALUE

S. No	Material	Impact Strength (Joules)
A	Al6082-100%	4
B	2%-ZrO_2 + 1% B_4C +1%Gr Remaining Al-6082	3
C	4%-ZrO_2 + 2% B_4C +1%Gr Remaining Al-6082	2
D	6%-ZrO_2 + 3% B_4C +1%Gr Remaining Al-6082	2

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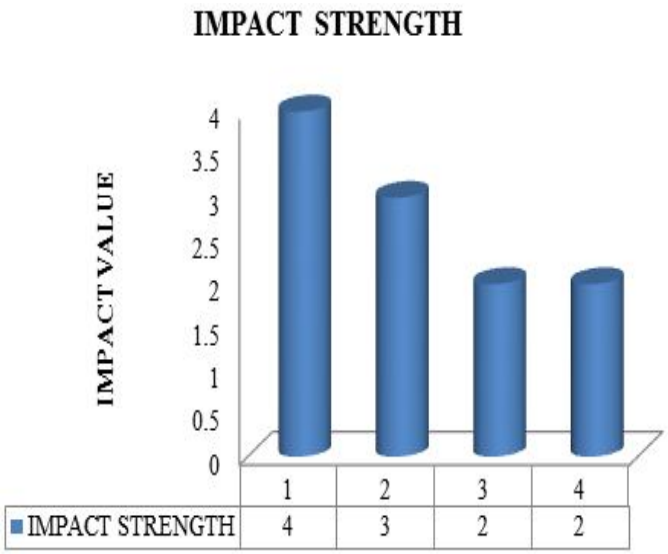


Fig. 3 Ratio Vs Impact Strength

C. Tensile Strength Value

TABLE V
TENSILE STRENGTH VALUE

Sample	Dia (mm)	CSA (mm^2)	YL (kN)	YS (N/mm^2)	TL (KN)	TS (N/mm^2)	IGL (mm)	FGL (mm)	%E	FD	%RA
A	16.41	211.58	10.57	49.96	20.19	95.42	50.00	50.81	1.62	15.87	6.47
B	16.45	212.62	10.87	51.12	22.76	107.05	50.00	50.96	1.92	15.91	6.46
C	16.33	209.53	12.46	59.47	24.38	116.36	50.00	50.67	1.34	15.69	7.68
D	16.12	204.17	10.67	52.26	21.19	103.79	50.00	50.69	1.38	15.24	10.62

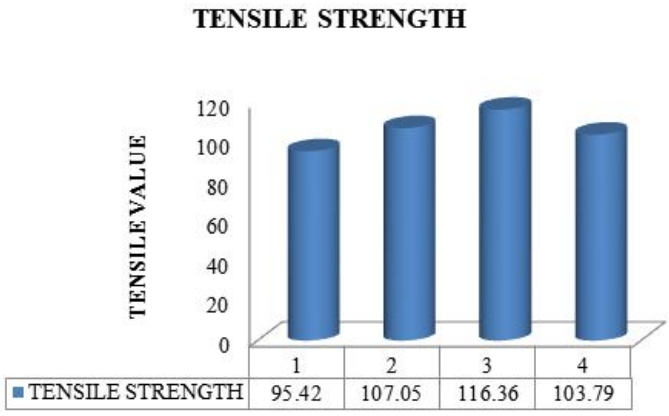


Fig. 4 Ratio Vs Tensile Strength

D. Elongation

1) Sample A Composite 1-1.62 mm
2) Sample B Composite 2-1.92 mm
3) Sample C Composite 3- 1.34 mm
4) Sample D Composite 4- 1.38 mm

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V. CONCLUSION

Composite materials especially Aluminum 6082 and Zirconium oxide, Boron carbide & Graphite composites having good mechanical properties compared with the conventional materials. It is used in various industrial applications these materials having light weight along with high hardness. The following conclusions were observed in this existing study,

The tensile strength value was increase as adding reinforcement upto Sample C and upon adding reinforcement, strength decreased subsequently. The optimum value of ultimate strength was 116 Mpa achieved at 4%-ZrO_2 + 2% B_4C +1% Gr Remaining Al-6082 reinforcement.

