# Fabrication And Testing of Al7075-B4C Composite Prepared By Stir Casting Route

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***Abstract-*** *Stir casting is one of the established manufacturing processes used to produce components with complex geometries, with tailor made strength, high stiffness, and tolerances to be produced in one single operation without subsequent machining which results in low cost and low environmental impacts. Properties obtained by stir casting are unattainable by other manufacturing process and has advantages over conventional methods of composite fabrication process. In this project Aluminium 7075 is used as matrix material and boron carbide is used as reinforcement material. The composite Al7075/B4C was produced by stir casting technique. Specimens were prepared by varying B4C content (0, 2, 4, and 6%) and melting temperature from (450°C to 700°C). Mechanical properties like hardness, tensile and compressive strength properties were studied. Scanning electron microscope was used to study the microstructure of composite. Results revealed, that hardness and ultimate compressive strength of composite increases with increase in % B4C varies from 0% to 6% and melting temperatures from 450°C to 750°C*

## I. INTRODUCTION

Composites can be defined as the structural material created by combination, of two or more materials insoluble in each other, which has the desired properties which may also consist of secondary filler materials or reinforcement materials.

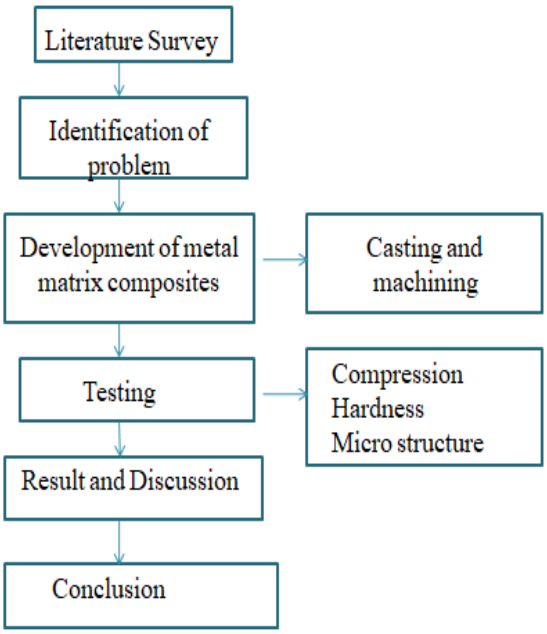
- Composites consists of matrix phase and reinforcement phase.
- Classification based on the matrix material:
  - Polymer Matrix Composites (PMCs)
  - Ceramic Matrix Composites (CMCs)
  - Metal Matrix Composites (MMCs)
- Classification based on Reinforcing Materials:
  - Particulate reinforced
  - Fibre reinforced
  - Planar Reinforcement
- Applications:
  - Space craft
  - Aircraft
  - Mechanical tools
  - Abrasive materials
  - automobiles

## II. LITRATURE SURVEY

- Cambronero, et al [1] had studied the mechanical properties of Al7015 composite reinforced with ceramic particles created by powder metallurgy system further took after by hot extrusion. The microstructure result demonstrates a uniform distribution, of ceramics (B4C, TiB2 and Si3N4) in the aluminium alloy (AA7015) matrix. With expanding the measure of ceramics prompts higher hardness, bring down the plastic, deformation of composite and preferable wear behaviour of composite over AA7015. What's more, he recommended "further studies should be, carried out in order to' justify the worst' mechanical properties of the fabricated composite.
- Topcu, et al [2] produced pure Al/B4C composite by powder metallurgy route and explored its mechanical characteristics. They found that the "hardness of the composite were expanded with expanding weight percent of B4C and sintering temperature. But 'the effect of sintering temperature above 625°C' is lost after 15 wt% of B4C. The effect resistances of the composite were diminished with expansion in B4C particles in the matrix material and sintering temperature.
- Ibrahim, et al [4] examined "mechanical properties and crack of Al-15vol% B4C based" MMCs. The creators found that the ductility of the "composite material reductions with expanded vol% B4C and the break of B4C reinforcements happens by a cleavage mechanism."
- Kalaiselvan, et al [7] fabricated Al6061-B4C composite by stir casting route. They observed that the 'micro and 'macro, hardness of 'composite linearly increased' from 51.3 HV to 80.8 HV and 34.48 BHN to 58.6 BHN with expansion of B4C,"particles (wt%) and also tensile strength increased from 185Mpa to 215Mpa.
- C. Mathazhagan, et al [14] studied the effect of graphite, reinforcement on mechanical, properties of Al/B4C composites. Authors concluded that with expanding graphite particles the hardness of the composite is diminished.

- S. Suresh, et al [17] studied procedure improvement in stir casting and examination on microstructures, and wear behaviour of TiB2 on, Al6061 MMC. Authors revealed that strength, macro and micro hardness of Al6061 composites expanded with inclusion of ‚reinforcement" (TiB2) in it.

