Fabrication and Characterization of in Situsynthesized B4c/Gr/Al Composite

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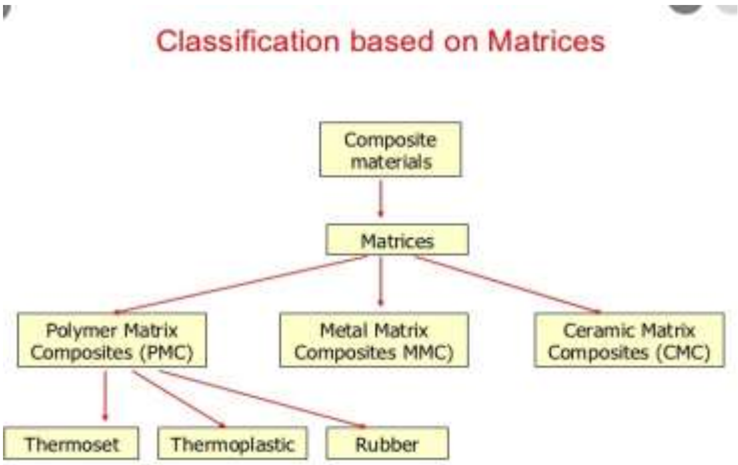
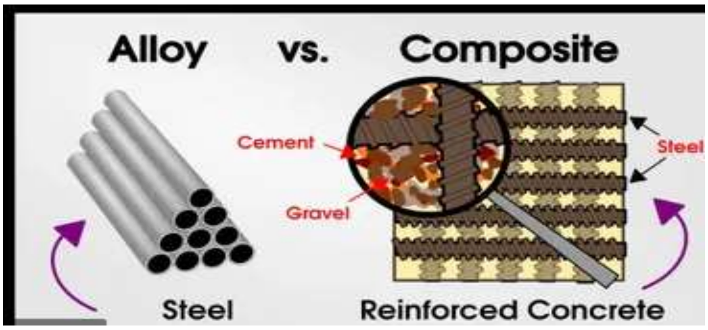
ABSTRACT
Conventional monolithic materials have limitations in achieving good combination of strength, stiffness, toughness and density. To overcome these shortcomings and to meet the ever increasing demand of modern day technology, composites are most promising materials of recent interest. The present research work involves the study of AA 5052-B_4c –Gr composite through stir casting route. This in-situ method involves formation of reinforcements within the matrix by the chemical reaction of two or more compounds which also produces some changes in the matrix material within the vicinity. boron carbide (B4c) was the reinforcement in the matrix of AA 5052 alloy which can be suitable for space, aircraft and automotive components at elevated temperatures. The mechanical properties in terms of hardness, heat treatment and wear test were carried out. The sample of AA5052 alloy was also casted and tested for comparison

Keywords: Hybrid metal matrix composite, Aluminium, stir casting method, mechanical properties, Al5052, B4C & Gr.

INTORDUCTION
In general, composites are classified according to the type of matrix material and then nature of reinforcement at two distinct levels. The first classification includes ceramic matrix composites (CMCs), organic matrix composites (OMCs) and metal matrix composites (MMCs). The term organic-matrix composite is generally assumed to include polymer Matrix composites (PMCs) andcarbon matrix composites. The second classification refers to the reinforcement form; particulate reinforcements, whiskers, continuous fiber, laminated composites and woven composites.



DIFFERENCE BEWEEN ALLOY AND COMPOSITES



OBJECTIVES:

PrimaryObjective:

The main objective of our project is to design and fabricatation and characterization of situ synthesized **B4C/Gr/Al COMPOSITE**.

SecondaryObjective:

Besides the main objective, following are our secondary objectives:

1. Tounderstandprojectplanningandexecution
2. To understand the fabrication techniques in a mechanical workshop
3. Tounderstandtheusageofvariousmechanical machine tools and also measuring tools
4. To make day to day human life more easier byproper use of technology

2. LITERATUREREVIEW

Properties	Metric	Imperial
Tensile strength	310 MPa	45000 psi
Yield strength	276 MPa	40000 psi
Shear strength	207 MPa	30000 psi
Fatigue strength	96.5 MPa	14000 psi
Elastic modulus	68.9 GPa	10000 ksi
Poisson's ratio	0.33	0.33
Elongation	12-17%	12-17%
Hardness, Brinell	95	95

