Evaluation of Mechanical Behavior and Microstructure of AA6063 - B_4C - Al_2O_3 Hybrid Composites

[1]P.Viswabharathy, [2]Dr.A.Senthilkumar, [3]J.Vairamuthu

[1]Assistant Professor, [2]Professor, [3]Research Scholar,
Department of Mechanical Engineering,
[1]Shivani College of Engineering and Technology, [2,3]Sethu Institute of Technology,
[1]Trichy, [2,3]Madurai

***Abstract*-Nowadays the aluminium based composite is enormously used in automobiles, aerospace and structural member due to its proven mechanical properties. The present work focuses on the fabrication of aluminium Alloy 6063 reinforced with boron carbide and Aluminium Oxide composite through stir casting process. This research focuses on the fabrication of AA6063/ 5 % B_4C of / Al_2O_3 in step of 4%, 8% and 12% with the help of stir casting method. Microstructure of fabricated hybrid composites and the tested hybrid composites will be viewed by Scanning Electron Microscope (SEM) and then hardness test is taking to find the hardness of the hybrid composite material. The SEM and hardness test result were carried out for different percentage 4%, 8% and 12% of hybrid composite materials improve the hardness of the material especially 12% Al_2O_3 composition. So,12 % Al_2O_3 very suitable for composite with AA 6063 material.**

Index Terms-Metal Matrix Composites (MMC), Aluminium Oxide (Al_2O_3), B_4C, AA6063, Scanning Electron Microscope (SEM)

1. INTRODUCTION

Aluminium metal matrix composites are outstanding candidates in the field of automotive brakes, drive shafts, and cylinder liners, electronic-packaging and thermal-management applications because of its improved physical as well as mechanical properties. These composite materials are recently developed enormously in many ways, among the various manufacturing processes; Inset stir casting process is a promising route due to its simplicity, flexibility and applicability to large quantity production. Aluminium based particulate metal matrix composites reinforced with hard ceramic particles like SiC, Al_2O_3, and B_4Chas recently brought much attention in both industry and research level in order to get significant benefits and superior combination of properties like improved strength, high elastic modulus, increased wear resistance, low density, high electrical and thermal conductivity. Among various reinforcements is very interesting because it has high hardness, high elastic modulus, stiffness, wear resistance, low density, good wet ability with molten aluminium and highest ability.

Generally the aluminium alloys have attractive properties like low density, high strength, good ductility, high toughness and resistance to fatigue and widely used as structural materials, especially 6063 aluminium alloy extensively used in aircraft structures because of its high strength-to-density ratio .Limited attempt shave been made to examine the effect of reinforcement on the cold forming behavior of composites. Formability is the ability of a material to endure the induced internal stresses of forming former to the occurrence of splitting of material.

1.1 Metal Matrix Composite (MMC)

Composites are combination soft materials in which one of the materials , called there in forcing phase ,is in the form of fibres, sheets, or particles, and are embedded in the other materials called the matrix phase. There in forcing material and the matrix material can be metal, ceramic or polymer. Composites are used because overall properties of the composites are superior to those of the individual components. MMCs combine metallic properties (ductility and toughness) with ceramic characteristics (high strength and modulus),leading to greater strength in shear and compression and to higher service temperature capabilities.

The attractive physical and mechanical properties that can be obtained with MMCs, such as high specific modulus, strength, and thermal stability, have been documented extensively. Interest in MMCs for use in the aerospace and automotive industries, and other structural applications, has increased over the past 20years as a result of the availability of relatively in expensive reinforcements and the development of various processing routes which result in reproducible microstructure and properties. The family of discontinuously reinforced MMCs includes both particulates and whiskers or short fibers.
More recently this class of MMCs of attracted considerable attention result of,

- Availability of various types of reinforcement at competitive costs.
- MMCs with reproducible structure and properties.
- The work has led to the development of novel composites inside MMCs in which there in for cement are synthesized in a metallic matrix by chemical reaction between elements or between element and compound during the composite fabrication.

1.2 Area of Application of Metal Matrix Composites

- Military tank track shoes.
- Tracked vehicles.

- Aerospace structures.
- Electronic substances.
- Pistons.
- Cylinders liners.
- Disk brake rotors.
- Drive shaft and torques.
- Recreational and sports.
- Used for punches and dies.

1.3 Worldwide statistical data about the usage of Metal Matrix Composites

The application so composites [14] in Europe,USA and Asia are shown inTables1.1, 1.2& 1.3.

Table 1.1Distribution of the application of composites in Europe

Applications	Percentage (%)
Transportation	33
Constructions and public works	31
Industry and Agriculture	14
Shipbuilding and consumer goods	10
Electricity and Electronics	08
Other applications	04

Table 1.2Distribution of applications of composites in the U.S.A

Applications	Percentage (%)
Transportation	32
Constructions and public works	30
Industry and Agriculture	18
Shipbuilding and consumer goods	09
Electricity and Electronics	07
Other applications	04

Table 1.3 Distribution of applications of composites in the Asia

Applications	Percentage (%)
Transportation	17
Constructions and public works	30
Industry and Agriculture	08
Shipbuilding and consumer goods	11
Electricity and Electronics	32
Other applications	02

II.LITERATURE REVIEW

[1]**IbrahimIa& Mohamed F a & Lavernia (1991),** The processing methods utilized to manufacture particulate reinforced MMCs can be grouped depending on the temperature of the metallic matrix during preceding. Accordingly, the process can be classified into three categories: (a) liquid phase processes, (b) solid state processes and (c) two phase premise regarding physical properties. Strengthening in metal matrix composites has been related to dislocations of a very high density.

