A Review on Mechanical Properties and Microstructure of Aluminium Metal Matrix Composites

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ABSTRACT: *The applications of aluminium and its alloys can be found in almost every engineering field such as aerospace, marine, automotive, structural and various other fields. Due to its versatile properties it is preferred for fabricating different types of metal matrix composites. Metal matrix composites exhibit better and improved strength, toughness, formability, corrosion resistance, machinability, stiffness, wear, creep, fatigue and numerous other mechanical properties as compared to metals. With the invention and development of these aluminium metal matrix composites various drawbacks faced by the engineering society have been overcome and best possible solutions are provided. This review paper mainly focuses on the mechanical behavior and microstructural changes occurred in various types of aluminium metal matrix composites*

Keywords : Composites, Aluminium, Microstructure, Optical Microscopy, SEM, reinforcement.

INTRODUCTION

Composites are a blend of materials with different composition. These materials even possess their identities in their composite, i.e. it does not fuse or conjugate completely into each other. There are different types of composites based on their matrix constituents, they are Metal Matrix Composite (MMCs), Ceramic Matrix Composite (CMCs), Polymer Matrix Composite (PMCs), and other composites based on the layers of materials provided [1]. Metal Matrix Composites is a combination of two or more components, i.e. matrix and reinforcing material, usually matrix will be low density metal such as titanium, aluminium, copper etc. and reinforcing material will be a different material or metal such as fibre, ceramic, polymer etc. Matrix is the monolithic material and continuous in nature in which diverse materials are embedded in it. Reinforcements are added to the matrix to improve its properties like hardness, strength, elongation, conductivity, corrosion resistance etc. The applications of MMCs are rapidly increasing in various sector due to its improved properties when compared to monolithic metals[2]. The modern trend for potential applications is to optimize the mechanical properties and heat treatment of MMCs. The selection criteria of these metals involves the requirement of good corrosion resistance and high strengthened alloys as the matrix and the reinforcement material are added in order to increase elastic modulus and yield strength at least expense. [3]. Among many host matrix metals, Aluminium receives wider attention because of its low density, low cost, strength to weight ratio, high corrosion resistance and other properties.

Aluminum metal matrix composites(AMCs) with non-metallic reinforcement such asB_4C, SiC, TiC ,Si_3N_4, AlN, , TiB_2, TiO_2, Fly ash etc. embedded into Al matrix to improve creep resistance, dimensional stability, abrasion resistance, higher strength-to-weight, and stiffness-to-weight ratio. [4]. AMCs reinforced with discontinuous phases in the forms of fibres, whiskers and particulates, which possess magnified strength values at high temperature, thermal expansion, low coefficient of friction, stiffness and good wear resistance when compared to host matrix metal. The matrix consists of continuous phase embedded in a discontinuous phase, whereas the reinforcements consists of only discontinuous phase. The discontinuous phase was far stronger and harder when compared to continuous phase [5].

Aluminium metal matrix may be laminated, fibres or particulates composites. MMCs are processed through liquid cast metal technology, powder metallurgy route or by using special manufacturing process. The processing of discontinuous particulate MMCs consists of two processes (i) liquid cast metal technology and (ii) powder metallurgy. The powder metallurgy process has its own demerits such as size of the components and processing cost. Therefore, only the casting method is to be considered as the most optimum and economical route for processing of aluminium composite materials [6]. Among various casting process, Stir casting is considered to be most effective method. Stir casting is the process of stirring the molten metal with its metal alloy continuously and then poured into sand mould to cool and then to solidify. In stir casting, the particles get accumulated often; the accumulated particles can be dissolved at higher temperature by vigorous stirring [1].