- Gopal Krishna U, Sreenivas Rao K V written a journal in waterstones have reported that the aluminum matrix can be strengthened by reinforcing with hard ceramic particles like Sic, Al2O3, B4C etc. An effort is made to enhance the mechanical properties like tensile strength and hardness of AMCs by reinforcing 5052Al matrix with B4C particles. The microstructure and mechanical properties of the fabricated AMCs was analyzed. Based on the results obtained from tensile strength test of the metal matrix composites of different particle sizes, 105 size B4C was chosen. They concluded that from the micro structure analysis increase the grain size, increase in the material weight increase in tensile strength.
- Keshava Murthy R et.al studied about Al7075-TiB2 in-situ composite, processed by stir casting technique using commercially available Al-10%Ti and Al- 3%Br master alloys. Both matrix alloy

and composite were subjected to microstructure analysis, micro hardness test, grain size studies and tensile test. Microstructure shows fairly uniform distribution of TiB2 particles in matrix alloy. Average grain size of the composite was lower than unreinforced alloy. Micro hardness, yield strength and ultimate tensile strength of Al7075-TiB2 composite, were considerably higher when compared with unreinforced alloy

MATERIALS

Aluminium Alloy (AA) 5052

The 5052 alloy is primarily composed of aluminum, magnesium and silicon. Its other metallic elements include iron, copper, chromium, zinc, manganese and titanium, in descending order of quantity. Alloy 5052 set the standard for a medium-to-high strength, lightweight, economical material. Earlier alloys had been susceptible to stress-corrosion cracking, but the addition of a small amount of Chromium made this alloy highly resistant to corrosion.

Boron carbide

Boron Carbide (B_4C) is one of the hardest materials known, ranking third behind diamond and cubic boron nitride. It is the hardest material produced in tonnage quantities. Originally discovered in mid 19th century as a by-product in the production of metal borides, boron carbide was only studied in detail since 1930

Property	Value
Density (g.cm^{-3})	2.52
Melting Point (°C)	2445
Hardness (Knoop 100 g) (kg.mm^{-2})	2900 - 3580
Fracture Toughness (MPa.m$^{1/2}$)	2.9 - 3.7
Young's Modulus (GPa)	450 - 470
Electrical Conductivity (at 25 °C) (S)	140
Thermal Conductivity (at 25 °C) (W/m.K)	30 - 42

Boran carbide

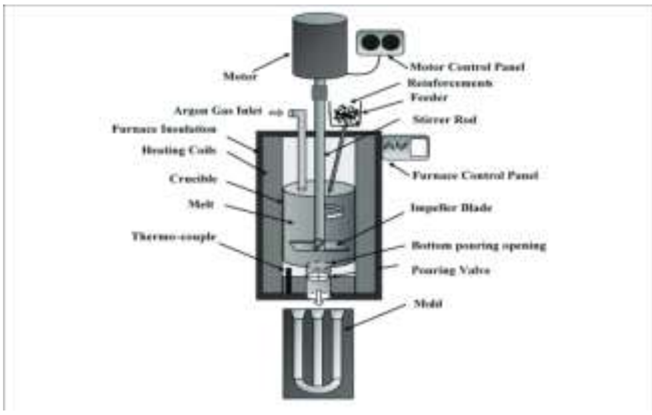
GRAPHITE **Graphite** is a crystalline allotrope (form) of the element carbon. It consists of many stacked layers of graphene, typically in the excess of hundreds of layers. Graphite occurs naturally and is the most stable form of carbon under standard conditions. Synthetic and natural graphite are consumed on a large scale (1.3 million metric tons per year in 2022) for uses in many critical industries including refractories (50%), lithium-ion batteries (18%), foundries (10%), lubricants (5%), among others (17%).[6] Under extremely high pressures and extremely high temperatures it converts to diamond. Graphite's low cost, thermal and chemical inertness and characteristic conductivity of heat and electricity finds numerous applications in high energy and high temperature processes.[7]

