Effect of Percentatage of Reniforcements on Hybrid Aluminium Composites

(Al 6061 with SiC and B_4C)

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***Abstract* — The Development of lighter materials with high specific strength, stiffness and wear resistance, the application of particle reinforced metal matrix composites have their unique importance in the field of automotive and aerospace. The mechanical properties of metal matrix composites enhanced with particle reinforced carbide material, i.e to develop particle reinforced metal matrix composite. The reinforcing of two particles will enhance better properties than the single reinforcing.**

The Development of Hybrid metal matrix composite got more importance, though the enhanced properties better are than the single particle reinforced metal matrix composites. The work carried out on the Aluminium 6061 alloy, reinforcing with two particles i.e silicon carbide and boron carbide through liquid metallurgical route. The Mechanical properties are evaluated.

Keywords* — *Boron carbide, Hybrid, metallurgical route

I. INTRODUCTION

Developing particle reinforced aluminium matrix composites (PR-AMCs), based on liquid methods, because they can be used to produce components by casting processes. The fabrication of PR-AMCs using casting techniques is very suitable because it permits a low-cost and easy design fabrication, casting processes to current production process are requisites for flexibility in designing the components through process controlled solidification[1].

PR-AMCs applications mainly in the field of automotive, aerospace (production of engine parts, brake components, transmission rods and some sporting equipment), because of the high stiffness, strength and wear resistance that these materials have. In generally, stiffness and strength ,two controlled properties have their importance. Further the importance given to the friction characteristics and wear resistance. Due to these supportive properties and characteristics, application of these materials are vastly distributed, So that development of advance materials being well adopted to this field of research. Therefore it is necessary to evaluate the properties of the composite and characteristics in development process[1].

some well-known drawbacks have to be neglected or limited when the liquid stir casting method is used. Particularly the scarce wettability of ceramic carbides by molten aluminium has to be overcome. Moreover, the reaction of the carbide particle interface with aluminium, which has to be controlled. The present paper is focused on the effect of these material related factors, quite common in the obtaining of PR-AlMCs by stir casting method[1,2].

II. DEVELOPMENT PROCESS

Development of the component is a typical example of a group of products coming from Automotive field, which can take advantages of the light weight and high wear resistance of PR-AMCs along with fatigue strength[1,2].

First is to obtaining a good quality PR-AMC by stir method is faced. Two carbide particles, silicon carbide (SiC) and boron carbide (B_4C), very common more rarely used, it's known. Indeed, PR-AMCs based on SiC are largely described in literature, because the easy availability and low cost of SiC carbides[1,2].

In developing process, despite its high wear resistance properties, studies dealing with the stir casting method to obtain PR-AMCs based on B_4C are very scarce. Using the double stir procedure, a variant of the stir casting method, both ceramic carbides are forced to be absorbed by liquid aluminium[1,2].

Since the distribution of carbide particles and the presence of weak compounds mainly affect the mechanical and wear resistance properties of the component, the uniform distribution of SiC or B_4C carbide particles is measured by image analysis technique. Moreover, the developed products on the interface is known by using optical and/or scanning electron microscope. Finally, (a dry) friction test is conducted for individual composites and hybrid composite materials[1,2,3].

Though the aluminium alloy Al 6061 has good property of castability and the chemical compositions which is as shown in below table ,used as matrix material(Base material for composite material).In order to improve the wettability of carbide particles, additional extra percentage of Magnesium is added(say 1% - 2%)[2,3].

Component	Mg	Si	Fe	Cu	Zn	Ti	Mn	Cr	others
Amount (wt.%)	0.8-1.2	0.4 – 0.8	Max. 0.7	0.15-0.40	Max. 0.25	Max. 0.15	Max. 0.15	0.04-0.35	0.05

Table 1: Chemical Composition of Al 6061alloy

Now a days more researches going on the SiC reinforcements due to its best matching with aluminium alloy, ie Al-SiC, Also because due to its readily available and low cost. B_4C was added because its remains suspended in molten aluminium, longer due to its low density, compared with base material, aluminium alloy. Whereas SiC rapidly settles. The B_4C is chosen due to its best combined effect on carbide particles of SiC. Also the most important in selecting these carbide materials are due to their wettability and chemical compatibility with the base aluminium alloy. Below table shows the properties of Al 6061 alloy with reinforcements SiC and B_4C[2,3].