LITERATURE SURVEY

Tamer Ozbenet al. [7] investigated the mechanical and machinability properties of SiC particle reinforced Al-

MMC. With the increase in reinforcement ratio, tensile strength, hardness and density of Al MMC material increased, but impact toughness decreased. SedatOzdenet al. [8] investigated the impact behaviour of Al and SiC particle reinforced with AMC under different temperature conditions. The impact behaviour of composites was affected by clustering of particles, particle cracking and weak matrix-reinforcement bonding. The effects of the test temperature on the impact behaviour of all materials were not very significant. Sujan et al. [9] studied the performance of stir cast Al2O3 and SiC reinforced metal matrix composite material. The result showed that the composite materials exhibit improved physical and mechanical properties, such as low coefficient of thermal expansion as low as 4.6x10-6/N C, high ultimate tensile strength up to 23.68%, high impact strength and hardness. The composite materials can be applied as potential lightweight materials in automobile components. Experimentally it is found that with addition of AlSiC reinforcement particles, the composite exhibited lower wear rate compared to Al-Al2O3 composites. BalasivanandhaPrabhuet et al. [10] analysed the influence of stirring speed and stirring time on distribution of particles in SiC AMC. The study was about high silicon content aluminium al with 10% SiC synthesized using different stirring speeds and stirring times. The analysis revealed that at lower stirring speed and time, the particle clustering was more at some places, by increasing them the distribution resulted better and also it had its effect on hardness of the composite. Uniform hardness values were achieved at 600 rpm with 10 min stirring.

Fly ash particles are potential discontinuous dispersions used in metal matrix composites due to their low cost and low density reinforcement which are available in large quantities as a waste by product in thermal power plants. The major constituents of flyash are SiO2, Al2O3, Fe2O3, and CaO. Rajan et al. [11] compared the effect of the three different stir casting methods on the properties of fly ash particles reinforced Al-7Si-0.35Mg alloy. Zuoyong Dou et al. [12] studied the electromagnetic interference shielding effectiveness properties of Al 2024 alloy and flyash,but addition of fly ash particulate decreases the tensile strength of the composites. Ramachandra and Radhakrishna [13] experimentally found that the wear resistance of Al MMC increases with the increase in flyash content, but decreases with increase in normal load and sliding velocity, and also observed that the corrosion resistance decreases with the increase in fly ash content.

Ravichandran M et.al carried out the research work by fabricating aluminium metal matrix composites through liquid powder metallurgy route. The aluminium matrix composite containing TiO2 reinforcement particle was produced to study the mechanical properties such as tensile strength and hardness. The characterization studies are also carried out to evident the phase presence in the composite and the results are discussed for the reinforcement addition with the mechanical properties. Results show that, the addition of 5 weight percentage of TiO2to the pure aluminium improves the mechanical properties.

Uvarajaet .al [14]observed that Hybridization is commonly used for improving the properties and for lowering the cost of conventional composites. Hybrid MMCs are made by dispersing two or more reinforcing materials into a metal matrix. They have received considerable research and trials by Toyota Motor Inc., in the early 1980s. Hybrid metal matrix composites are a relatively new class of materials characterized by lighter weight, greater strength, high wear resistance, good fatigue properties and dimensional stability at elevated temperatures than those of conventional composites. Due to such attractive properties coupled with the ability to operate at high temperatures, the Al matrix composite reinforced with SiC and B4C particulate are a new range of advanced materials. It was found that applications of hybrid composites in aerospace industries and automobile engine parts like drive shafts, cylinders, pistons and brake rotors, consequently interests in studying structural components wear behaviour. . Anand Kumar et.al research work carried out by Addition of reinforcement such as TiC, SiC, Al2O3, TiO2, TiN, etc. to Aluminium matrix for enhancing the mechanical properties has been a well–established fact. In-situ method of reinforcement of the Aluminium matrix with ceramic phase like Titanium Carbide (TiC) is well preferred over the Ex–situ method. In the present investigation, Al-Cu alloy (series of 2014 Aluminium alloy) was used as matrix and reinforced with TiC using In-situ process. The Metal Matrix Composite (MMC) material, Al-.5%Cu/10%TiC developed exhibits higher yield strength, ultimate strength and hardness as compared to Al-4.5%Cu alloy. Percentage increase in yield and ultimate tensile strengths were reported to be about 15% and 24% respectively whereas Vickers hardness increased by about 35%. The higher values in hardness indicated that the TiC particles contributed to the increase of hardness of matrix.