[2]**Chapman TR ,Niesz D E & Fox R T (1999),**Variations in processing yielded samples with a range of mechanical

properties and subsequent test behavior. Of these, successful samples were produced from coarse, bimodal B_4C powders that were highly reacted with in filtrated aluminium. These particular materials exhibited wear rates more than an order of magnitude lower than current asbestos and semi metallic materials while producing no increase in rotor wear.

[3]**Lashgari HR, Sufizadeh AR & Emamy M (2010),**This study was undertaken to investigate the effect of strontium (0.5%) as a modifier on the microstructure and dry sliding wear behavior of A356–10%B_4C particulate metal matrix composite (PMMC). The composite ingots were made by stir casting process.

[4]**ShorowordiKM,LaouiT,HassebASMA,CelisJP&FroyenL (2012),**Good wetting is an essential condition for the generation of a satisfactory bond between particulate reinforcements and liquid Al metal matrix during casting composites, to allow transfer and distribution of load from the matrix to the reinforcements without failure. Strong bonds at the interface are required for good wetting.

[5]**MohantyRM,BalasubramanianK&SeshadriSK (2008),**The study forms the basis to commercialize ABC composites for required applications, and it is concluded that even though uncoated boron carbide reinforcement sem brittle the aluminium matrix in as-reinforced condition, improvement in other as discussed properties is significant. The study also indicates that the ductility of the metal matrix composite (MMC) may be improved by increasing the interfacial bonding and decreasing the overall porosity contents of the composite.

[6]**ToptanF,KilicarslanA,CigdemM&KertiI(2010),**In the present work, AA 1070 and AA 6063 matrix B_4C reinforced composites were produced by casting route at 850 _C and titanium-containing flux (K_2TiF_6) was used to overcome the wetting problem between B_4C and liquid aluminium metal. AA 6063/B_4C composite samples were then subjected to solution treatment .The microstructure of matrix/reinforcement interfaces of both as-cast and heat treated samples with or without Ti additions were investigated with SEM studies the wetting improved by the formation of very thin TiC and TiB_2 reaction layers.

[7]**AbenojarJ,VelascoF&MartinezM.A (2007),**The processing parameters of the Al + 10% B_4C system have been studied in this work. The mechanical alloying process optimization has been carried out in a planetary ball mill up to 12 h. The milling process was systematically studied by taking out powder samples every 2 h. Apparent density and flow rate were measured. Micro structural evolution was analyzed using scanning electron microscopy (SEM).

[8]**KertiI&ToptanF(2008),**The present work introduces a cost- effective and reliable casting technique to overcome the wetting problem between B_4C and liquid aluminium metal as well as the formation of undesirable phases at the interface using K_2TiF_6 flux. For this aim, experimental work was carried out using B_4C powders with different particle sizes to reinforce commercially available aluminium using casting technique.

