Effect of TiCp on AA2219 Metal Matrix Composite

[1]Jenkins Hexley Dhas S [2]Edwin Raja Dhas J
[1]Research Scholar [2]Professor & Deputy Director-Admissions
[1]Department of Mechanical Engineering
[1,2]Noorul Islam Centre for Higher Education, Nagercoil, 629180, India

Abstract

Composite plays a vital role in material science especially in the field of aerospace, marine, automobile, military and structural applications. It consists of two or more physically and chemically distinct phases. The composite has hybrid characteristics than those of individual components. Metal Matrix Composites (MMC) is those which are based on metals as matrix. Usually the reinforcing component is distributed in the continuous or matrix component. MMC focuses mainly on a relatively high strength and wear resistance applications. Aluminium Matrix Composites (AMC) is one in which Aluminium is the matrix and it has the property of high strength to weight ratio. The purpose of the work is to process and to determine the mechanical properties of AA2219-TiCp.Aluminum Matrix reinforced with TiC_p composite was produced using modified stir casting process. Five different weight % of TiC_p addition were performed without defects. The weight fractions used were 3%, 4%, 5%, 6%, 7%. The colour optical graphs, XRD, EDX analysis revealed the presence of TiC in the cast AMC. Tensile test, micro-hardness test shows the clear indication of considerable increase in Ultimate Tensile Strength(UTS) when the percentage of TiC_p addition was increased.

Keyword- Composite, Casting, Tensile Strength, Hardness, X ray Diffraction

---

I. INTRODUCTION

Composite material is defined as the combination of two or more distinct materials having a recognizable interface between them. Composite differs fundamentally from conventional engineering materials in that a second phase material is usually added to produce performance and characteristic not possible by monolithic material [Nami et al, 2011; Belete Sirahbizu Yigezu,etal. 2014, Mohsen Barmouz et al,2011].Composites based on metals and alloys are known as MMCs. In MMC matrices used are aluminium, magnesium and titanium reinforced with ceramic fibres, particles or whiskers are being investigated widely due to its higher specific strength and stiffness [Surya Sulaiman et al. 2014; Siddesh Kumar N.G,etal,2014; Rajeshkumar Gangaram Bhandare,etal,2014]. Aluminium matrix composite plays an important role in structural applications due to high strength to weight ratio at room or elevated temperatures. Now various researchers are interested in finding composites which have better mechanical property [Ramesh et al. 2010; Bharath et al, 2012; Mallesh G et al, 2015; Shubham Mathur et al. 2013]. Best production methods are also required for preparing the composites in a better quality. Aluminium metal matrix composites have been found to be quite useful in a number of engineering applications. However, the presence of hard ceramic particle reinforcement makes difficult in machining and a challenging task. Many approaches were used for the fabrication of MMC. If the wet ability and distribution of reinforced material are good then the mechanical properties of the MMC were increased. So the method of production of MMC plays a vital role in the qualities of MMC [Malek Ali, et al,2012]. Table 1 shows the chemical composition of the materials AA2219.

Elements	*Cu*	*Mn*	*V*	*Zr*	*Ti*	*Al*
Percentage	*6.3*	*0.3*	*.10*	*0.18*	*0.06*	*93*

Table 1: Chemical Composition of AA2219

In stir casting mixing of articulate with metal matrix is by mechanical stirring .Mixing is a very important character in MMC which will improve its mechanical properties but in stir sting method mixing is not proper also atmospheric reactions are un avoidable [Pardeep Sharma et al. 2015; Boon peng chang et al. 2015; Balasivanandha Prabu S et al. 2006; Ajay Singh et al. 2013].So the modified stir casting was adopted to minimize these effects [Gopalakrishnan S, et al, 2012].

II. PRODUCTION OF AMC

AMC having AA2219 metal matrix and TiC_p reinforcement less than two microns were produced by stir casting process. Due to improper mixing and atmospheric reaction modified stir casting was used in an argon atmosphere. AA2219 metal matrix blanks

were cut in to small size rods by EDM and introduced in the crucible furnace. The temperature of the furnace is increased to 700^{o}C and aluminium rods were melted. Magnesium (1% by weight) was added to promote the wetting between matrix and reinforcement. Proper stirring of magnesium was done, Argon gas was supplied at 21pm inside the crucible to prevent the atmospheric reaction during mixing. The furnace temperature was again raised to70^{o}C above the melting point of the metal to compensate the losses during cooling. TiC_p was added in to the metal matrix at the required percentage and continuous stirring was done. The temperature was measured using thermocouple. Then the liquid AMC was poured in to the die which is kept below the crucible in a pre-heated condition by operating the handle .Again stirring was continued during pouring for proper distribution of reinforcement. After cooling the casting were taken out of the die having various percentage of TiC_p reinforcement from 3 to 7% were casted. The castings of AMC were shown in Figure 1.