ALUMINIUM SILICON CARBIDE

Aluminium silicate has high strength to weight ratio, which is three times more than mild steel. In addition, composites containing SiC (reinforcing material) and Al (matrix) have high modulus, strength values, wear resistance, high thermal stability, less weight and a more effective load carrying capacity compared to many other materials [16]. It is also expected that this composite will exhibit good corrosion/ oxidation properties since silicon carbide forms a protective coating of silicon oxide at 1,200°C [17].Aluminium is mixed with 10% SiC to increase the physical and mechanical properties of the composite. Wettability of aluminium based composite is usually improved by addition of Magnesium(Mg). The composite is fabricated by stir casting. X-ray diffraction and SEM Analysis is used to study the structure of the composite[14].

RESULTS AND DISCUSSION

The following results are shown when aluminium is mixed with 10% SiC.

Mechanical Properties

Density

The density of aluminium is around 2.60g/cm³ .The density of the composite was experimentally determined by the Archimedes Principle.At higher concentration [(Al(10%SiC)], the density was decreased 2.3125 g/cm³ which is about 11% improvement when compared to pure aluminium[17].

Tensile Strength

The increase in volume fraction of reinforcing particles initially decreases the micro yielding stress due to increase in number of stress concentration points (Chawla, 2006). Tensile behaviour was tested using computerized UTM testing machine as per the ASTM E-8 standards. Tensile Strength of pure aluminium is 236 N/mm², and the resultant hybrid composite of Al/(10%SiC) has tensile strength of 265 N/mm² which is about 12.28% improvement when compared to pure aluminium[17].

Yield Strength

Yield Strength was tested using computerized UTM testing machine as per the ASTM E-8 standards. Yield Strength of pure aluminium is 220 N/mm², and the resultant hybrid composite of Al/(10%SiC) has yield Strength of 257 N/mm² which is about 16.8% improvement when compared to pure aluminium[17].

Elongation

Elongation was tested using computerized UTM testing machine as per the ASTM E-8 standards. Elongation of unreinforced aluminium is 19.4%, and the resultant hybrid composite of Al/(10%SiC) has elongation of 18.2% which is about 6% improvement when compared to pure aluminium[17].

Hardness

Bulk Hardness was tested using standard Brinell hardness testing Machine. Load applied was 10kg and indenter used was square diamond indenter. Hardness value of pure Al is found out to be 79.9 BHN and after the addition of 10% SiC its hardness increased to 87.2 BHN which is about 9% improvement when compared to pure aluminium[17].

Table 1 Mechanical Properties of Al-SiC MMCs at various Composition [17]

Sample No.	Al grams	Composition wt in % SiC	Density g/cm³	Tensile Strength N/mm²	Yield Strength N/mm²	Elongation in %	Hardness (BHN)
1	100	0	2.7000	236	220	19.4	79.9
2	100	5	2.4660	248	236	19.0	85.3
3	100	10	2.3125	265	257	18.2	87.2

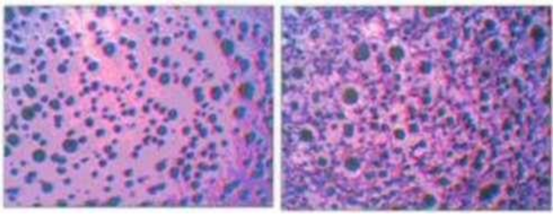
Aluminium Alloy Reinforced with Silicon Carbide and Fly Ash Hybrid Metal Matrix Composites

Aluminium alloy 2024 has good machining characteristics, higher strength and fatigue resistance than both 2014 and 2017[17]. Silicon carbide (SiC) is a compound of silicon and carbon[19]. Silicon carbide was originally produced by a high temperature electrochemical reaction of sand and carbon. The high thermal conductivity coupled with low thermal expansion and high strength gives this material exceptional thermal shock resistant qualities[20]. Fly ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants[21]. Aluminium when mixed with (10%) SiC and (10%) Fly ash which result in tremendous increase in hardness, wear resistance, and corrosion resistance of the resultant composite material when compared to the pure aluminium. These hybrid composite was fabricated by stir casting method and structural characteristics was studied by x ray diffraction studies and optical microscopy was used to study the microstructure of MMC.