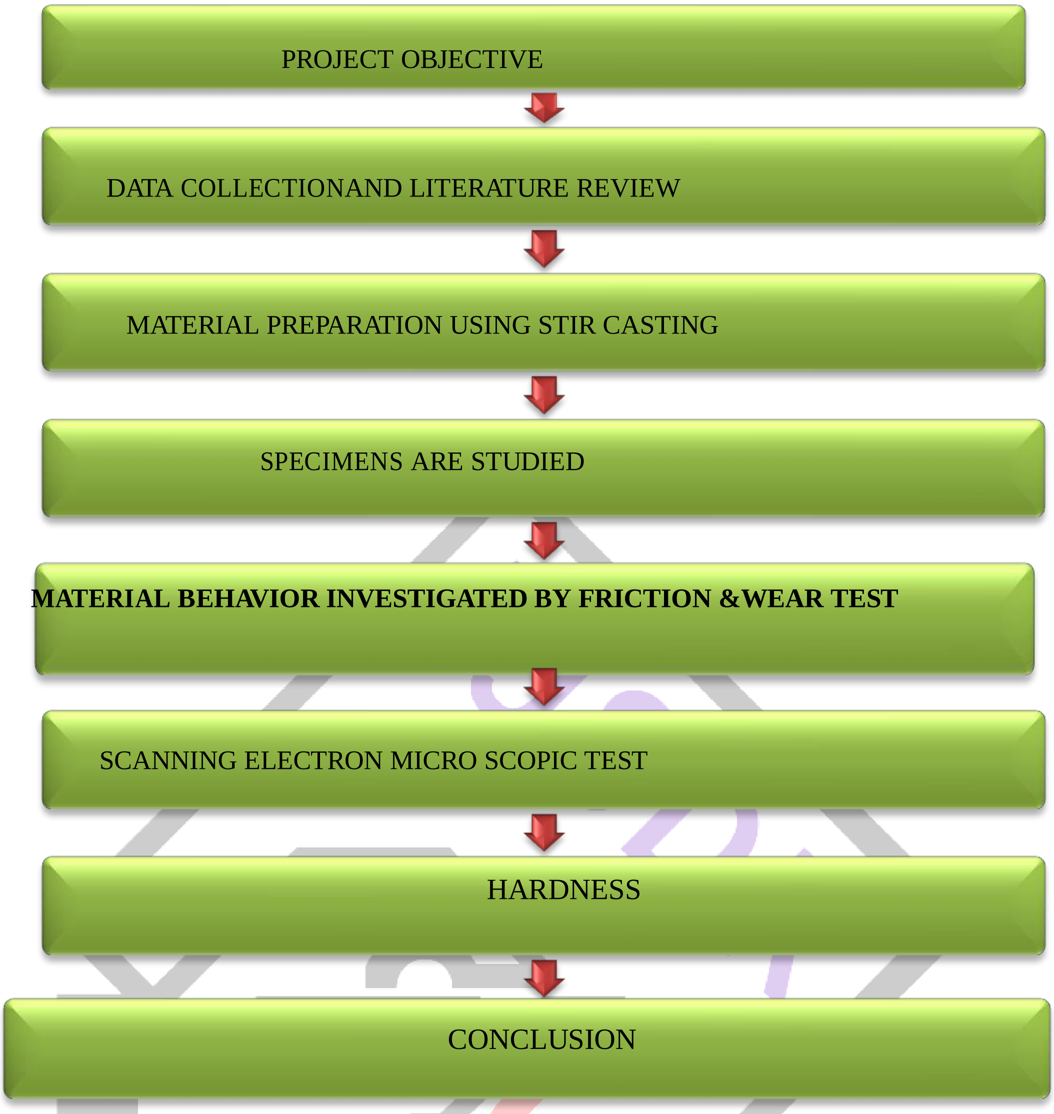
[9]**KalaiselvanK, MuruganN &ParameswaranS (2011),**This work of causes on the fabrication of aluminium (6063-T6)matrix composites(AMCs) reinforced with various weight percentage of B_4C particulates by modified stir casting route. The wett ability of B_4C particles in the matrix has been improved by adding $K_2 TiF_6$ flux in to the melt .The micro structure and mechanical properties of the fabricated AMC s are analyzed.

[10]**Busquets-mataix- Matrix GL,D, Amigo V & Salvador MD(2009),**This study deals with the feasibility of using boron carbide (B_4C) as reinforcement for aluminium matrix composites(AMCs)obtained by solid-state processes (powder metallurgy and extrusion). Two different reinforcements were considered: B4C as the object of this study and SiC for direct comparison of results.

III.PROBLEMDESCRIPTION

In this paper a series of fracture problems in composite materials are identified, their method so solution are briefly discussed ,and some sample results a represented. The main problem of interest is the determination of the hardness and stress state in then eight or hood of localize imperfections such as cracks and inclusions which may exist in the composite .Particular emphasis's placed on the evaluation of quantities such as the hardness and stress intensity factors, the power of the stresses angularity, and the strain energy release rate, which may be used directly or indirectly in connection with an appropriate fracture criterion for the prediction of fracture initiation and propagation load levels .The topics discussed in the paper include a hardness and crack in layered composites, and inclusion problems in bonded materials. This composition type (AA 6063/5% B_4C of /12% Al_2O_3) reduce crack and increase the hardness of the material.

IV.PROPOSED METHODOLOGY



V.MATERIALS

5.1 Matrix Material

TheselectedAA6063alloynominalchemicalcompositionand physicalPropertieswasgiveninTable5.1& 5.2

5.1.1 AA6063 Chemical Composition

A typical chemical composition ofAA6063 is presented in Table. Its superior corrosion resistance makes it a suitable candidate material for marine structural applications.

Table 5.1 AA6063 Chemical composition

S.NO	COMPONENTS	VALUES
1	Aluminium	Balance
2	Magnesium	0.45-0.90
3	Silicon	0.20-0.60
4	Iron	max0.35
5	Copper	max0.10
6	Zinc	max0.10

7	Titanium	max0.10
8	Manganese	max0.10
9	Chromium	max0.10
10	Others	0.05

5.1.2 AA6063 Physical Properties

Al alloy Al6063is widely used in numerous engineering applications including transport and construction where superior mechanic al properties such as tensile strength, hardness etc., are essentially required.

Table5.2 AA6063 Physical Properties

Properties	Amount	Units
Density	2.70	g/cm^3
Melding Point	655	°C
Modulus of Elasticity	**69.5**	Gpa
Poission ratio	0.33	-

5.1.3AA6063Thermal Properties

Co-Efficient of Thermal Expansion (20-100°C):24x10^{-6} m/m.°C Thermal Conductivity:197W/m.K..

