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FABRICATION & TESTING OF ALUMINIUM METAL MATRIX COMPOSITES

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ABSTRACT

Aluminium Metal Matrix Composites (AMMCs) have shown great interest in recent times due to its potential of applications in aerospace and automotive industries because of having superior strength to weight ratio. The wide use of particular metal matrix composites for engineering applications has been obstructed by the exact use of Al_2O_3 & B_4C by weight %, hence high cost of components. Although there are several technical used for casting technology rather it can be used to overcome this problem. Materials are frequently chosen for structural applications because they have desirable combinations of mechanical characteristics. Development of hybrid metal matrix composites has become an important area of research interest in Materials Science. In view of this, the present study focuses on the behavior of Al_2O_3 & B_4C hybrid metal matrix composites. The present study was aimed at evaluating the mechanical properties of Aluminium in the presence of Alumina & Boron Carbide with different weight percentages of Alumina (0, 2.5%,5%) & Boron Carbide (0,2.5%,5%) combinations. Consequently aluminium metal matrix composite combines and exhibit huge strength of the reinforcement with the toughness of the matrix to achieve a combination of desirable properties not available in any single conventional material. The compositions were added up to the ultimate level and Powder Metallurgy method was used for the fabrication of aluminium metal matrix composites. The results indicate the behavior and properties of material is quite successful to obtain exact use of aluminum metal matrix composites according to the requirement.

KEYWORDS: Mechanical properties, investigation of Aluminium metal matrix composites (AMMC), Ceramics, Reinforcement.

I. INTRODUCTION

A **metal matrix composite** (**MMC**) is composite material with at least two constituent parts, one being a metal necessarily, the other material may be a different metal or another material, such as a ceramic or organic compound. When at least three materials are present, it is called a **hybrid composite**. An MMC is complementary to cermets.

Composition: - MMCs are made by dispersing a reinforcing material into a metal matrix. This can be done by different processes in which powder metallurgy process plays very important role of making aluminium metal matrix. In this research work we have prepared different metal matrix composition using various reinforcement.

Matrix: - The matrix is the monolithic material into which the reinforcement is embedded, and is completely continuous. This means that there is a path through the matrix to any point in the material, unlike two materials sandwiched together. In structural applications, the matrix is usually a lighter metal such as aluminium, magnesium, or titanium, and provides a compliant support for the reinforcement. AMMC are used for different industrial purpose. So in this research work we used aluminium as metal matrix.

Reinforcement:- The reinforcement material is embedded into a matrix. The reinforcement does not always serve a purely structural task (reinforcing the compound), but is also used to change physical properties such as wear resistance, friction coefficient, or thermal conductivity. AMMC used different reinforcement to improve their property. So in this research work we used different reinforcement material (Al_2O_3, B_4C, etc). To prepare the metal matrix composite.

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II. METHODOLOGY

a) Procurement of Material:- Powdered form Material Selected (Alumina, Aluminium fine powder & B_4C extra pure)

Fig-1: Alumina, Aluminium fine powder & Boron Carbide.

b) Methods for Fabrication of AMMC:-There are various fabrications methods given below:-

1. Flux-casting techniques.
2. Stir casting.
3. Liquid metal infilteration.
4. Powder metallurgy.
5. Ingot metallurgy process.

But in this project we are using **Powder Metalurgy Method.**

c) Powder Metalurgy Method:- In this process following processes are used:-

1. Blending.
2. Compacting.
3. Sintering.

Blending:- In this process different metal powders are used to prepare 4 types of sample i.e. Aluminium & Boron carbide, Aluminium & Alumina, Aluminium-Alumina & Boron Carbide and Aluminium at different weight ratio. We have mixed these metals for 15 minutes in morter and pestle device. We have used a binder for proper binding of powders.

Fig- 2: Mannually blending using morter & pestle

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Sr. No.	Al (in %)	Al_2O_3 (in %)	B_4C (in %)	Weight of Al in gm	Weight of Al_2O_3 in gm	Weight of B_4C in gm
1	100	0	0	20	0	0
2	95	5	0	19	0	1
3	95	0	5	19	1	0
4	95	2.5	2.5	19	0.5	0.5

Compacting:- The compacting process is the compressing of fine sized blended powder between a role compacter or in a die. A pressure of 150kg/cm^2 is applied for preparing the compacted sample.

Fig-3: Compacted sample & Compacting Machine

Sintering:- It is the process of compacting and forming a solid mass of material by heat and pressure without melting it to the point of liquefaction. By doing so the bonding between our compacted samples get strong. We have performed the sintering process in sintering machine at temperature 873-973K.