Fig. 1: Castings of AMC

The runner and riser were removed from the casting by EDM; visual inspection was carried to find the surface defects if any. The TiC_p present in the castings were identified by optical micrograph and x ray diffraction test.

III. RESULTS AND DISCUSSION

The tensile strength test specimen of 3 numbers were prepared as per ASTM standard E08 and the test was carried out in TUE C-1000 at room temperature. The observed readings are shown below in Table 2. The figure 2 and 3shows the effect of % of TiC_p on ultimate tensile strength and percentage of elongation.

Sl.No	*Percentage of Titanium Carbide*	*Tensile Strength Mpa*	*Percentage Elongation*
1	*0*	*170.00*	*10.12*
2	*3*	*179.00*	*8.23*
3	*4*	*201.00*	*7.12*
4	*5*	*215.00*	*6.69*
5	*6*	*234.00*	*6.37*
6	*7*	*234.00*	*6.37*

Table 2 Mechanical Properties

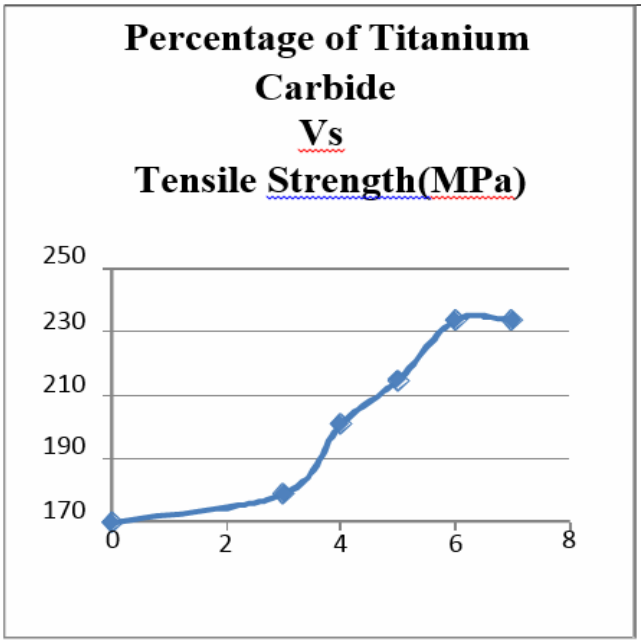


Fig. 2: Percentage of TiC_p on Ultimate Tensile Strength.

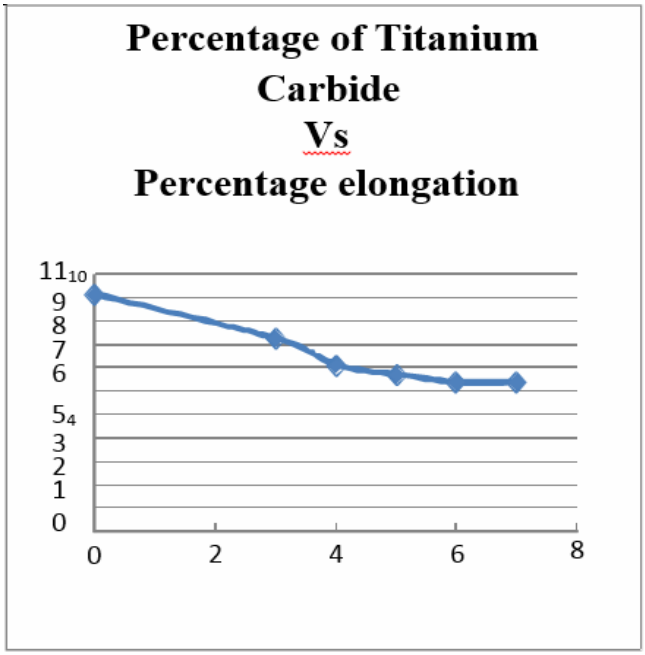


Fig. 3: Percentage of TiC_p on Elongation.

A. Effect of % of TiCp on Tensile Strength and Elongation

From Table 2 the tensile strength of AMC increases with the increase in percentage of TiC_p.The values increases from 3% to7%.This may be due to the reason that the bonding made by the reinforcement is more and it gives resistance to deformation. One important requirement is the percentage of elongation for the composite it decreases in small amount as the % of titanium carbide increases.