Results and Discussion

Optical Micrographs of MMC

The morphology, density, type of reinforcing materials used and its distribution plays a vital role in influencing the properties of composites so it is necessary to distribute particles uniformly throughout the casting process to prevent segregation/agglomeration of particles during pouring and solidification. Magnesium is used to improve the wettability. The particles were not uniformly distributed in the case of Al/(5% SiC), Al/(10% SiC), Al/(5% fly ash) and Al/(10% fly ash) they tend to segregate, but aluminium composite were uniformly distributed in the presence of 10% SiC-10% fly ash[19].



(a) (b)

Fig 1 Optical micrograph (100X) of Al 2024 (10%SiC+10% fly ash). (a) before etching and (b) after etching[19].

Mechanical Properties

Density

In the study SiC and fly ash particles used have low density of around 2.2g/cm³The density of the composite was experimentally determined by the Archimedes Principle. At higher concentration [(Al(10%SiC+10%fly ash)], the density was decreased 2.06 g/cm³which was around 54% improvement when compared to resultant hybrid composite[19].

Tensile Strength

The increase in volume fraction of reinforcing particles initially decreases the micro yielding stress due to increase in number of stress concentration points (Chawla, 2006). Tensile behaviour was tested using computerized UTM testing machine as per the ASTM E-8 standards. Tensile Strength of pure aluminium is 236 N/mm², and the resultant hybrid composite of Al/(10%SiC+10%fly ash) has tensile strength of 293 N/mm² which is about 57% improvement when compared to resultant hybrid composite [19].

Yield Strength

Yield Strenth was tested using computerized UTM testing machine as per the ASTM E-8 standards. Yield Strenth of pure aluminium is 220 N/mm², and the resultant hybrid composite of Al/(10%SiC+10%fly ash) has yield Strenth of 287 N/mm² which is about 67% improvement when compared to resultant hybrid composite [19].

Elongation

Elongation was tested using computerized UTM testing machine as per the ASTM E-8 standards. Elongation of unreinforced aluminium is 19.4%, and the resultant hybrid composite of Al/(10%SiC+10%fly ash) has elongation of 11.9% which is about 75% reduction when compared to unreinforced aluminium[19].

Hardness

Bulk Hardness was tested using standard Brinell hardness testing Machine. Load applied was 10kg and indenter used was square diamond indenter. Hardness value of unreinforced Al is found out to be 79.9 BHN and after the addition of 10% SiC and 10% fly ash its hardness increased to 95.7 BHN[19].

Table 2 Mechanical Properties of Hybrid MMCs at various Composition[19]

Sample No.	Al(%) grams	Composition Weight in % Mg	SiC	Fly ash	Density g/cm³	Tensile strength N/mm²	Yield strength N/mm²	Elongation in %	Hardness (BHN)
1	100	1.5	0	0	2.6000	236	220	19.4	79.9
2	100	1.5	5	0	2.4660	248	236	19.0	85.3
3	100	1.5	10	0	2.3125	265	257	18.2	87.2
4	100	1.5	0	5	2.4400	245	233	16.3	80.6
5	100	1.5	0	10	2.2700	263	252	15.8	83.8
6	100	1.5	5	5	2.2000	276	262	14.4	88.2
7	100	1.5	5	10	2.1250	278	269	13.8	89.7
8	100	1.5	10	5	2.1170	285	275	12.8	93.9
9	100	1.5	10	10	2.0600	293	287	11.9	95.7