3. MATERIAL COMPOSITION

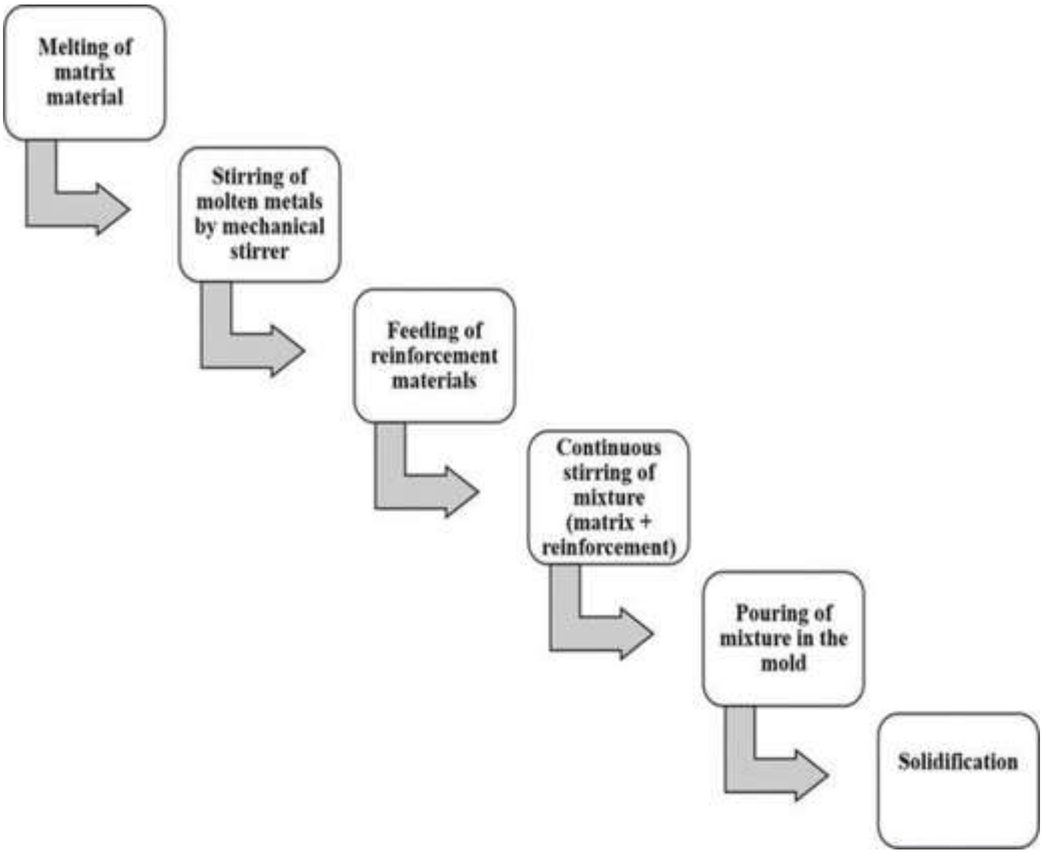
1)Al 5052 (96%) + B4C (2%)+Gr(2%)
(2)Al 5052 (94%) + B4C (4%)+Gr(2%)
(3)Al 5052 (98%) + B4C (6%)+Gr(2%)
(4)Al 5052 (90%) + B4C (8%)+Gr(2%)
Al 5052 = Aluminum 5052
B4C = Boron Carbide
Gr -Graphite

4.METHODOLOGY

Stir casting is one of the most popular and widely used method in which material formation (mainly Metal Alloys and Metal Matrix Composites) is done by melting metals and casting them into suitable shapes and sizes by pouring them into cavities. It is also called as liquid metallurgy.



Steps involved in Stir casting



WORK PROGRESS

MATERIAL PURCHASE

- **Materials purchased in India Mart**

  FABRICATION
- **Material composite fabrication is done by Stir casting route in Vignan's Foundation For Science, Technology and Research (VFSTR),GUNTUR (Vignan University)**

  TESTING
- **Jyothi Spectro Analysis Private Limited, HYDERABAD**

TEST SPECIMENS



CRUCIBLE

SPECIMEN

RESSULTS

Hardness is a measure of how much a material resists changes in shape. Ability of material to resist wear, tear, scratching, abrasion cutting is **called hardness**. Harder materials are more difficult to cut and shape than softer ones. They are also usually more brittle which means they do not bend much but can shatter

VICKERS HARDNESS TESTER

The Vickers hardness test determines a material's hardness by measuring the diagonal length of an indentation left by a diamond pyramid indenter under a specific load, with the Vickers hardness value (HV) calculated from the load and indentation area.