Silicon carbide in general a transition form non wetting to wetting occurs at high temperature because of dissociation of surface oxides. Heat treatment of particles before dispersion into the molten aluminium aids their transfer by causing oxide formation[2,3].

Here the combination effect of two reinforcement particles were determined; Basically Silicon carbide(SiC) along with in addition of Boron carbide(B_4C).Both the reinforcement particles are characterized by high hardness and wear resistance along with good thermal stability[3,4].

Properties	Al 6061 alloy	SiC	B_4C
Density (g/cc)	2.7	3.21	2.52
Hardness(Vicker's)	107(500g)	2800(500g)	30 – 38(1000g)
Ultimate Tensile Strength(MPa)	310	450 - 560	300 - 500
Modulus of Elasticity(GPa)	68.9	430	360 - 460
Melting Point ^{0}C	582 - 852	1370	1763

Table 2: The properties of Al 6061 alloy with reinforcements SiC and B4C

The particles of B_4C exhibit good wet-ability property when combined with aluminium alloy, by forming a layer of liquid B_2O_3 on the B_4C particles. Due to its low melting point, B_2O_3 exits above 450^{0}C as a liquid on the surface of B_4C and enhances wet-ability through a liquid phase reaction by forming B_2O_3 Al_2O_3 oxide compound. Also small percentage additional K_2TiF_6 to liquid aluminium helps in wetting, which can be found particularly successful. Therefore additional percentage of K_2TiF_6 added during the processing[3,4].

The development process is carried in Liquid route metallurgy i.e Stir casting process. A set of 910g of Al 6061 was is melted to around 753^{0}C in a graphite crucible with the help of resistance furnace. The molten metal is stirred with the help of mechanical stirrer. About 3.5g of SiC is preheated to near 780^{0}C is added to the melt and which is stirred further to disperse the ceramic particles in the medium, further around 4.5g of B_4C particles preheated to 800^{0}C is added to this and double stirred with the mechanical stirrer along with 0.25 t0 0.40 g of K_2TiF_6.Degassing tablet is added within the intervals to the vortex and slag is removed from the molten melt[3,4].

The molten metal is carefully poured to the preheated die or to the mould and left to solidify. Further By keeping SiC constant , the addition of B_4C is varied (say 3.5 to 8 wt %) the composite material can be developed by adopting above same procedure[5].

III. MICROSTRUCTURE AND TESTING

The small pieces of cut specimens as per standard metallography, were taken and the surfaces are grinding through 600 to 900 mesh size grind wheel, later final velvet polishing is done to get fine surface finish[4,5].

After the specimens are etched by using Keller's reagent , then observed through optical microscope. Later for different wt.% , the PR-AMCs specimens are observed and shown in figures[4,5,6].

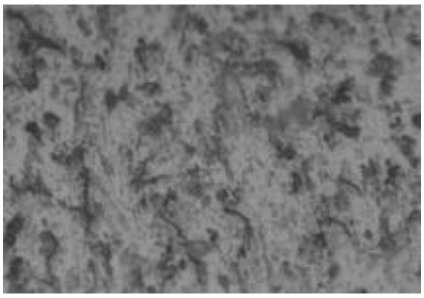

Figure 1: Particle distribution of the component(Al 6061 with SiC and B_4C)

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IV. MECHANICAL PROPERTIES-TESTS AND RESULTS

A. Tensile Test

To test for tensile strength, the specimens are prepared as per the ASTM standard.For different Wt. % of reinforcements the specimens are tested. The graphs shows the tensile property of prepared specimens.