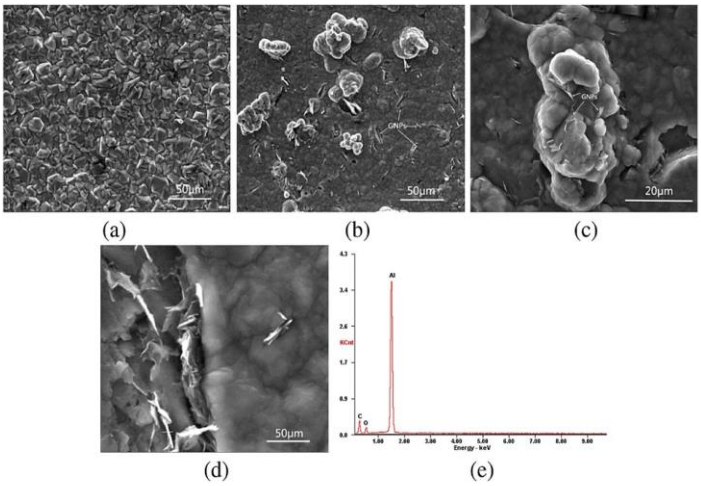
Aluminium Graphene

Graphene is a 2-dimensional material consisting of sp2 hybridized carbon atoms, having unique mechanical, thermal and electrical properties. In particular, graphene is specified by both superior tensile strength of 125GPa and Young modulus of 1 TPa [19]. Graphene, if used as reinforcement in Aluminium based MMCs can reduce the weight as well as improve the mechanical properties. CVD(Chemical Vapour Deposition) is used to synthesize wrinkled, curled, overlapped stacks of graphene sheets and then these graphene sheets are synthesize by Powder Metallurgy to form GNPs/Al composite. Microstructure and morphology are studied using Scanning Electron Microscopy (SEM) and EDS.

Results and Discussion:

SEM and EDS Analysis

The surface of Al-graphene composite coating changes significantly with high roughness and a good deal of asperities in comparison with pure aluminium coating shown in Fig 1(a). Graphenenano-platelets suspended in the electro-deposition solution move toward the cathode with the electro-deposition solution by magnetic stirring and get incorporated into the deposit along with the growing aluminium layer. The embedded graphenenano-platelets endow aluminium ions with abundant active nucleation sites due to its high large specific surface area and excellent electrical conductivity, which leads aluminium ions to be reduced on the surface of embedded graphenenano-platelets preferentially. This explains the appearance of Al-graphene composite coatings[19]. A lot of small bright white wires or sheets like structures marked with white arrows distribute on the surface of composites and they are graphenenano-platelets not being covered completely by aluminium coating shown in Fig 1(b) and EDS analysis is shown in Fig 1(e).



SEM images of (a) Al coating; (b) Al-graphene composite; (c) asperities in the composite coating; (d) higher magnification of composite with EDS; (e) EDS of selected point in (d). 524N. Li et al. / Materials and Design 111 (2016) 522–527

The distribution of carbonaceous composition along the straight line in and the carbon content is high at the position of bright white wire or sheet like structures, which demonstrates the distribution of graphenenano-platelets in the composite is shown in Fig 2.

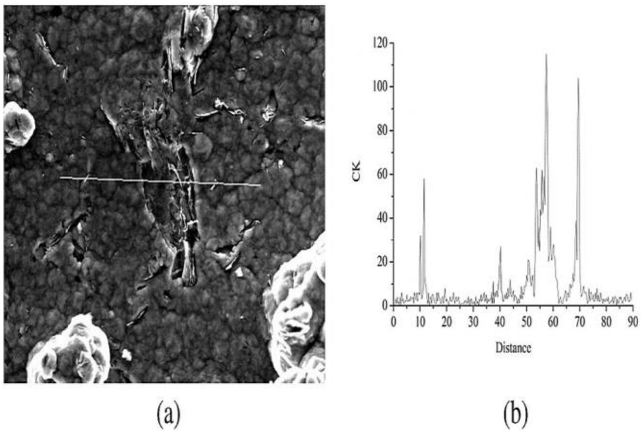


Fig. 2. SEM image of Al-graphene composite coating (a) and (b) EDS spectrum selected line in (a)[19].

Mechanical Properties

The following result are shown when Aluminium with 1.00GNPs:

Density

The density of the samples was calculated using Archimedes Principle. Before Extrusion, the density of Al is 2.70g/cm^3, after the addition of [(Al(1.00GNPs)] the density decreased to 2.6901g/cm^3. Similarly After Extrusion, the density of Al is 2.70g/cm^3, after the addition of [(Al(1.00GNPs)] the density decreased to 2.6911g/cm^3 [19].

Tensile Strength

Tensile behaviour was tested using computerized UTM testing machine as per the ASTM E-8 standards. . Before Extrusion, ultimate tensile strength of Al is 105MPa, after the addition of [(Al(1.00GNPs)] ultimate tensile strength increased to 108MPa. Similarly After Extrusion, the ultimate tensile strength of Al is 186MPa, after the addition of [(Al(1.00GNPs)] ultimate tensile strength increased to 203MPa[19].