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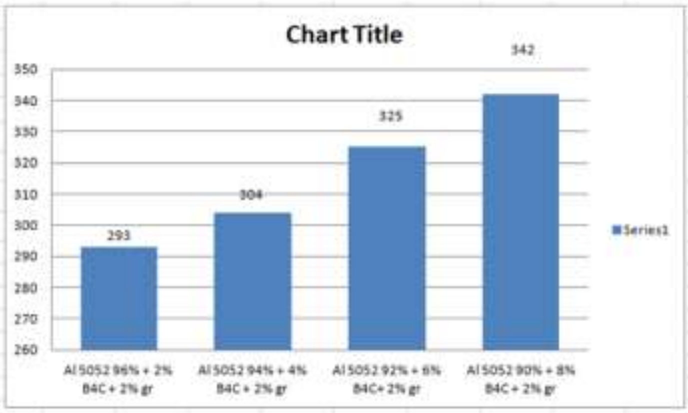
Compositions	Trail 1			Trail 2			VHN
	D1	D2	VHN	D1	D2	VHN	
Al 5052 96% + 2% B_4C + 2% gr	78	88	290	67	76	296	293
Al 5052 94% + 4% B_4C + 2% gr	67	76	302	87	87	306	304
Al 5052 92% + 6% B_4C+ 2% gr	89	76	325	67	67	326	325
Al 5052 90% + 8% B_4C + 2% gr	87	86	340	79	57	345	342



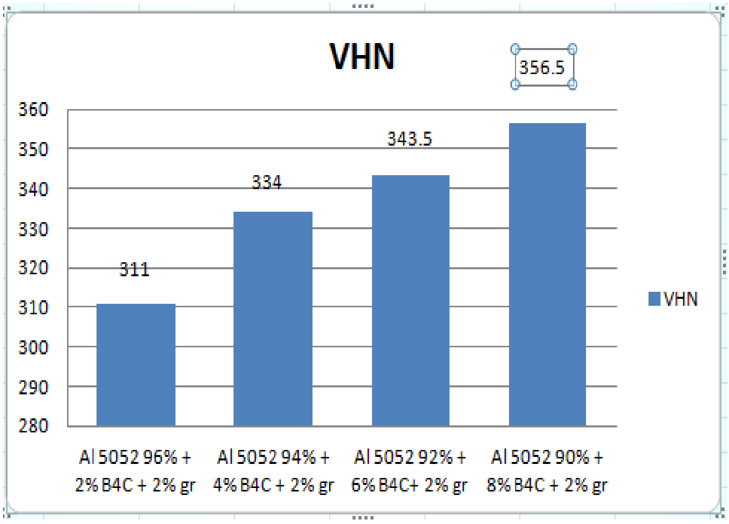
Heattreatment

Heat treatment is a group of industrial, thermal and metalworking processes used to alter the physical, and sometimes chemical, properties of a material

HEAT TREATED HARDNESS @ 4 water

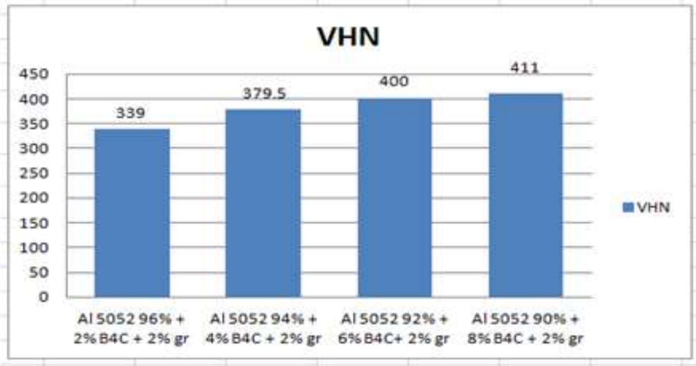
Compositions	Trail 1			Trail 2			VHN
	D1	D2	VHN	D1	D2	VHN	
Al 5052 96% + 2% B_4C + 2% gr	87	79	310	89	96	312	311
Al 5052 94% + 4% B_4C + 2% gr	76	67	323	98	94	345	334
Al 5052 92% + 6% B_4C+ 2% gr	68	89	344	98	93	343	343.5
Al 5052 90% + 8% B_4C + 2% gr	59	67	357	96	92	356	356.5

Wear test



Heat treatment @ ice

Compositions	Trail 1			Trail 2			VHN
	D1	D2	VHN	D1	D2	VHN	
Al 5052 96% + 2% B_4C + 2% gr	69	79	337	78	67	341	339
Al 5052 94% + 4% B_4C + 2% gr	78	89	376	79	78	383	379.5
Al 5052 92% + 6% B_4C+ 2% gr	79	98	397	67	90	403	400
Al 5052 90% + 8% B_4C + 2% gr	87	67	410	79	89	412	411