Fig-4: Sintering Machine

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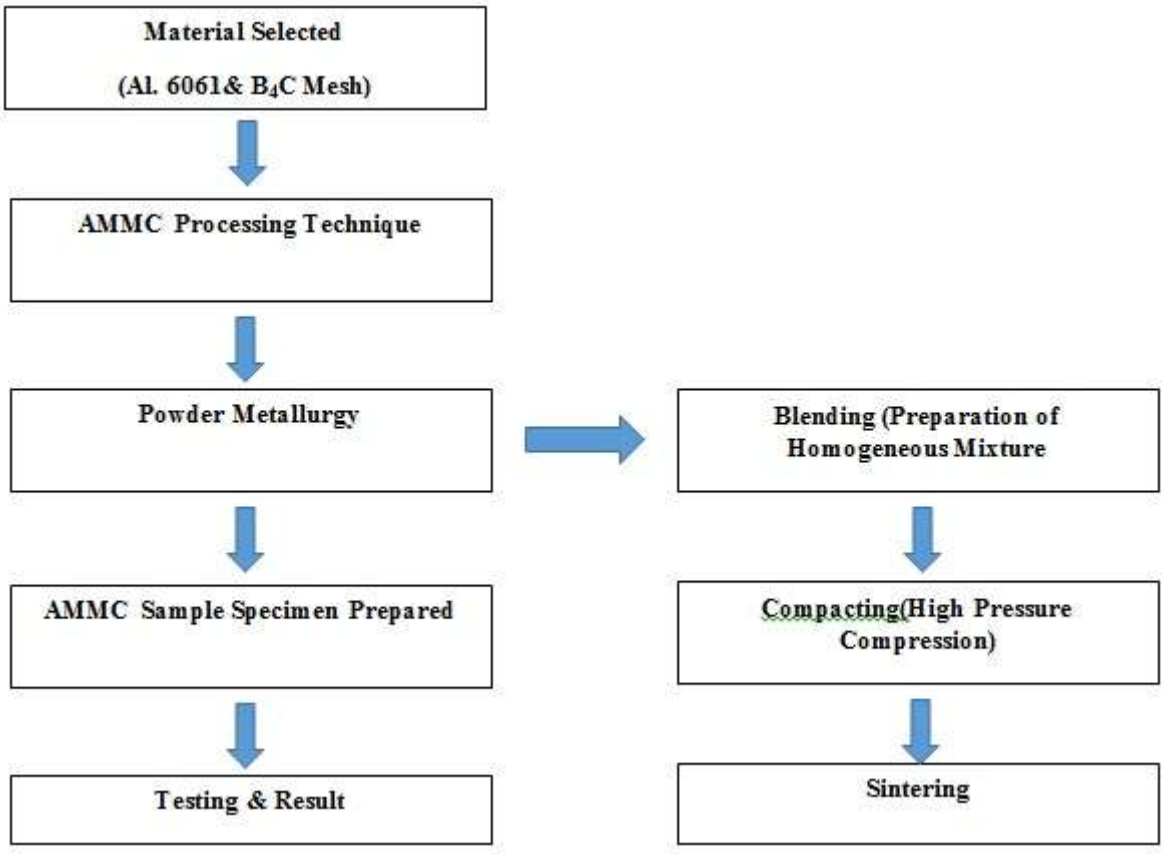
Fig-5:Prepared Sample After Sintering

After this process we have prepared four different samples i.e. Al, Al-B_4C, Al-Al_2O_3, Al-B_4C-Al_2O_3



III. MODELING AND ANALYSIS

We are going to perform following testing on our prepared sample:-

a) Charpy Impact Testing.
b) Hardness testing.

Fig-6: Impact Testing Machine & Tested Material

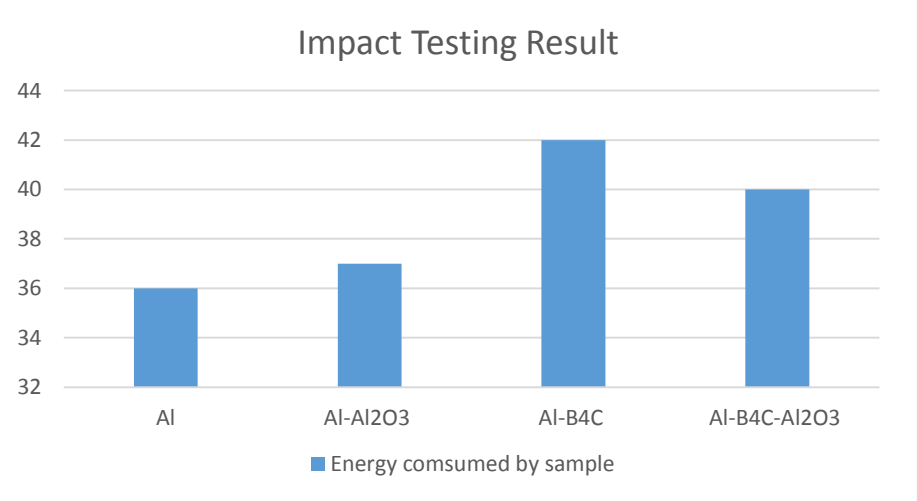
Fig-7: Rockwell Hardness Testing Machine & Tested Material

IV. RESULTS AND DISCUSSION

Table- 1: Charpy Impact Testing

Sr. No.	Material	E_1(Energy before striking) in joules	E_2(Energy after striking) in joules	$E=E_1-E_2$ (in joules) (Energy comsumed by sample)
1	Al	300	264	36
2	Al-Al_2O_3	300	263	37
3	Al-B_4C	300	258	42
4	Al-B_4C-Al_2O_3	300	260	40

Graphical representation of Charpy Impact Testing:-



Rockwell Hardness Test:-

Table: 2

Material Name	Al	Al-Al_2O_3	Al-B_4C	Al-B_4C-Al_2O_3
RHN	<17	29	41	31

RESULT:- From the above testing analysisof the prepared samples we can say that Aluminium-Boron Carbide metal matrix composites have more strength & hardness.

V. CONCLUSION

The aluminium alloy composites containing different amount of boron carbide particles were produced by Powder Metallurgy Method successfully. After the above result and discussion of the prepared samples, we can conclude that Aluminium-Boron Carbide metal matrix composites have more strength and hardness.

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