5.2 Reinforced Material

5.2.1BoronCarbide Description (B_4C)

B_4C Known as the third hardest material. A high performance abrasive material with chemical and physical properties similar to diamonds ,such as chemical resistance and hardness .Boron carbide's extra hardness gives it the nick name "black diamond". Color is black or gray,

5.2.2 B_4C Chemical Properties

1) General Industrial Grades Available: B+C=94%min.(B=77%min &C= 17%max.)and B +C= 98% min.(B= 74%min.& C= 24% max.)
2) Standard Grade :B= 74%min.,andC= 24%max.,B+C= 98%min.
3) Nuclear Grade :B= 76.5% min.
4) High Purity Grade: B=75-80%

5.2.3 B_4C Particle Sizes Available

FEPA Grit Sizes from F100 to F1500.Also granulations from coarse granules to angstrom size particles.

Table 5.3 B_4C Physical Constants

S.NO	DESCRIPTION	VALUES
1	Molecular Weight(g/mol.)	55.25515
2	Theoretical Density(g/cm^3)	2.52
3	Melting Point(°C)	2450-2723
4	Boiling Point(°C)	3500
5	Knoop Hardness	2750
6	Particle Shape	Irregular &whiskers
7	Specific Gravity	2.51
8	Specific Heat(cal-mol-c)	12.5
9	Crystallography	Mono crystalline

5.2.4 B_4C Typical Applications

Steel modification component with high boron content, grinding, lapping, polishing, hot pressing and sintering of hard and abrasion resistant parts with light weight, metallurgical refractoriness with high corrosion and oxygen resistance, moderators, and nuclear technology (reactor control rods and neutron absorbing materials).

- High pressure water.
- Scratch and wear resistant coatings.
- Cutting tools and dies.
- Neutron absorber in nuclear reactors.
- Metal matrix composites.
- High energy fuel for solid fuel ramjets

Table 5.4 B_4C Mechanical properties

S.NO	DESCRIPTION	VALUES
1	Density(g.cm^{-3})	2.52
2	Melting Point(°C)	2445
3	Hardness(Knoop100g) (kg.mm^{-2})	2900-3580
4	Fracture Toughness(MPa.m$^{-1/2}$)	2.9 -3.7
5	Young's Modulus (GPa)	450–470
6	Electrical Conductivity(at 25°C)	140
7	Thermal Conductivity(at 25°C) (W/m.K)	30–42
8	ThermalExpansionCo-eff.x10^{-6}(°C)	5

5.3 Ceramic Particles

5.3.1AluminiumOxide Properties

Aluminium oxide, commonly referred to as alumina, possesses strong ionic inter atomic bonding giving rise to its desirable material characteristics. It cans existence viral crystalline phases which all revert to the most stable hexagonal alpha phase at elevated temperatures. This is the phase of particular interest for structural applications and the material available from occur at us.

Alpha phase alumina is the strongest and stiffest of the oxide ceramics. Its high hardness, excellent dielectric properties, refractoriness and good thermal properties make it the material of choice for a wide range of applications. High purity alumina is usable in both oxidizing and reducing atmospheresto1925^{0}C.

Weight loss in vacuum ranges from 10^{-7}to10^{6}g/cm^2.sec over a temperature range of 1700^{0}to2000^{0}C.It resists attack by all gases except wet fluorine and is resist ant to all common reagents except hydro fluoric acid and phosphoric acid. Elevated temperature attack occurs in the presence of alkali metal vapors particularly at lower purity levels. The composition of the ceramic body can be changed to enhance particular desirable material characteristics. An example would be addition so chrome oxide or manganese oxide to improve hardness and change color. Other additions can be made to improve the ease and consistency of metal films fired to the ceramic for subsequent brazed and soldered assembly.

Table 5.5 Al_2O_3 Engineering Properties

94% Aluminium oxide			
Mechanical	**Units of Measure**	**SI/Metric**	**(Imperial)**
Density	gm/cc (lb/ft^3)	3.69	(230.4)
Porosity	%(%)	0	(0)
Color	-	White	
Flexural Strength	MPa (lb/in^{2}x10^3)	330	(47)
Elastic Modulus	GPa (lb/in^{2}x10^6)	300	(43.5)
Shear Modulus	GPa (lb/in^{2}x10^6)	124	(18)
Bulk Modulus	GPa (lb/in^{2}x10^6)	165	(24)
Poisson's Ratio	-	0.21	(0.21)

Compressive Strength	MPa $(lb/in^2 x10^3)$	2100	(304.5)
Hardness	Kg/mm^2	1175	-
Fracture Toughness K_{IC}	MPa $.m^{1/2}$	3.5	-
Maximum Use Temperature (no load)	^0C (^0F)	1700	(3090)

VI.EXPERIMENTATION

6.1 STIRCASTING PROCESS

This involves incorporation of ceramic particulate into liquid aluminium melt and allowing the mixture to solidify .Here, the crucial thing is to create good wetting between the particulate reinforcement and the liquid aluminium alloy melt. The simplest and most commercially used technique is known as vortex technique or stir-casting technique. The vortex technique involves the introduction of pre-treated ceramic particles into the vortex of molten alloy created by the rotating impeller.

