International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 11 Nov 2021, pp: 849-855 www.ijaem.net ISSN: 2395-5252

Experimental analysis of aluminiumre in forced boronnitride composites

MANOJ KUMAR K (AssistantProfessor), SUNDARESWARAN.E (Student), ABISHEK.T(Student), SUBASH CHANDRA BOSS M, SRI BALAJI S
(Student)DepartmentofAeronauticalEngineering, HindusthancollegeofEngineeringand Technology

Submitted: 10-11-2021 Revised: 24-11-2021 Accepted: 27-11-2021

ABSTRACT
The purpose of this study was to see how the weight % of ingredients affected the manufacturing of an aluminium-based composite material. Al2O3 (Aluminium Oxide) and BN are used to strengthen the aluminium alloy 6061. (Boron Nitride). By adjusting the weight percentage of BN in A16061 composite, an experiment study is performed to obtain Impact energy, Hardness, and Wear rate. Aluminium alloy (A16061) serves as the matrix material, while Al2O3 (Aluminium Oxide) and BN (Boron Nitride) serve as reinforcements. Then, using the stir casting method, the aluminium alloy is reinforced with alumina and BN in various volume fractions.The goal is to improve the reinforced material's wear resistance and strength. Specimens are made utilising ASTM standards for impact, hardness, and wear tests once the composite is manufactured. The results of the hardness and wear tests show that increasing the amount of reinforcements increases the material's strength and wear behaviour, respectively.

CHAPTER 1

1. INTRODUCTION

A composite material is made up of two or more separate components that have a distinct interface. Electrical, thermal, and environmental applications are all possible with composites. Modern composite materials are usually designed to attain a specific balance of qualities for a specific set of uses. Given the wide range of materials that can be classified as composites and the wide range of applications for which composite materials can be used, the application of composite materials in the advancement of new materials and alloys is limited to materials that contain a continuous matrix constituent that binds together and provides from to an array of stronger, stiffer reinforcement constituents.

MMCs have been employed in aerospace and automotive applications for many years. The weight-to-strength ratio is a significant factor in composite applications, which call for low-density, high-strength materials for space flight and naval uses. Transition earth metals like Ti, Ir, and Mo are employed in high-strength applications, whilst lightweight materials like Al and Mg are used in traditional applications. Al is particularly appealing due to its vast availability, low cost, light weight, low melting point, and ease of manufacture and machining Only a few studies on Boron Nitride added Aluminium composites were found in the literature review. There are various aluminium alloys, but we chose Al6061 since it is easier to weld than other aluminium alloys. This is why we chose Aluminium Al6061.

1.1 Composite Materials

Composite materials have a high strength-to-weight ratio, they are increasingly being used in the construction of military vehicles and equipment, sports equipment (crash helmets, pole vault, tennis rockets, bicycle frame works and wheels, building roofs, structures and bridges, air-space crafts, fuel tanks and pressure vessels, and so on. Composites are usually divided into two categories. The matrix constituent is frequently used to classify the initial level of categorization. Organic-matrix composites are one of the most common types of composites (CMCs). The second level of classification refers to the reinforcement form –particulate reinforcement, whisker reinforcements, continuous fibre laminated composites and woven composites.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 11 Nov 2021, pp: 849-855 www.ijaem.net ISSN: 2395-5252

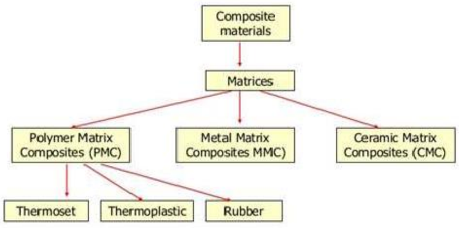

Figure 1.1 Classification of Composite materials

CHAPTER 2

2. LITERATURE SURVEY

The manufacture and mechanical investigation of Al6061, hBN metal matrix composites is the subject of this paper. Al6061 is a matrix metal with good toughness, corrosion resistance, weld ability, and breakability. Stir casting is used to create this piece.