Yield Strength

Yield Strength was tested using computerized UTM testing machine as per the ASTM E-8 standards Before Extrusion, yield strength of Al is 57MPa, after the addition of [(Al(1.00GNPs)] yield strength increased to 59MPa. Similarly After Extrusion, yield strength of Al is 112MPa, after the addition of [(Al(1.00GNPs)]yield strength increased to 145MPa[19].

Failure Strain

Failure Strain was tested using computerized UTM testing machine as per the ASTM E-8 standards. Before Extrusion, failure strain of Al is 18%, after the addition of [(Al(1.00GNPs)] failure strain increased to 10%. Similarly After Extrusion, failure strain of Al is 15%, after the addition of [(Al(1.00GNPs)]failure strain increased to 13%.[19]

Hardness

Bulk Hardness was tested using standard Vicker hardness testing Machine. It is observed that the hardness value increases with increase in GNPs composition in matrix. Before Extrusion, hardness value of Al is 69Hv, after the addition of [(Al(1.00GNPs)] hardness value increased to 77Hv. Similarly After Extrusion, hardness value of Al is 76Hv, after the addition of [(Al(1.00GNPs)] hardness value increased to 90Hv [19].

Table 3 Mechanical Properties of Al-Graphene at various Composition[19]

Sample No.	Condition	Al grams	GNPs Wt	Density g/cm³	Tensile Strength MPa	0.2%Yield Strain MPa	Failure Strain in %	Vickers Hardness (Hv)
1	Before Extrusion	100	0	2.7000	105	57	18	69
2		100	0.25	2.6991	119	58	27	71
3		100	0.5	2.6976	116	64	13	74
4		100	1.0	2.6943	108	59	10	77
5	After Extrusion	100	0	2.7000	186	112	15	76
6		100	0.25	2.6991	166	117	22	80
7		100	0.5	2.6976	175	120	08	85
8		100	1.00	2.6943	203	145	13	90

Aluminium and Titanium Carbide

Aluminium is used in wide areas and also lot of research is going on. The aluminium is cheeper than other material and also good mechanical properties, corrosive resistance and improve the strength by using reinforcement .there are many reinforcement for example (TiC,SiC,Al2O3,BN)[11]. TiC is one of the hardest material ,it has good thermal conductivity.by using the TiC is the reinforcement. The AL-TiC metal has higher hardness, good wear resistance, low density, young's modulus[11].

Experimental Procedure

The aluminium matrix composite of(AA7075)metal and titanium carbide of average size of 2μm is used for the reinforcement the material .the aluminium alloy is take into the furnace and melted at 800°C. after the melting the magnesium ribbon is added to the alloy so that the reinforcement of the matrix is dispersed[12]. The 2%TiC powder is added to the metal at 800°C to remove the moisture ,drift etc. while using stir casting process , it rotating at constant speed of 300rpm for 15 minutes the uniform mixture of matrix and reinforcement material. The metallic moulds is preheated at400°C.the cooled at room temperature while process is repeated for different percentage of TiC, the composite is carried by hardness test, wear test and microstructure[13].

Result and Discussion

Hardness Test

The test is conducted by Vickers hardness testing machine at room temperature of diamond 10mm diameter and load of 5kg is applied for three different place taking average hardness value of the material. The hardness of the material is 202GPa at 8%wt.the hardness of the material is decreases with increasing the weight of more than 8%.the hardness is maximum than other metal reinforcement matrix[13].

Tensile Test

The tensile strength of the material is increases by adding Tic. The elongation of the material is also increases of about 130MPa by adding 8%weight . there is increases in% of weight the elongation of the material is reduced . the TiC improves the mechanical properties[13].