Lloyd (1999) reports that vortex-mixing technique for the preparation of ceramic particle dispersed aluminium matrix composites was originally developed by Surappa &Rohatgi (1981) at the Indian Institute of Science .Subsequently several aluminium companies further refined and modified the process which are currently employed to manufacture a variety of AMCs on commercial scale .Liquid aluminium alloy is injected/infiltrated into the interstices of the porous pre-forms of continuous fibre/short fibre or whisker or particle to produce AMCs. Depending on the nature of reinforcement and its volume fraction perform can be in filtrated, with or without the application of pressure or vacuum. AMCs having reinforcement volume fraction ranging from10to70%canbe produced using a variety of infiltration techniques.

In order for the perform to retain its integrity and shape ,it is often necessary to use silica and alumina based mixtures as binder Micro structural in homogeneities can cause notably particle a glomeration and sediment action in the melt and subsequently during solidification. In homogeneity in reinforcement distribution in the cast composites could also be a problem as a result of interaction between suspended ceramic particles and moving solid-liquid interface during solidification. Generally itispossibletoincorporateupto30%ceramicparticlesinthe size range 5 to100 min a variety of molten aluminium alloys.

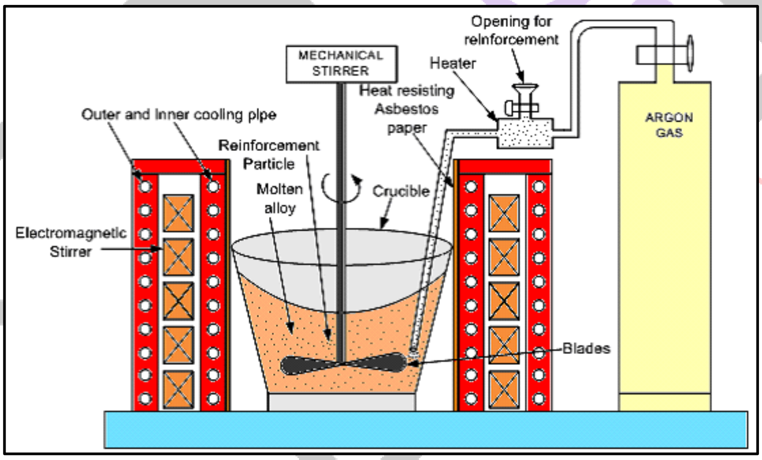


Figure 6.1- Stir Casting process

The process is not suitable for the incorporation of sub-micron size ceramic particles or whiskers. Another variant of stir casting process is compo-casting. Here, ceramic particles are incorporated into the alloy in the semi solid state.

6.2 FABRICATIONOFTHE COMPOSITES

Sample soft the hybrid composites were prepared by stir casting route. The amount soft the matrix material and the reinforcements were determine during the relation ρc=ρmVm+ρr2Vr2,where ρm, and ρ are the densities of the materials of the matrix and the in forcements respectively and Vm, and V are volume fractions of the matrix and the reinforcements respectively.ρcr2 is the density of the composite. The melting was carried out in a resistance furnace .Scraps of aluminium were preheated at450°C for 3 to 4h before melting. The B_4C particles were also preheated at around 1,000to1,200°C to make their surfaces oxidized. The preheated aluminium scraps were first heated to above the liquid to the temperature to melt them completely.

The boron carbide (5%) and aluminium oxide (4%) were mixed with AA6063in the crucible .They were then slightly cooled to below the liquids, to maintain the slurry in the semi-solid state. This procedure has been adopted while stir casting aluminium composites with single reinforcement. The preheated reinforcements were added and mixed manually. The composite slurry was then reheated to a fully liquid state and mechanical mixing was carried out for about 10–15 min at an average mixing speed of 150–300rpm.Thefinal temperature was controlled to be within 750°C±10°Cand pouring temperature was controlled to be around 720°C.

6.2.1Stirring Speed

Stirring speed is the import ant process parameter as stirring is necessary to help in promoting wet ability i.e .bonding between matrix & reinforcement .Stirring speed will directly control the flow pattern of the molten metal .Parallel flow will not promote good reinforcement mixing with the matrix.

6.2.2Stirring Temperature

It is an important process parameter. It is related to the melting temperature of matrix i.e. aluminium. Aluminium generally melts at650◦C.The processing temperature is mainly influence the viscosity of Al matrix. The change of viscosity influences the particle distribution in the matrix. The viscosity of liquid decreased when increasing processing temperature with increasing holding time stirring time. It also accelerates the chemical reaction b/w matrix and reinforcement.

6.2.3Reinforcement Pre heats Temperature

Reinforcement was preheated at a specified 900◦C temperature 30 min in order to remove moisture or any the reinforcement. The pre heating of also promotes the wet ability of reinforcement with matrix.

6.2.4Blade Angle

The blade angle and number of blades are prominent factor which decides the flow pattern of the liquid metal at the time of stirring. The blade with angle 45° &60° will give the uniform distribution.