B. Micro Structure Analysis

The microstructure of AA2219 alloy is having aluminium matrix and TiCp. The particle distributions were identified by visual inspection. It was identified that the composite material made by the investigated processing technique had a cast microstructure of the matrix with particles distributed homogeneously. The grain sizes were reduced as the percentage of TiCp was increased. Also no pores were identified in the micro structure shown in figure 4 and figure 5.

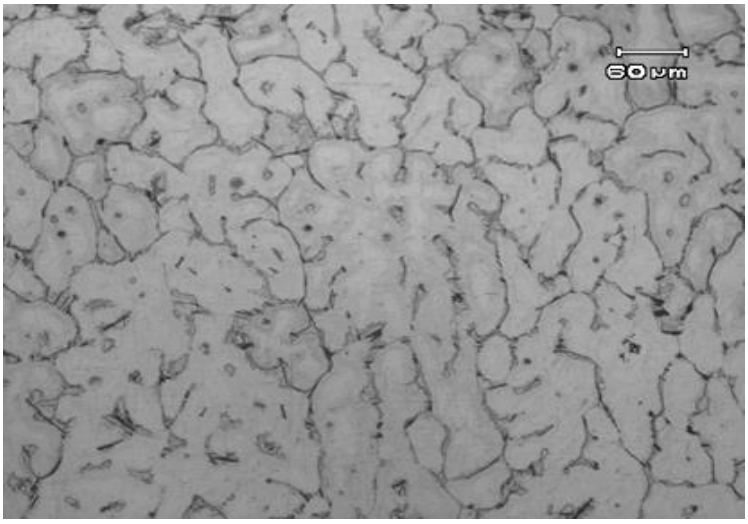


Fig. 4: Optical photomicrographs of AA 2219+ TiCp 3%

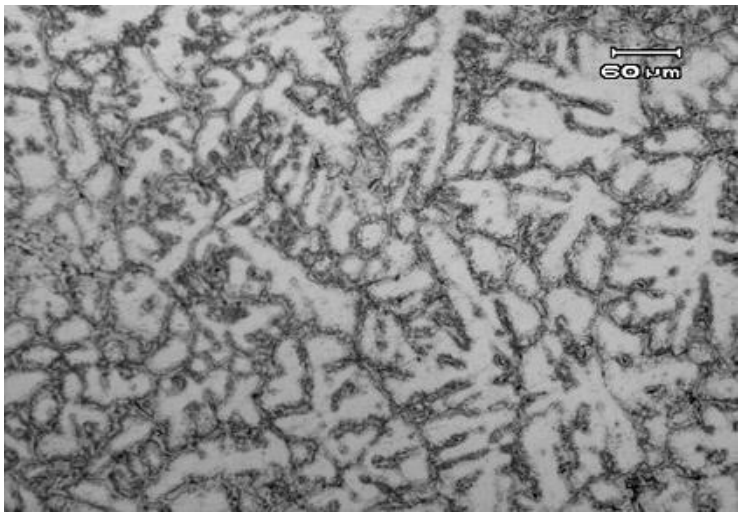


Fig. 5: Optical photomicrographs of AA 2219 + TiCp 7%

C. XRD Test

XRD TEST reveals that the presence of TiCp in Aluminium matrix for TiCp 6% .It is shown in figure 6. Thus the presence of TiCp in Aluminium matrix is conformed.

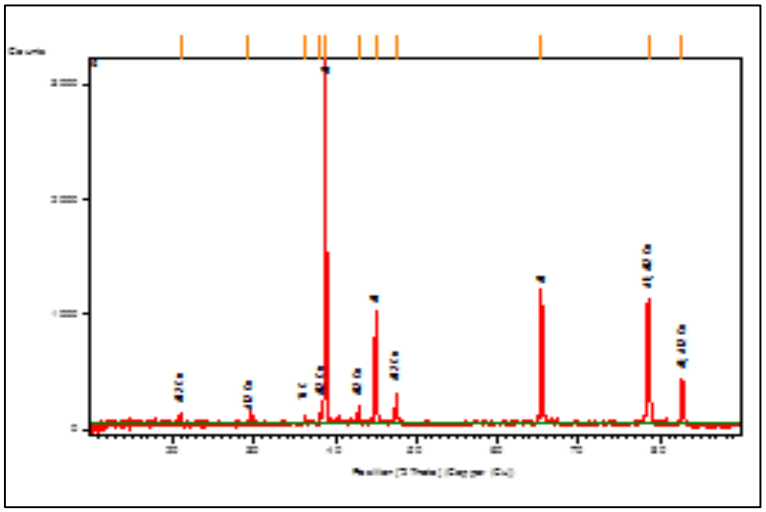


Fig. 6: XRD Pattern – TiCp6%

D. EDS Test

The EDS test shows the % of elements at various points with and without TiC particles. EDS test reveals the presence of TiC in Aluminium matrix for particle spectrum 1 and not presence for particle spectrum 4.The elements are shown in table 3 and 4.The SEM for the elements are shown figure 7 and 9.The EDX test for the elements are shown in figure 8 and 10.