After solidification, the specimens are prepared according to ASTM standards to assess tensile, density, and hardness.[1]

The aluminium alloy is utilised in this study to heat transfer or dissipate over heat for cooling purposes. Bottom tapping stir casting was used to make aluminium matrix composites (AMC) reinforced with cubic boron nitride (cBN) particulate. [2]

This work investigates the development of a composite metallic matrix for aluminium (AMMCs), which has outstanding mechanical properties while being light and strong[3]

The static structural analysis for unreinforced alloy and reinforced composites with various weight percentages of reinforcements is presented in this study, which takes into account the combined loading of gas pressure force and inertial force. The mechanical behaviour or performance of Aluminium – Fly ash – Alumina composites is compared in this work to that of conventional materials and also to that of materials with no reinforcement. [4]

CHAPTER 3

3. MATERIAL SELECTION

3.1 Aluminium Alloy(Al6061)

It serves as a matrix for reinforcing the structure. Copper could be included in the Al alloy for this inquiry (4.5 percent wt). They are corrosion-resistant and low in weight. It melts at 660 degrees Celsius. Automobile gearbox cases, pump parts, aeroplane fittings, and control parts are just a few of the places where it's used. This alloy's unique features include excellent casting and welding capabilities.

In engineering structures, aluminium alloys with a wide range of characteristics are used. Alloy systems are categorised using either a numbering system or names that indicate the primary alloying ingredients.

Mechanical Properties

The temper heat treatment of 6061 has a significant impact on its mechanical properties. Regardless of temper, Young's Modulus is 69GPa.The highest tensile strength of annealed 6061 is 120 MPa (18000Psi), and the maximum yield strength is 55 MPa (8000Psi). The material has a 25-30 percent elongation.

Low density, high specific strength, high specific modulus, high heat conductivity, and high abrasion and wear resistance are among the mechanical, physical, and thermal features of metal matrix composites.

3.2 Alumina

The fine ceramic substance alumina is the most well-known and widely used. Sapphire and Ruby both have a sintered crystal body. It's been used in electrical components for decades because of its excellent electrical insulation, and it's also widely utilised in mechanical parts because of its high strength, corrosion resistance, and wear resistance.

The resistance of metallic aluminium against weathering is due to the presence of aluminium oxide. In a matter of hundreds of picoseconds, a thin passivation layer of Aluminium Oxide (4nm thickness) grows on any exposed Aluminium surface.

3.3 Boron Nitride

Hexagonal form (h-BN)

Hexagonal Boron Nitride (h-BN, -BN, gBN, and Graphite Boron Nitride) is the most stable crystalline form. Hexagonal Boron Nitride has a layered structure similar to graphite (point group = D6h, space group = P63/mmc). Strong covalent bonds hold Boron and Nitrogen atoms

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 11 Nov 2021, pp: 849-855 www.ijaem.net ISSN: 2395-5252

together within each layer, while weak Van der Waals forces hold the layers together.

CHAPTER 4

4.FABRICATIONAND PROCESSING METHODS

4.1 STIR CASTING METHOD

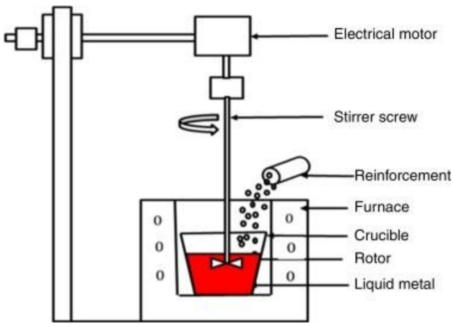

Figure4.6StirCasting

4.1.1 Fabrication

A stir casting procedure was used to create the composite. In a pit furnace, 1.2kg of aluminium was packed into a graphite crucible and melted to 660oC. About 15gm of magnesium was added to the melt as a wetting agent between the matrix and the reinforcement as the metal melted.

After that, the molten aluminium was delivered to the stir casting apparatus' holding furnace. The boron nitride content of alumina and boron nitride particles was kept amorphous below 800oC by heating them to 700oC for 1 hour.

As a result, the crucible, which is made of graphite, can withstand temperatures up to 1800°C. The aluminium alloy pieces are stored in a crucible that is mounted inside the stircasting furnace, which heats the crucible and melts the aluminium alloy.

4.6.2 EXPERIMENTAL PROCEDURE

Mould Preparation

Fabrication

The primary reinforcement materials were alumina and boron nitride, with Al6061 serving as the matrix. Below is a step-by-step explanation of the process. After heating the alumina to 500°C, the carbonaceous material was removed by heating it again to 600°C. The alumina is totally consumed in the presence of oxygen during this process. The ash is then heated in an electrical furnace to 750°C to get the necessary characteristics. Alumina is utilised as a filler in this application.