6.2.5Inert Gas

As aluminium melt it start reacting with environment oxygen and will produce an oxide layer at the top. This oxide layer will avoid further oxidation but along that it will difficult to brake.

6.2.6Preheated Temperature of Mould

In casting porosity is the prime defect .In order to avoid these preheating the permanent mould is good solution. It will help in removing the entrapped gases from the slurry in mould It will also enhance the mechanical properties of the cast AMC.

6.2.7Powder Feed Rate

To have a good quality of casting the feed rate of powder particles must be uniform .If it is non-uniform it promotes clustering of particles at some places which inturnenhances the porosity defect and inclusion defect, so the feed rate of particles must be uniform length.

6.2.8Heat Treatment

Two type so heat treatment such solution heat treatment and aging heat treatment is done in order to increase strength of composites using muffle furnace.

6.2.9Aspect Ratio

Cylindrical specimens are prepared with standard dimension of initial diameter(Do) of 20mm and height(ho) of 10mm,15mm,20mm to give an a spent ratio of 0.4,and 0.8 and1.2Based on the formula (L/D).

6.3 Fabrication Photos

Figure 6.2- Aluminium Alloy Rod AA6063

Figure 6.3- Boron Carbide powder

Figure 6.4- Aluminium oxide

Figure6.5 Casting Work

VII. SCANNING ELECTRON MICROSCOPE TEST

7.1. 1Composite material Sample1

The sample one combination of AA 6063/ 5% $B_4C_p$of /Al_2O_3in step of 4% reinforcement is the aluminium matrix is uniform throughout the composite .In the SEM analysis image given below,

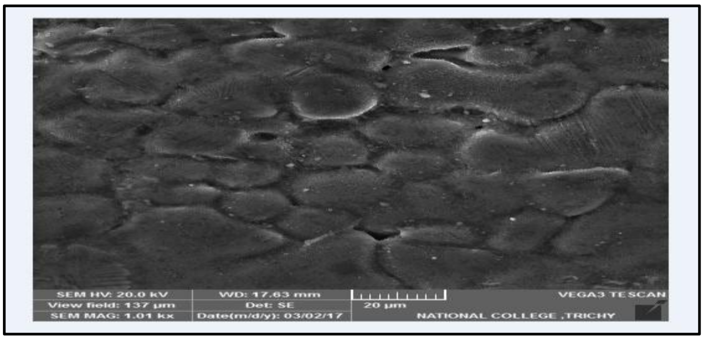


Figure 7.1AA6063/ 5%B_4C of/Al_2O_3 in step of 4% -SEM

7.1. 2 Composite material Sample 2

The sample one combination of AA6063/5%B_4C/Al_2O_3 in step of 8% reinforcement is the aluminium matrix is uniform throughout the composite. In the SEM analysis image given below,

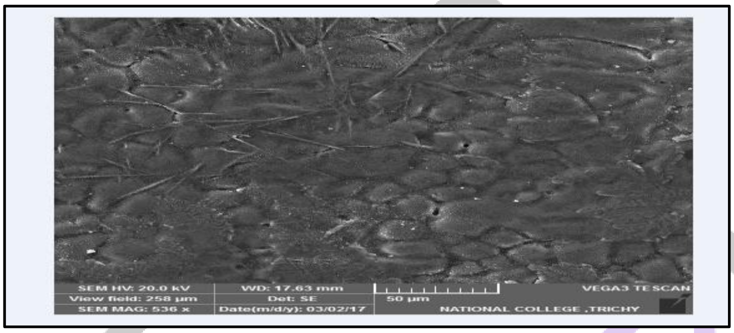


Figure 7.2 AA6063/5% B_4C of / Al_2O_3 in step of 8%- SEM

7.1.3Composite material Sample 3

The sample one combination of AA6063/5%B_4C of/Al_2O_3 in step of12% reinforcement is the aluminium matrix is uniform throughout the composite. In the SEM analysis image given below,

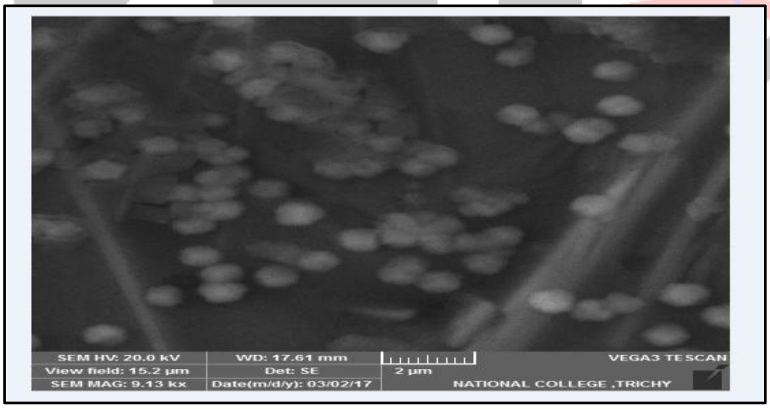


Figure 7.3 AA6063 /5 %B_4C of/Al_2O_3in step of 12% - SEM

VIII.HARDNESS TEST

8.1 Hardness Test

Hardness test are carried out on cast composites using the Rockwell hardnesstest.At100loadkgfloadusing blind enter (Scale B)for30 seconds dwell time It is observed from the table. The hardness of composites is increased linearly with the addition of B_4C_p reinforcement. The density of casted aluminium, boron carbide composite decreased due to presence of lesser density B_4C(2.52g/cc) particle in the aluminium matrix. The density of composites are decreased linearly because of the density of boron carbide composite is less than the density of AA6063 (2.7g/cc).Hence the overall density of the AA6063-B_4C-Al_2O_3compositewasdecreasedintheAA6063–B_4C-Al_2O_3composites.