Wear Test

The wear rate of the material is increasing % percentage of the TiC. the improvement hardness and reduced the area contact.the area of contact decreases the wear rate decreases.the wear rate minimum at 8%of weight.[13]

Micro structure

The micro structure is conducted by optical microscope and sem test microscopy. The micro structure of ALTiCof different % of weight.the uniform distribution of the reinforcement of material. one the most consideration of fabrication of material the solidification rate is achieve by intra granular distribution of particles during the stir casting process.[13]

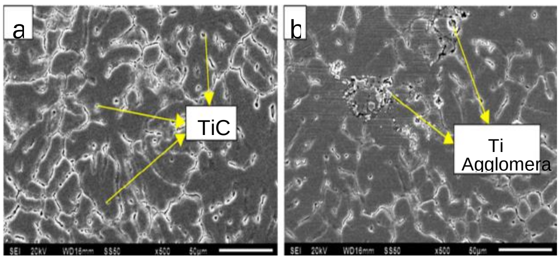


Fig 3. Reinforcement of Tic OF 8% and 10%

Aluminium Oxides(Al2O3)reinforcement

Aluminium alloys have good mechanical and physical properities compare to metals. while improving hardness, strength and wear resistance by using reinforcement of Al2O3 it has high density ,hardness and strength .the MMC is mostly used in automobile industry and aerospace because of its hardness and wear resistance[10]. In the present work, aluminium alloy reinforced with various percentages of Al2O3 particles (5, 10, 15 and 20 wt %) were prepared .the reinforcement of MMC is prepared stir casting process.it is the most economical method of froming metal matrix composites and also microstructure analysis ,hardness test , wear resistance also calculated[5].

Experimental Procedure

The composites used in the experiments are produced by the stir casting method .For Al-Al2O3 composite material ,Aluminium alloy powders are mixed with Aluminium oxide (Al2O3) particles of uniform size (400 μm) in the weight fraction of 5%, 10%, and 15%. Moisture in the particles is evaporated by adding the particle reinforcement into the matrix early in the process, before it disperses into the molten metal matrix. the wettability between the reinforcement particles and the metal matrix improves. All the samples are melted in the furnace for 2 hours at 700°C. The molten composite is then left to solidify on the ceramic plate inside the furnace.

Result and Discussion

Density

The density of Aluminium oxide (Al2O3) is relatively higher than the reinforcement of silicon carbide (SiC). the composite MMC are significantly lighter than gray cast iron of density 7.2g/cm3.the composite difference the pure aluminium alloy has density of 2.70 g/cm3and also the weight percentage of(5%,10%,15%,20%)has 2.73,2.86,3.02 g/cm3.compare to the silicon carbide of 20%wt has 2.81 g/cm3[5].