Element	*Weight%*	*Atomic%*
C K	*20.74*	*51.06*
Ti K	*79.26*	*48.94*
Totals	*100.00*	*100.00*

Table 3: Element % for spectrum 1

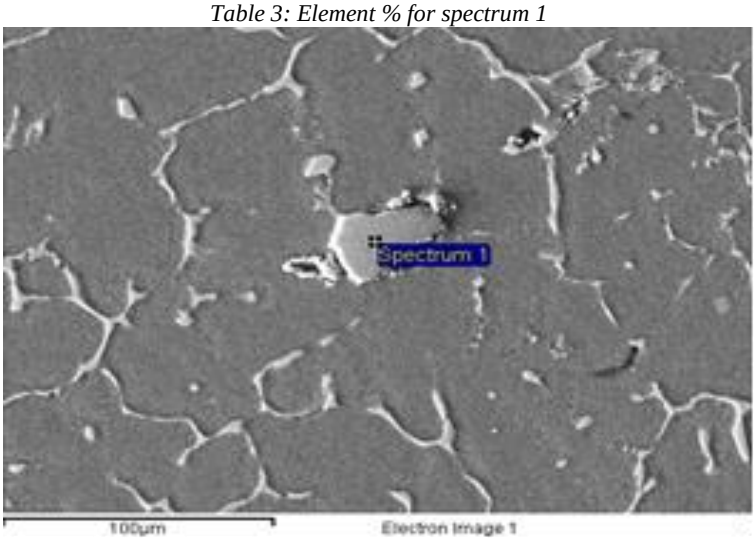
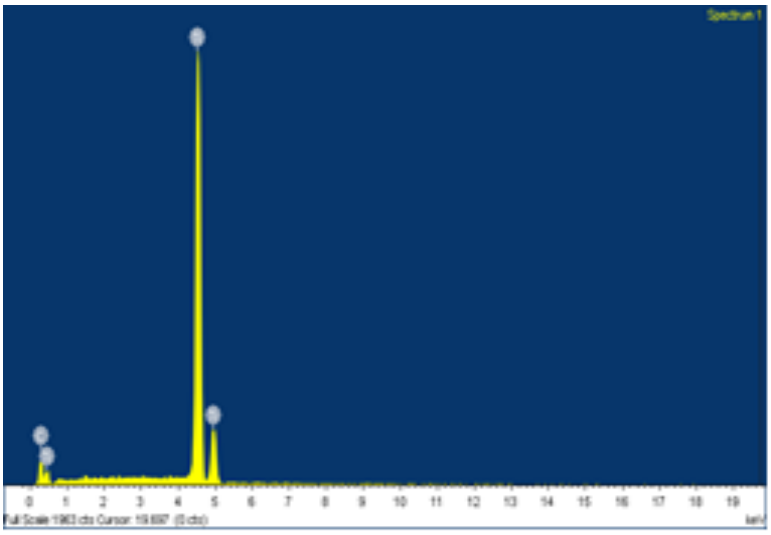


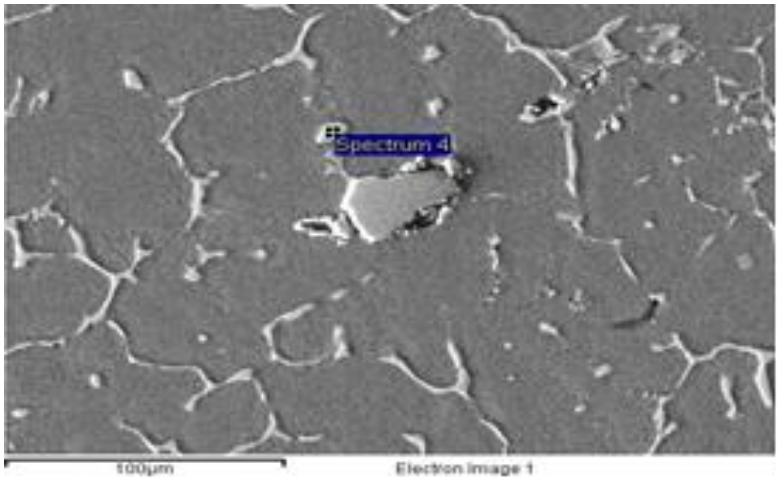
Fig. 7: SEM test for spectrum 1



Fig, 8: EDS test for spectrum 1

Element	*Weight%*	*Atomic%*
Al K	*48.22*	*68.68*
Cu K	*51.78*	*31.32*
Totals	*100.00*	*100.00*