Figure8.1Hardness test

8.1.1Hardness test sample 1

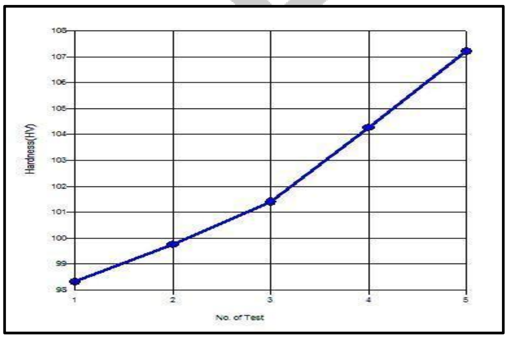
Data File Name :00_Sample_1UCEP_1.csv
Date of Test:2017/03/214:16:40[Condition]
Sample Name : Sample_1UCEP

Sample No.: 1

Memorandum:
TestLoad:HV0.1 (980.7mN) Duration Time : 10sec.
Shape of Test Piece :Flat
Max. Hardness: None Min. Hardness: None

Table8.1: Hardness test sample 1

No	X-Axis	Y-Axis	Force (MN)	Horizontal Length	Vertical Length	Average Length	Hardness(HV)
1	0	0	0.005(49.03)	9.79	9.63	9.71	98.3
2	0	0	0.001(98.03)	13.71	13.64	13.56	98.3
3	0	0	0.025(245.2)	21.34	21.43	21.38	101
4	0	0	0.05(490.3)	29.76	29.88	29.84	104
5	0	0	0.1(980.5)	41.21	41.67	41.83	0
Maximum Value							104
Minimum Value							0
Average							98.3
Standard							3
Variation							29.76
Coefficient							5.2



Graph 8.1Hardness test

8.1.2 Hardness test sample 2

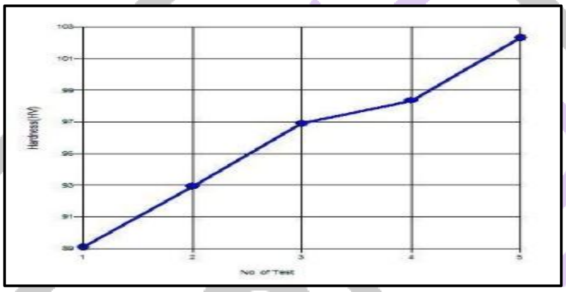
Data filename :00_Sample_2UCEP_1.CSV Date of test:
2017/03/214:32:5
Sample name : Sample_2UCEP

Sample No:2

Memorandum:TestLoad:HV0.005(49.03mN)DurationTime:10Secs
Shape of test: Flat
Upper hardness value: None
Lower hardness value :None
{Result}

Table 8.2:Hardness test sample 2

No	X-Axis	Y-Axis	Force (MN)	Horizontal Length	Vertical Length	Average Length	Hardness (HV)
1	0	0	0.005(49.03)	10.13	10.18	10.23	89.1
2	0	0	0.001(98.03)	14.10	14.15	14.13	92.9
3	0	0	0.025(245.2)	21.93	21.82	21.88	96.9
4	0	0	0.05(490.3)	30.74	30.66	30.54	98.4
5	0	0	0.1(980.5)	42.49	42.63	42.71	102
Maximum Value							102
Minimum Value							89.1
Average							95.63
Standard							5.08
Variation							5.03



Graph 8.2 Hardness test

8.1.3Hardnesstest sample 3

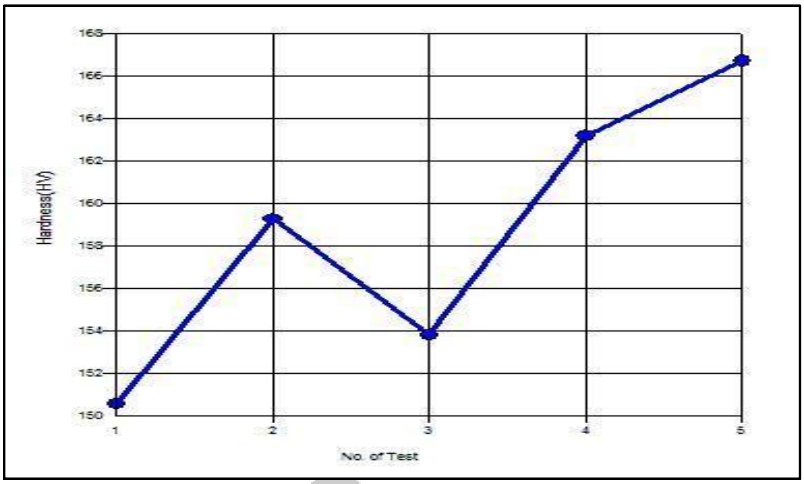
Data file name :00_Sample_3UCEP_1.CSV Date oftest:2017/03/214:56:05,Sample name : Sample_3UCEP