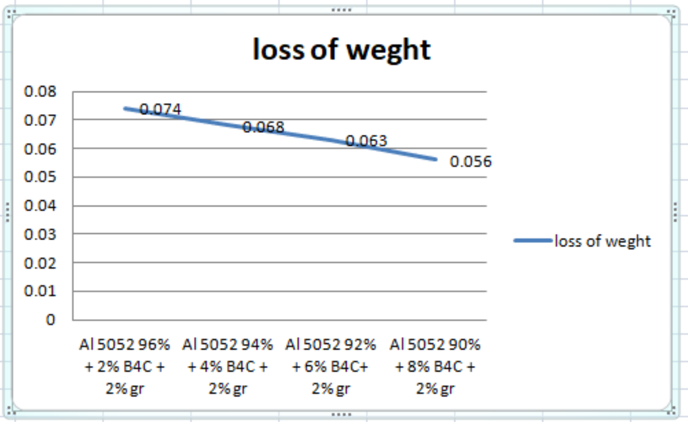


HEAT TREATED HARDNESS @8 hours

compositions	Trail 1			Trail 2			
	D1	D2	VHN	D1	D2	VHN	MICRO VHN
Al 7075+2%B_4C	87	88	345	86	76	352	348.5
Al 7075+4%B_4C	86	89	368	89	78	378	373
Al 7075+6%B_4C	83	86	376	88	77	386	381
Al 7075+8%B_4C	89	85	389	85	68	389	389

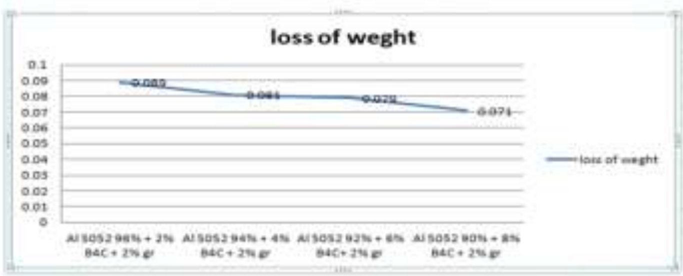
Wear at 1kg load 200mts

S.n o	Material	Initial weight	Final weight	Loss of weight
1	Al 5052 96% + 2% B_4C + 2% gr	14.675	14.601	0.074
2	Al 5052 94% + 4% B_4C + 2% gr	15.876	15.808	0.068
3	Al 5052 92% + 6% B_4C+ 2% gr	14.864	14.801	0.063
4	Al 5052 90% + 8% B_4C + 2% gr	15.897	15.841	0.056



wear at 1kg load 400mts

S.no	Material	Initialweight	Final weight	Loss of weight
1	Al 5052 96% + 2% B_4C + 2% gr	14.464	14.375	0.089
2	Al 5052 94% + 4% B_4C + 2% gr	13.567	13.486	0.081
3	Al 5052 92% + 6% B_4C+ 2% gr	14.345	14.266	0.079
4	Al 5052 90% + 8% B_4C + 2% gr	14.434	14.363	0.071



Conclusions

- As the composites are subjected to the heating the upto 230^{o}cin the muffle furnace and subjected to soaking for 2 hours
- In order to check the frictional behavior of composites it was further subjected to load conditions by the pin on disc.to evaluate the results of thes here it self taken different speeds, rpm and load
- Initially it was subjected to 200mts of distance at 1 kg load 400 rpm
- From the results it was conclude that as the percentage of reinforcements were increasing there was also increases in the wear.it wass very high comparatively very high than the non hybrid composites

same results also for the reaming composites in the wear

- All the composites were having highest wear which having ore weight loss
- The compression strength increases as the fraction of reinforcement enhances in the matrix material. The 8 wt.% of B4C AND SIC reinforced as-cast aluminum AL5052-B_4C-gr nanocomposite
- The AL5052-B_4C-gr AND Sic metal matrix composite materials have been fabricated by stir casting method followed by extrusion process Fabricated process further subjected to various testing's
- The B_4C, Sic and sic particulates are evenly dispersed in the matrix alloy. The micro hardness of AL5052-B_4C-gr metal matrix composite material is superior than the matrix material which is less than previously fabricated AL5052-B_4C-gr
- As the percentage of reinforcement increases than the hardness also increased, by the addition of graphite hardness decreased With the results of hardness comparatively less than without graphite of same compositions
- There was decreases of hardness 16% of in every composites with addition of graphite due graphite having machinability property
- Further compents subjected to the heat treatment process in order improve all the properties in different mediums like water, oil and ice.
- The wear rate in both the AL5052-B4C metal matrix composites and the matrix material enhances as the sliding distance increases.
- The wear rate in both the AL5052-B4C metal matrix composites and the matrix material decreases as the sliding velocity enlarges. The wear rate of aluminium (AL7075-B4C MMC decreases by 13.29% as sliding velocity increases to 1.728 m/s.

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