## III. METHODOLOGY




## IV. PROCEDURE

- Clean the crucible which is coated with graphite and ceramic.
- Stir casting: Stir Casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring.
- Procedure:
  - Setting furnace temperature from 0* to 700*c
  - Put billets into crucible which is placed in furnace.
  - Preheat the reinforcement at 0* to 500*c temperature.
  - Add reinforcement material to matrix material.
  - Stirrer coated by ceramic and graphite is rotated at speed of 500rpm.
  - Skum powder is added to remove slag and flux.
  - Degasing tablets( EXOCROETHEEN) is added to avoid gas formation .
  - Pour molten mixture into dies and allow it for an hour to solidify composite.
  - open the dies and remove the composite material using tools and hammer.
  - cut down the product and machine it to required dimension

**Table 1 Mass fractions used in fabrication**

| specimen | Al 7075 (gms) | $B_4C$ (wt%) |
|---|---|---|
| 1 | 2000 | 0 |
| 2 | 2000 | 2 |
| 3 | 2000 | 3 |
| 4 | 2000 | 4 |

## V. RESULT AND DISCUSSION

### Hardness Test

Hardness test was carried on and the results are under Table 2 with 0%, 2%, 4%, 6% variations

**Table 2 Hardness Test Result**

| Percent variation | Result-1 | Result-2 | Result-3 | Average |
|---|---|---|---|---|
| 0% | 77.3 | 78.9 | 76.2 | 77.46 |
| 2% | 84.5 | 85.9 | 84.1 | 84.83 |
| 4% | 99.2 | 98.3 | 98.1 | 98.53 |
| 6% | 112.2 | 113.5 | 113.6 | 113.1 |

### Compression Test

**Table 3 Compression Test Result**

| Percent variation | Width X Thickness | Area mm2 | Compression load KN | Compression strength MPa |
|---|---|---|---|---|
| 0% | 20.00 | 314.2 | 198.32 | 631.2 |
| 2% | 20.00 | 314.2 | 215.9 | 687.1 |
| 4% | 20.00 | 314.2 | 236.3 | 752.3 |
| 6% | 20.00 | 314.2 | 248.2 | 790.1 |

### Tesnsile Test

**Al7075+0%B4C**

Test Method : ASTM E8M-15a

**Table 4 Tensile result for 0% B4C**

| TESTS | RESULTS |
|---|---|
| Initial Area mm2 | 64.32 |
| Initial gauge length mm | 45.00 |
| Final Gauge Length mm | 50.36 |
| Yield Strength Mpa | 199.79 |
| Ultimate Tensile Load KN | 15.01 |
| Ultimate Tensile Strength Mpa | 233.45 |
| % Elongation | 11.91 |

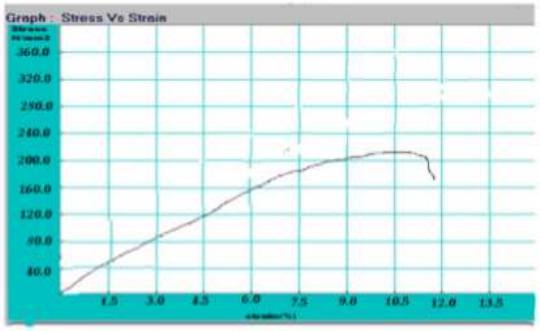



**Fig 1 Stress vs Strain Graph for 0% B4C**

**Al7075+2%B4C**
Test Method : ASTM E8M-15a

**Table 5 Tensile result for 2% B4C**

| TESTS | RESULTS |
|---|---|
| Initial Area mm2 | 65.84 |
| Initial gauge length mm | 45.00 |
| Final Gauge Length mm | 49.47 |
| Yield Strength Mpa | 233.6 |
| Ultimate Tensile Load KN | 18.54 |
| Ultimate Tensile Strength Mpa | 281.7 |
| % Elongation | 9.93 |

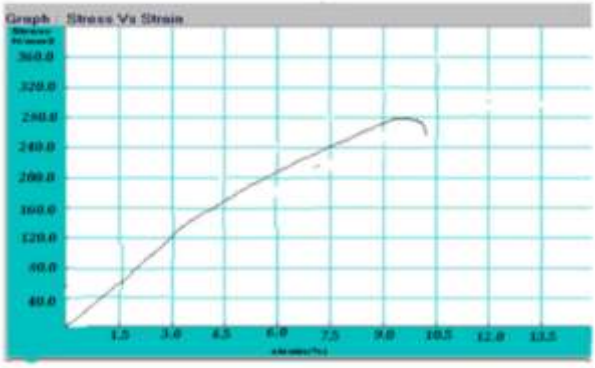



**Fig 2 Stress vs Strain Graph for 2% B4C**

**Al7075+4%B4C**
Test Method : ASTM E8M-15a

**Table 6 Tensile result for 4% B4C**

| TESTS | RESULTS |
|---|---|
| Initial Area mm2 | 65.84 |
| Initial gauge length mm | 45.00 |
| Final Gauge Length mm | 48.97 |
| Yield Strength Mpa | 260.4 |
| Ultimate Tensile Load KN | 21.43 |
| Ultimate Tensile Strength Mpa | 325.6 |
| % Elongation | 8.82 |