Sample No:3

Memorandum: Test Load:HV0.005 (490.03mN) DurationTime:10Secs
Shape of test: Flat, Upper hardness value : None, Lower hardness value : None
{Result}

Table 8.3Hardness test samples 3

No	X-Axis	Y-Axis	Force (MN)	Horizontal Length	Vertical Length	Average Length	Hardness(HV)
1	0	0	0.005(49.03)	7.89	7.63	7.94	151
2	0	0	0.001(98.03)	10.77	10.81	10.79	159
3	0	0	0.025(245.2)	17.43	17.30	17.56	154
4	0	0	0.05(490.3)	23.89	23.75	23.81	163
5	0	0	0.1(980.5)	33.29	33.42	33.56	167
Maximum Value							102
Minimum Value							89.1
Average							95.63



Graph 8.3 Hardness test

VIII. CONCLUSION

The AA6063/5%B_4C of /Al_2O_3 in step of 4%,8% and 12% were produced through stir casting method. The mechanical properties of the composite of as cast and SEM and harness were evaluated and compared matrix material and observed the distribution of reinforcements (precipitates) are homogenously distributed. The following conclusions are made from the study.AA6063/5%B_4C of/Al_2O_3 instep of4%,8%and12% were successfully fabricated by stir casting method. The mechanical properties of composite of a stand SEM and harness showed better value than all other composites .Out of all the conditions by the at treatment of12%AA6063/5%B_4C of/Al_2O_3showsbetter hardness. Optical micrographs and SEM micrographs revealed that the B4C and Al_2O_3 particles were well distributed in the Aluminium matrix composition.

REFERENCE

1. Ibrahim IA &Mohamed FA& Lavernia, Particulate reinforced metal matrix composites – a review, J Mater Sci, 26 (1991) pg:1137-1156.
2. Chapman TR,NieszDE& FoxRT, Fawcett, Wear–resistant aluminium–boron–carbide Cermets for automotive brake applications, Wear, 236(1999)pg:81-87.
3. Blumenthal WR ,Gray G T &Claytor T N, Response of aluminium- infiltrated boron carbide Cermets to shock wave loading, J Mater Sci, 29/17(1994)pg:4567-4576.
4. Lashgari HR, Sufizadeh AR& Emamy M, The effect of strontium on the microstructure and Wear properties of A356-10% B4C cast composites ,Mater Des, 31(2010) pg:2187- 2195.
5. Shorow or diKM,LaouiT, Hasseb ASMA, CelisJP & FroyenL, Microstructure and interface Characteristics of B4C, SiC and Al2O3 reinforced al matrix composites: a comparative study, J Mater ProcessTechnol,142(2003) pg:738-743.
6. Mohanty RM, BalasubramanianK &SeshadriSK, Boron carbide– reinforced aluminium 1100 matrix composites: fabrication and properties, Mater SciEngine,498(2008)pg:42-52.
7. ToptanF, Kilicarslan A,CigdemM& KertiI, Processing and micro structural characterization of AA1070 and AA6063 matrix B4C reinforced composites, Mater Des,31(2010)pg:87-91.
8. AbenojarJ ,Velasc oF &MartinezM.A, Optimization of processing parameters for the Al+10% B4C reinforced composites,J Mater Procss Technol, 184(2007) pg:441-446.
9. KertiI & ToptanF, Micro structural variations in cast B4C– reinforced aluminium composites (AMCs),Mater Lett, 62(2008) pg:1215-1218.
10 Hashim,J, Looney & LHashim MSJ, Metal matrix composites: production by the stir casting Method ,J Mater Procss Tech nol,92-93(1999)pg:1-7.
11. KalaiselvanK, MuruganN &ParameswaranS, Production and characterizationofAA6063-B4C stir cast composite, MaterDes32 (2011) pg:4004-4009.
12. Busquets-mataix-Mataix G L, D, AmigoV& Salvador M D, Analysis of boron carbide aluminium matrixcompositesJ CompositesMater,vol.43(2009)No.9,pg:987-995.
13. RiazAhamedA, AshokanP& AravindanS, EDM of hybrid Al- SiCp-B4Cand Al-SiC-Glass MMCs,InternationalJ Adv Manuf Technol, 44(2009) pg:520-528.
14. RamaraoS &Padmanabhan ,Fabrication and mechanical properties of aluminium–boron carbide composites, IntJ Mater BiomaterAppl,2(3) (2012) pg:15-18.
15. AnandakrishnanV ,BaskaranS &SathishS, Synthesis and forming behavior of in –situ AA7075-TiC Composites Adv Mater Res,651(2013) pg:251-256.