Tensile strength

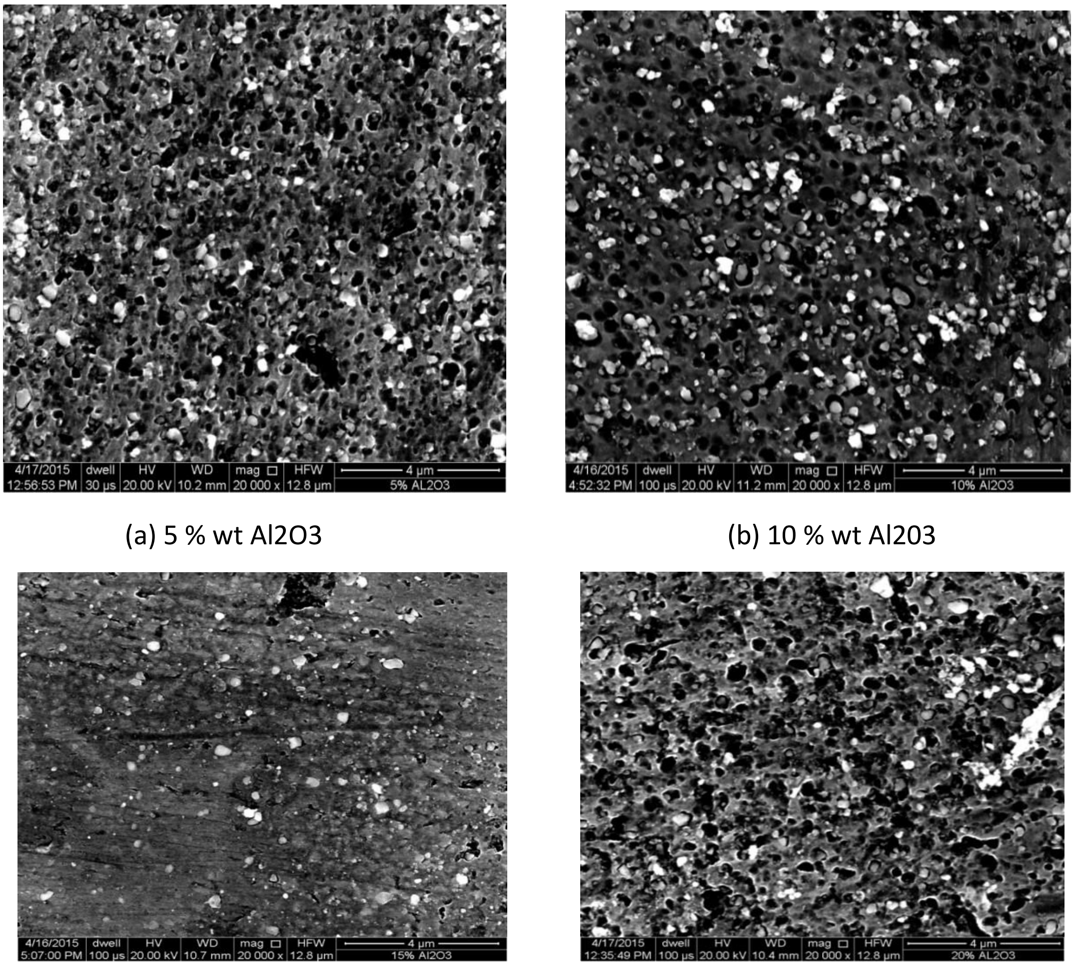
The tensile strength is measured by using Brinell and Rockwell Hardness test .the tensile strength is lesser than silicon carbide (SiC). the bonding of MMC is poor .if the bonding should be strength by reinforcement act as strengthening agent and it is filled in the pores of the metal composites which creates a stronger bonding.it show in Table no.4[5]

Table 4 Hardness and Tensile Strength of Al-Al2O3MMC

Composition with Al_2O_3wt%	Rockwell Hardness (HR)	Brinell Hardness (HB)	Tensile Strength (MPa)
100% Al	25	70	241.5
Al with 5%Al_2O_3	31	76	262.2
Al with 10%Al_2O_3	40	80	276.0
Al with 15%Al_2O_3	42	82	282.9

Micro Structure

The microstructure test is conducted by using optical microscopy and sem tester. Microscopy of different composites materials such as Al+5wt%Al_2O_3, Al+10wt% Al_2O_3, Al+15%Al_2o3,Al+20%Al203,as show in figures a,b,c,d. the uniformly distribution of reinforcement particles is. one the most consideration of fabrication of material the solidification rate is achieve by intra granular distribution of particles during the stir casting process.



(a) 5 % wt Al2O3

(b) 10 % wt Al203

(c) 15 % wt Al203

(d) 20 % wt Al203

Fig 5Micro structure of aluminium oxide

Conclusion

The literature review reveals the microstructure and various improvements occurred in the mechanical properties of aluminium Metal Matrix Composite due to the addition of various reinforcing materials such as SiC, TiC, Fly ash, Al_20_3, Grapheneetc..Stir Casting is used to fabricate the Aluminium MMC. Magnesium is used to improve wettability of MMC.

i. In comparison with the density of pure Al and its reinforcement, the density of fabricated Al Metal Matrix Composite is greatly reduced .

ii. Al with 10% SiC shows great improvement in the mechanical properties such as Hardness, Tensile Strength, Elongation etc..

iii. Al with 10%SiC and 10% Fly ash shows slightly greater improvement in mechanical properties in comparison with Al-SiC MMC due to the addition of fly ash.

iv. Al-Graphene is fabricated through powder metallurgy, after extrusion of Al MMC the mechanical properties increases, however Al-Graphene is quite costly when compared to other Al MMC.

v. Al with 8% TiC shows increase in mechanical properties, however increase in %TiC after results in decrease in mechanical properties.

vi. Al with 15% Al203 shows slighter improvement in mechanical properties in comparison with pure Al.

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