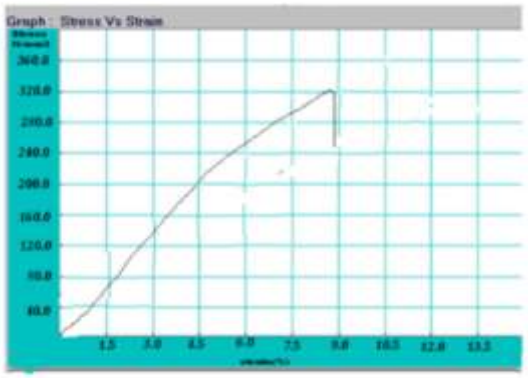



**Fig 3 Stress vs Strain Graph for 4% B4C**

**Al7075+6%B4C**
Test Method : ASTM E8M-15a

**Table 7 Tensile result for 6% B4C**

| TESTS | RESULTS |
|---|---|
| Initial Area mm2 | 65.84 |
| Initial gauge length mm | 45.00 |
| Final Gauge Length mm | 48.97 |
| Yield Strength Mpa | 260.4 |
| Ultimate Tensile Load KN | 21.43 |
| Ultimate Tensile Strength Mpa | 325.6 |
| % Elongation | 8.82 |

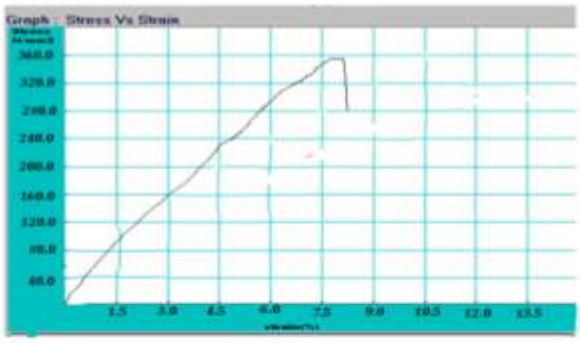
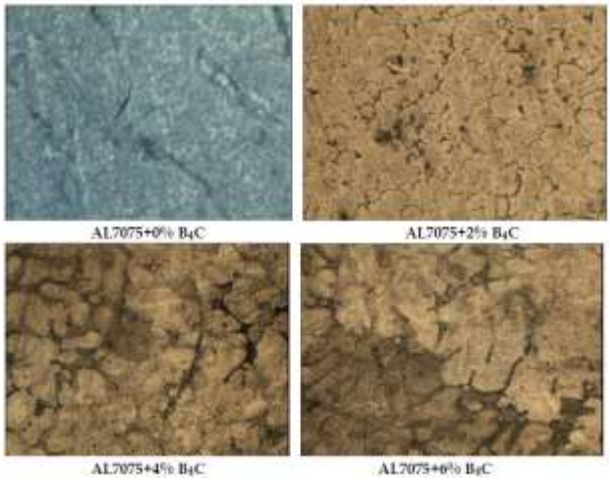



**Fig 4 Stress vs Strain Graph for 6% B4C**

## VI. MICROSTRUCTURE OBSERVATIONS

The examples for microscopic observations were set up by the standard procedure of grinding with, SiC abrasive papers, and polishing with a kellers reagent. From the above figures of microstructure of the prepared specimen, it can be detected that there is a reasonably uniform distribution of the „reinforcement particles" in the fabricated composite. It was found that the compacted specimen is subjected to these particles with increase in grain boundary and bonding causes tendency for particles accumulate in masses. More porosity is observed when the reinforcement composition increases in its

presence that is 4 to 6 percentages as observed from the micrographs.




## VII. CONCLUSION

Aluminium and its alloy based metal MMCs are the most auspicious materials for the future automobiles, aviation and other applications. The fabrication and experimentation of aluminium alloy Al7075 reinforced with varied weight fractions of boron carbide (B4C) successfully synthesized by using stir casting technique. The results of the test conducted were tabulated and results are compared. mechanical properties, such as compression and hardness of fabricated composites are evaluated and SEM analysis is conceded out to determine the microstructural uniform distribution of, reinforcement in the matrix.

The following conclusions can‟ be given from this‟ attempt

- Al7075 alloy MMCs reinforced with different weight percentages of $B_4C$ particles (2%, 4% & 6%) have been commendably produced by stir casting strategy. The optimum conditions of fabrication process were that melting temperature of 750˚C and cooling time of 1 hours.
- Results revealed that there was increase in hardness, density and compressive strength due to incorporation of B4C particles. This is mainly due to addition of reinforcement , where the strength of the composite increases due to better bonding of powder particles. High loads is also responsible for increased strength of the composite.

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