4.7 Experimental Specimen Preparation

4.7.1 Preparation of Aluminium Alloy (Al6061)

Initially, the graphite crucible was charged with Al6061 Al alloy. The aluminium alloy is first heated to around 750 degrees Celsius until it melts completely in the crucible. After the molten metal had completely melted, it was manually agitated to reduce porosity, or bubbles inside the aluminium alloy.

4.7.2 Mixing of Aluminium Alloy (Al6061) with Alumina & Boron nitride (BN)

The reinforcement particles alumina and boron nitride were warmed to 800°C for 1 hour in another crucible before being incorporated into the melt. During the stirring time, warmed alumina and BN particles were introduced to the molten metal at a consistent rate.

CHAPTER 5

5. MATERIAL TESTING

5.1 Izod Impact Test

Impact is a crucial factor in determining how long a structure will last. For example, a bird may strike a plane while it is cruising, or debris on the runway may strike the plane during take-off and landing, among other things.

5.2.3 Brinell Hardness

The table 5.2 represents the average value of the brinell hardness number.Load applying for the hardness test is 500 kg. The diameter of the pin ball is 5 mm.Tofindtheindentationdiameteroftheballimpressioninthespecimen.Totakethe2 set of tests for the brinell hardness test and getting average result for the differentcompositionofthespecimens.ThecombinationofAl6061+Al2O3(8%)+BN(12%)is havingdiameter oftheindentationisless

S. No	Material	Majorload(P)inkg	Diameterofballinindenter(D)in mm	Diameterofindentation (d)inmm	Brinellhardnessinkg/mm^2
1.	Al6061	500	5	4.1	29.77
2.	Al6061+Al2O3(8%) +BN(7%)	500	5	3.9	34.04
3.	Al6061+Al2O3(8%) +BN(10%)	500	5	3.8	36.38
4.	Al6061+Al2O3(8%) +BN(12%)	500	5	3.6	41.62

Al6061+Al2O3(8%)+BN(12%)is havingdiameter oftheindentationisless.

5.3 PIN ON DISC WEAR TESTING:

The pin specimen has a diameter of 8 mm and a length of 30 mm. In order to avoid rolling during the test, the test specimen was grasped in the wear testing equipment. The American Society For Testing and Materials (ASTM G-99) standard is used to prepare the most frequent wear test specimens. Two distinct loads must be applied.

S.No	Load(N)	Speed(rpm)	Track Radius(mm)	Time(min)	Material
1.	30	300	40	10	Al6061
2.	30	300	40	10	Al6061+Al2O3(8%)+BN(7%)
3.	30	300	40	10	Al6061+Al2O3(8%)+BN(10%)
4.	30	300	40	10	Al6061+Al2O3(8%)+BN(12%)

5.4 TECHNICAL SPECIFICATION

5.4.1 Wear Testing Specimen with Dimension

This depicts the test for the four specimens, which consisted of applying a continuous stress of 30 N to all of the test specimens. The wear rate is 300 rpm, and the track radius is 40 mm. Each specimen takes ten minutes to complete. All specimens should be tested at 300 rpm and 30 N at all times.

5.4.2 WearTestResults

Wear Rate

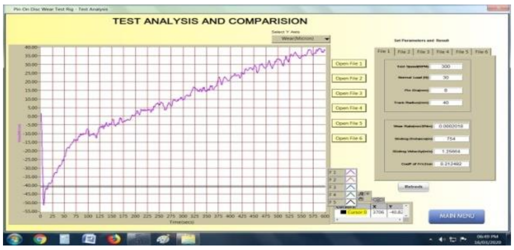

Figure5.4.1WearRateforSpecimen1

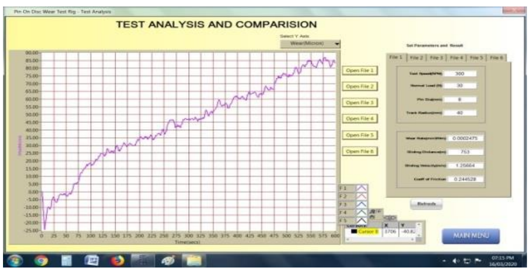

Figure5.4.2WearRateforSpecimen2

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 11 Nov 2021, pp: 849-855 www.ijaem.net ISSN: 2395-5252