The hardness value increases with increase in addition of reinforcement. The maximum hardness value was 71 HRB obtained at Sample D (6%ZrO_2 + 3% B_4C +1% Gr Remaining Al-6082).

The impact strength is maximum at Sample A. It shows that impact strength decreases with increase in weight percentage of reinforcement.

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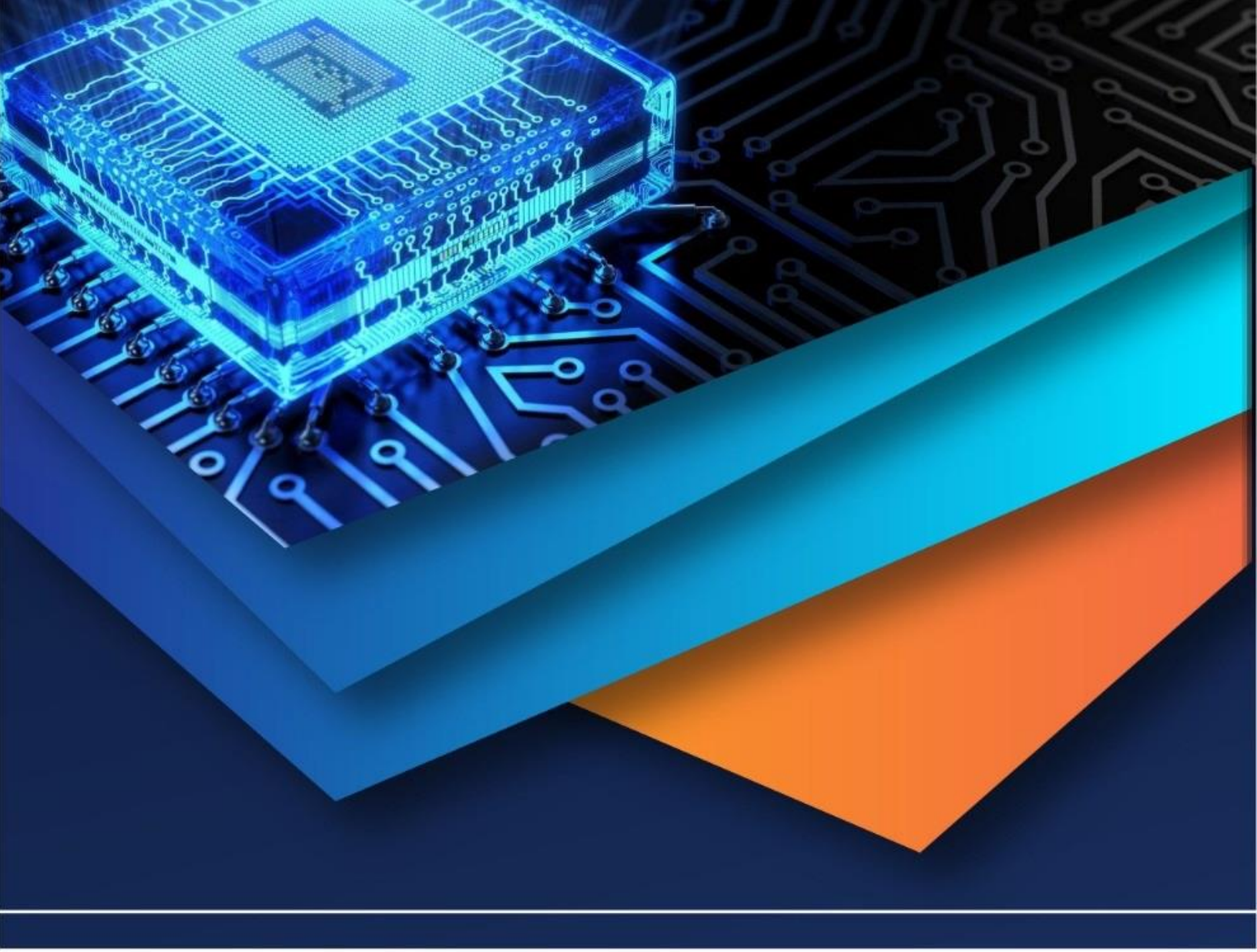
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