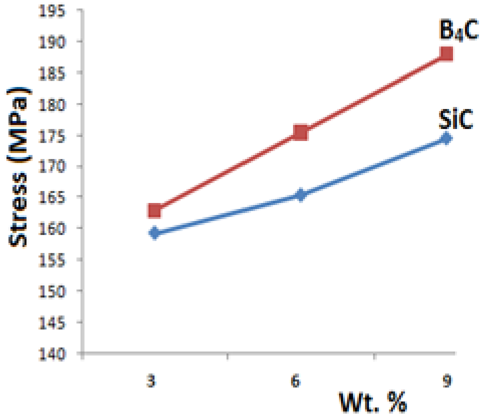

Figure 2 : The effect of Wt. % of SiC and B_4C on Tensile strength

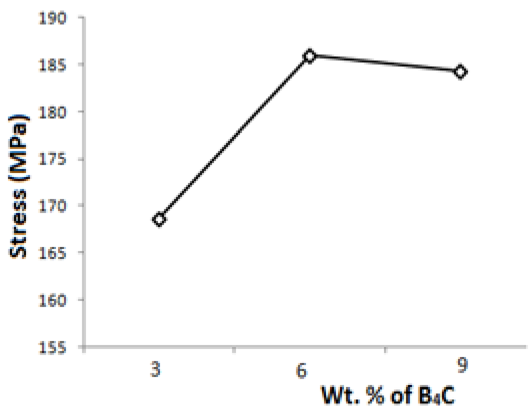

Figure 3 : The effect of Wt. % of B_4C with constant SiC on Tensile strength

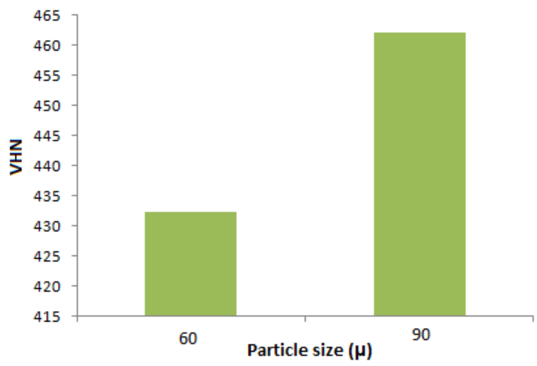

Figure 5: Effect of particle size on Hardness

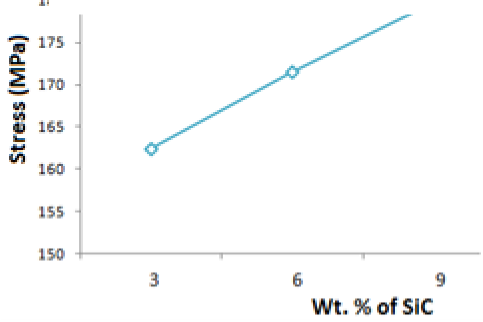

Figure 4 : The effect of Wt. % of SiC with constant B_4C on Tensile strength

B. Hardness test

From the below graph it is clears that the hardness of PR-AMCs has increased with increases in both particle size and the wt% of the two reinforcements (462.16 VHN)

C. Impact test

Graph below shows the varying Wt% of SiC and B4C, Impact strength of hybrid composite will decreases and the brittleness of material also increases.

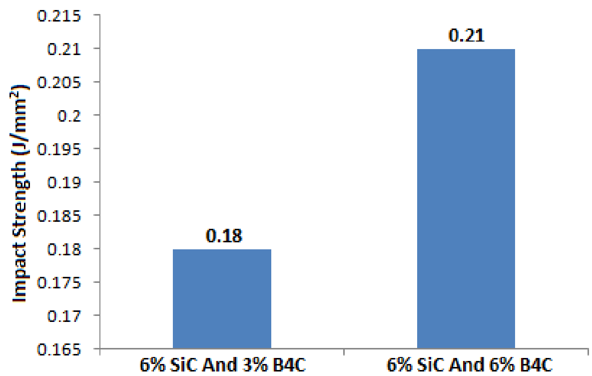

Figure 6; Effect of Wt.% of SiC and B_4C on Impact strength

V. CONCLUSION

The Al 6061 with SiC and B4C is developed through liquid metallurgical process, i.e through Stirr casting technique, for different Wt.% of reiforcements.From the work following conclusions were drawn

- Development of Hybrid composite is done through stir cast technique.
- Microstructure of composite at 3% SiC and 6% B_4C was shown
- Comparing with the tensile strength result, the Wt.% of B_4C plays very important role,found tobe maximum at 3% SiC and 6% B_4C.
- The further increase in Wt.% of B_4C results in more brittle.

VI. REFRENCES

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