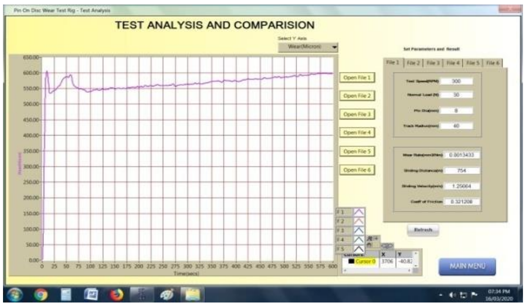

Figure5.4.3WearRateforSpecimen3

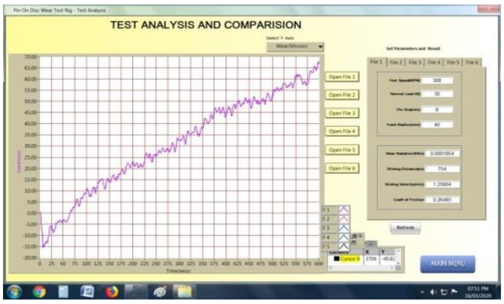

Figure5.4.4WearRateforSpecimen4

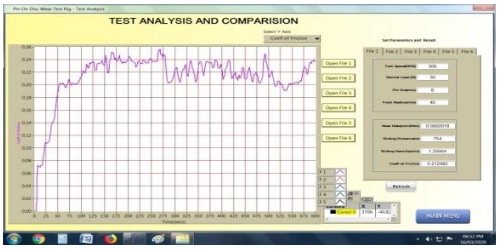

Figure5.4.5CoefficientofFriction 1

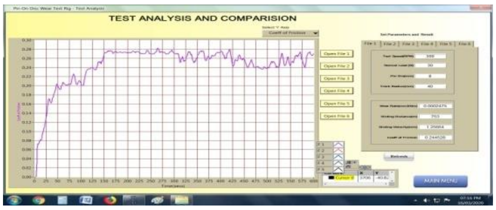

Figure5.4.6CoefficientofFriction2

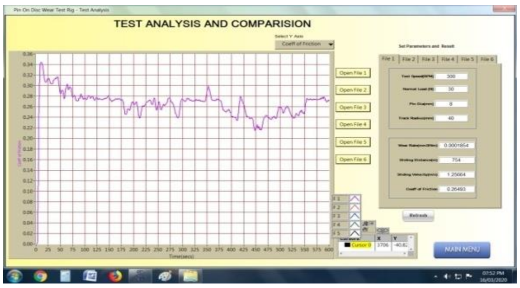

Figure5.4.7Co-efficientofFriction3

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 11 Nov 2021, pp: 849-855 www.ijaem.net ISSN: 2395-5252

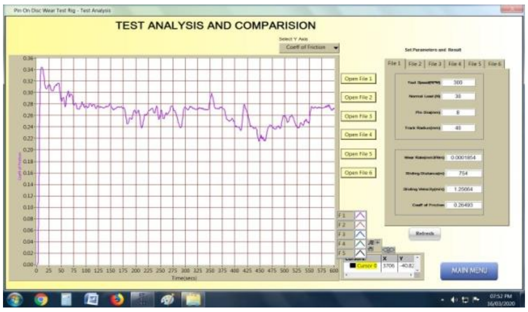

Figure5.4.8Co-efficientofFriction 4

CHAPTER 6

6. TEST RESULTS

6.1 SPECIMEN 1

Composition –1000gm of Aluminium alloy

Table 6.1.1 Specimen 1

S.No	Types of Test	Results
1.	Impact(Izod)	0.25J/mm²
2.	Hardness(Brinell)	29.77kg/mm²
3.	Weartest	0.0013433mmt/Nm

The test results are listed here. The Izod Impact, Brinell Hardness Number, and wear rate of the specimens are all displayed in the table. 6.1.1. These results are based on the average of the number of tests we completed. We take the two sets of tests for the Izod Impact test on specimen 1 and tabulate the average results. As a result, the result of the brinell hardness number is an average test result. We conducted four sets of hardness testing. The specimen 1 has a wear rate of 0.001343 mm3/Nm. Because specimen 1 is made of pure aluminium alloy 6061, the unreinforced alloy has a high wear rate. As a result, the wear resistance is reduced.

