

**MECHANICAL AND TRIBOLOGICAL PERFORMANCE OF AL7050
AMALGAMATED WITH BN-TiB2 MMC****Praveen U B¹, Dr. Manjunatha B², Dr. Puneeth Kumar N^{3*}, Mr. Manjunatha A N⁴**Department of Mechanical Engineering, SJCE, JSS Science and Technology University, Mysuru,
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ABSTRACT

The influence of fabrication on the structure and strength of reinforcement (TiB₂ & BN) and Al alloy composite has been studied. Al 7050 is chosen as matrix and TiB₂ & BN are selected as reinforcement. This Research work deals with the fabrication, tribological and mechanical behavior of Al based TiB₂ & BN matrix composite. The key properties that make Al a dominant material over additional characteristics are minimal weight, high strength and ease of machinability. TiB₂ & BN which are highly thermal stability and high strength, low density and easily available at moderate cost is included as a reinforcement. In this case, Stir casting, which entails combining the necessary amounts of additives into stirred molten Al, completes the fabrication. Each fabrication carries the TiB₂ & BN reinforcement content varied from 0wt. % - 5wt. %. Following solidification, the samples were prepared as per ASTM standards. They are further tested and computed to find the mechanical and tribological properties like wear properties, tensile, compression, hardness, corrosion and SEM Analysis. The tensile strength of the composite material increased by 67% at 5wt%, compressive strength increased by 13% at 0.5wt% and Hardness increased by 28% at 3wt% reinforcement. The wear resistance of the composite material increased by 50% compared to Al7050 without reinforcement. The reinforcement is uniformly distributed in the metal matrix and thus the propagation of cracks at the grain boundaries is slowed down or halted which improves the overall strength of the MMC. The corrosion rate for all wt% of the composite material is uniform and is at a rate of 0.001 mm/day or 0.33mm/yr.

Keywords: Aluminium; Compression; Hardness; Tensile; Scanning Electron Microscope**1. INTRODUCTION****1.1 Composite Material**

A system of materials made up of two or more physical phases that, when combined, result in

aggregate qualities that differ from those of their constituent parts and these composites could be natural or synthetic a careful blending of two or more substances it results in a synergistic effect[1,2]. This aluminum is used in variety of huge products and building structures including automotive parts, cans, kitchen, aircrafts parts, frames, and beer mugs because of its particular properties [3]. It has very less density and a non-toxic which has a high thermal conductivity with excellent resistance to corrosion and ease of use casted as per our requirement [4]. This is a non-magnetic and non-sparking metal. 1.1.2 Properties of Aluminium 7050. Table 1.1 indicates the different characteristics of Al7050 having average performance with in its range [5]. This is the second most malleable metal and the sixth most ductile material in the metal descriptions [6,7]. It frequently serves as an alloy because only by using aluminum itself is not particularly strong with the addition mixture alloying with zirconium, copper, manganese, magnesium, zinc, iron and silicon are lightweight but strong[8,9]. These materials are important in the construction of aircrafts and other forms of transport [10].



Fig 1.1: Representation of Al7050 round bar

1.2 Composition of Reinforcements

1.2.1 Properties of Boron nitride (BN)

It is a refractory compound of nitrogen and boron which have a thermal and chemical resistant, which are exists in the forms of crystalline that are iso-electric similarly structured to carbon lattice [11].

Table 1.1: Compositions of Al7050

Sl. no	Elements	Percentage (%)
1	Aluminium,	87.3 - 90.3

	Al	
2	Zinc, Zn	5.7 – 6.7
3	Copper, Cu	2.0 – 2.6
4	Magnesium, Mg	1.9 – 2.6
5	Iron, Fe	≤0.15
6	Silicon, Si	≤0.12
7	Manganese, Mn	≤0.10
8	Zirconium, Zr	0.08 – 0.15
9	Titanium, Ti	≤0.06

Table 1.2: Physical properties of Boron nitride

Properties	Metric
Tensile Strength	55 MPa
Density	3.49 g/cm ³
Melting Point	3027 °C
Modulus of Elasticity	103 GPa
Thermal conductivity	20 W/mK

2. MATERIAL

It is an initial step within

SELECTION

the process of designing

products of any type and building new object as during a product design context, the most goal is to realize minimize cost reduction while achieving product performance targets. Selection of material is that the act of choosing the fabric best suited to attain the wants of given application [13]. Many various factors enter determining the choice requirements, like mechanical, chemical, physical properties, electrical properties and price [14].

2.1 Procurement

Procurement is the act of obtaining goods or services, typically for business purposes [15]. Procurement is most frequently connected with businesses because companies need to solicit services or purchase goods, usually on a relatively large scale.

2.2 Method of Casting

A liquid material is often poured into a mold with a cavity of the appropriate shape during the casting manufacturing process, and the material is then allowed to solidify [16]. To finish the

process, the casting—also referred to as the solidified portion—is broken or ejected from the mold. Epoxy, concrete, plaster of Paris, and clay are examples of casting materials, which are often metals or other time-setting substances that solidify after combining two or more ingredients [17].

2.3 Volume Fraction Calculation

The test specimen is machined to the dimensions as per the standards, but at first the test specimen is casted as a cylindrical rod. The calculations are performed considering the wastage during casting and machining.

Factors affecting the volume of casting, Diameter to be casted, Diameter of the reduced section, Overall length to be casted, Length of reduced section, Volume of Cylinder = $\pi * r^2 * l$

Where, $\pi = 3.14$, r = Radius of casted cylindrical rod, l = length of casted cylindrical rod.

Mass = Volume of cylinder * Density and Volume Fraction = Mass * Percentage of reinforcement

Therefore, a cylinder of specific diameter and length is required which later will be machined as per ASTM Standards.

3. EXPERIMENTATION

3.1 Tensile Test (ASTM E 8)

The tensile testing yields data on the metallic material's ductility, tensile strength and yield strength. It gauges how much power is needed to shatter a composite or plastic specimen as well as how far the specimen elongates or stretches before breaking [18]. The resulting data a curve of force vs. extension shows in the test report profile of the examination until the specimen cracks. Along this tensile profile there are many points of interest, chief among them the elastic limit and force to break or failure point.

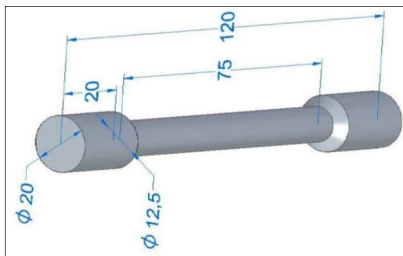


Fig 3.1a: Tensile Test Specimen



Fig 3.1b: Universal testing machine

Table 3.1: Volume fraction calculation for Tensile Test

Reinforcement	Boron Nitride (BN)	Titanium Diboride (TiB2)	Aluminium7050
(in wt%)	(wt in grams)	(wt in grams)	(wt in grams)
0.5	0.0456	0.088	101.60
1.5	1.356	2.665	100.60
3	2.700	5.320	99.02
5	4.510	8.870	97.01

3.2 Hardness

Test (ASTM E 18)

A hardness test is a technique used to gauge a material's hardness.. Hardness refers to a material's resistance to permanent indentation [21]. There are numerous techniques to measure hardness and each of these tests can identify varying hardness values for a single material under testing. Hence, hardness test as a method can be dependent and each test's outcome needs to be labeled to determine the kind of hardness test used.

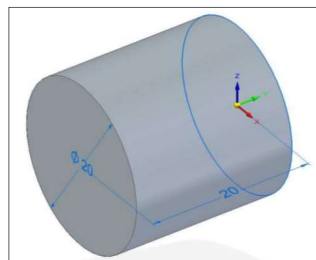


Fig 3.2 Specimen dimension for Hardness Test

Table 3.2: Volume fraction calculation for hardness Test

Reinforcement	Boron Nitride (BN)	Titanium Diboride (TiB2)	Aluminium7050
(in wt%)	(wt in grams)	(wt in grams)	(wt in grams)
0.5	0.00072	0.0142	16.25
1.5	0.216	0.425	16.09
3	0.433	0.851	15.84
5	0.722	1.412	15.51

3.3 WEAR TEST
(ASTM G 99)

Friction, which happens between moving parts, is frequently examined in components that come into contact with one another while in use, like power trains in cars. These parts wear and generate heat as a result of the friction. The majority of mechanical system failures is caused by heat generation and wear from friction, and the resulting financial losses are significant. Tribological tests are used to assess the materials and parts in order to minimize such losses. This test measures the wear volume and coefficient of friction by interacting a test component with an interfacing surface in relative motion. Research and development must assess how friction, wear, and abrasion affect the material in industries where parts come into touch with one another. To ensure the quality of motors, bearings, lubricants, and many other products, testing and analysis are necessary.

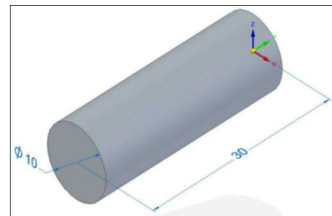


Fig 3.3a: Specimen dimension for Wear Test

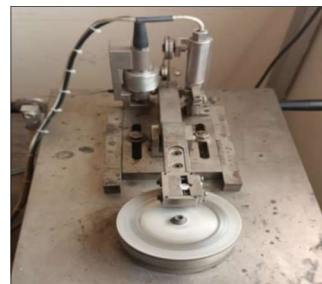


Fig 3.3b: Pin on disc equipment

Table 3.3: Volume fraction calculation for Wear Test

Total Reinforcement (in wt%)	Boron Nitride (BN) (wt in grams)	Titanium Diboride (TiB2) (wt in grams)	Aluminium 7050 (wt in grams)
0.5	0.013	0.026	6.564
1.5	0.041	0.079	6.498
3	0.081	0.159	6.399
5	0.135	0.266	6.267

4. CONCLUSION

We finally arrive at obtaining a composite material made from mixing Aluminium 7050 and (TiB2 + BN), with homogeneously distributed reinforcements.

From the mechanical tests and wear tests that were performed on the specimen, the following points are concluded with respect to Al7050 with 0wt. % reinforcement.

- ✓ The tensile strength of the composite material increased by 67% at 5wt.% reinforcement.
- ✓ Hardness of the composite material is increased by 28% at 3wt.% reinforcement.
- ✓ The corrosion rate for all wt.% of the composite material is uniform and is at a rate of 0.001 mm/day or 0.33mm/yr

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