6.2 SPECIMEN 2

Composition – Al+Al2O3(8%)+BN(7%)

Table 6.1.2 Specimen 2

S.No	Types of Test	Results
1.	Impact(Izod)	0.25J/mm²
2.	Hardness(Brinell)	34.04kg/mm²
3.	Weartest	0.0002475mmt/Nm

The specimen 2 is an Al+Al2O3(8%)+BN(7%) reinforced alloy. Aluminium oxide has a constant composition of 8% and boron nitride has a constant composition of 7%. Izod Impact value for specimen 2 is an average result. When opposed to specimen 1, where the unreinforced alloy has a high wear rate, the reinforced alloy has a high wear resistance. That means, the specimen 2 wear rate is 0.0002475 mm3/Nm. The specimen 2 has a higher hardness than the specimen 1.

6.3 SPECIMEN 3

Composition- Al+Al2O3(8%)+BN(10%)

Table 6.1.3 Specimen 3

S.No	Types of Test	Results
1.	Impact(Izod)	0.375J/mm²
2.	Hardness(Brinell)	36.38kg/mm²
3.	Weartest	0.0002018mmt/Nm

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 11 Nov 2021, pp: 849-855 www.ijaem.net ISSN: 2395-5252

Table 6.1.3 contains the test findings for specimen 3. The average findings of the two sets of Izod Impact tests are used to calculate the results. The reinforcements are added, with the aluminium oxide content remaining consistent at 8% for all three specimens and boron nitride at 10%. When comparing the addition of boron nitride reinforcements (7%) to boron nitride reinforcements (10%), the 10% BN produces better results. 0.0002018 mm3/Nm is the wear rate for specimen 3.

6.4 SPECIMEN 4
Composition- Al+Al2O3(8%)+BN(12%)

Table 6.1.4 Specimen 4

S.No	Types of Test	Results
1.	Impact(Izod)	0.05J/mm²
2.	Hardness(Brinell)	41.62kg/mm²
3.	Weartest	0.0001854mmt/Nm

The test findings for specimen 4 are listed in table 6.1.4. The specimen 4's composition is Al+Al2O3(8%)+BN(12%). When compared to the other composition values, the Izod impact test value is high here. The specimen 4's hardness is 41.62 kg/mm2. When compared to the other component data, the brinell hardness number is high. The specimen 4 has a wear rate of 0.0001854mm3/Nm. The inclusion of BN 12% reinforcing improves wear resistance.

CHAPTER 7

7. CONCLUSION

Stir casting is used to create aluminium metal matrix composites in this study. The stir casting process is used to make aluminium 6061 composites with varying percentages of boron nitride and constant in alumina.

As a result, unreinforced alloy materials are both strong and light. Reinforced matrix composites have a high strength-to-weight ratio when compared to unreinforced alloy materials. The stir casting procedure approach is used to bring it to a close. In comparison to non-reinforced alloy materials, the weight of the materials is reduced.

In comparison to the four examples, we can achieve higher wear resistance. While compared to the rest of the specimens, the wear rate when utilising pure aluminium alloy 6061 is excessively high. Wear rate is low for Al+Al2O3(8%)+BN(12%). That is why it has a high wear resistance.

The wear analysis findings suggest that the Al6061+Al2O3(8%)+BN(12%) composite has the best wear resistance and a reasonable coefficient of friction when compared to the other composites and Al6061 alloy. The combined impact of BN and Alumina results in a higher wear property.

The hardness of the materials is quite high in Aluminium +Alumina(8%)+boron nitride (12%). While compared to this pure aluminium alloy 6061 is having less hardness. The indentation of the diameter is less in the Aluminium +Alumina(8%)+boron nitride (12%).

We can use the materials where wear is produced in the future to replace the materials and improve wear resistance.

REFERENCES

[1]. Yathraj.K, Chandraiah MT, Mohan Kumar A.R.Evaluation of mechanical properties of Aluminium 6061 reinforced with Boron Nitride MMC’s using OM,Yathirajk,Chandraiah M T, Mohan kumar A R, 2016.
[2]. Manivannan A, Sasikumar R.Fabrication and characterization ofAluminium Boron Nitride composites for Fins,Science Direct,2018.
[3]. Dr.AliH.Hallem,TalibA.Jasim, Dr.NabaaS.Radhi.. Effect of alumina reinforced on some mechanical properties of AMC produced by stir casting process,international journal of Civil Engineering and Technology, 2018.
[4]. Prakash Godade, Arun LR.Characteristic of aluminium –Alumina – Flyash composites for piston analysis by CAE tools,International journal of Innovative research In Science Engineering And Technology,2013.