Table 4: Element % for spectrum 4



Fig, 9: SEM test for spectrum 4

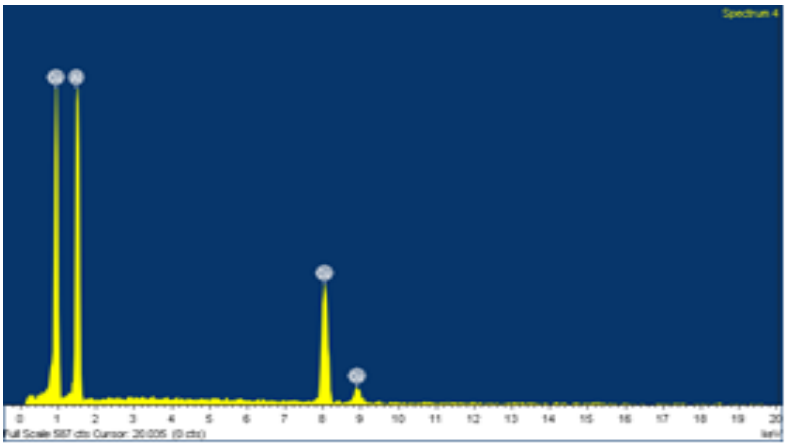


Fig. 10: EDS test for spectrum 4

E. Micro Hardness

The table 5 shows the hardness values of various percentages of TiCp .The values are measured at lower, middle and top of the castings for. Each percentage of TiCp .The average of these values are plotted. The other parameters which decide the micro hardness values are cooling rate, gravity effect and non-uniform distribution of the particles. The micro hardness value of the composite increases as the % of TiCp increases. This shows the effect of TiCp on the hardness of the composite.

Specimen ID	*Microhardness Values VHN Load :100gf*
AA 2219 + TiCp 3%	*142*
AA 2219 + TiCp 4%	*145*
AA 2219 + TiCp 5%	*147*
AA 2219 + TiCp 6%	*149*
AA 2219 + TiCp 7%	*151*

Table 5: Micro hardness value

IV. CONCLUSION

The approach of casting by modified stir casting technique was useful for making aluminium matrix composite. During the initial stage of heating moisture in the titanium particles and the matrix material is burn off and thus reduces the porosity, proper mixing is evidenced by micro structure, XRD, EDX test. The tensile test, micro hardness test shows the increase of tensile property and hardness value when the percentage of TiC increases. The percentage of elongation of the composite is slightly decreased when the percentage of TiCp increases.

REFERENCES

[1] Ajay Singh, Love Kumar, Mohit Chaudhary, Om Narayan, PallavSharma, Piyush Singh, Bhaskar Chandra Kandpal, Som Ashutosh, (2013),Manufacturing of AMMCs using stir casting process and testing its mechanical properties, International Journal of Advanced Engineering Technology;vol. Iv,(No.iii),pp. 26-29.

[2] Balasivanandha Prabu S , Karunamoorthy L , Kathiresan S ,Mohan B,(2006),Influence of stirring speed and stirring time on distribution of particles in cast metal matrix composite, Journal of Materials Processing Technology (No.171), pp.268-273.

[3] Belete Sirahbizu Yigezu, D. Venkateswarlu, M.M. Mahapatra, P.K. Jha, N.R. Mandal, (2014), On friction stir butt welding of Al + 12Si/10 wt% TiC in situ composite, Materials & Design, Vol.54,pp.1019-1027.

[4] Bharath V, Mahadev Nagaral, Auradi.V, (2012),Preparation, characterization and mechanical properties of Al2O3 reinforced 6061Al particulate MMC's, International Journal of Engineering Research and Technology,(No. 1),pp.1-6.

[5] Boon peng chang, Hazizan Md Akil, Ramdziah Bt Nasir,Abbas Khann , (2015),Optimization on wear performance of UHMWPE composites using response surface methodology , Tribology International,No. 88,pp. 252-262.

[6] Gopalakrishnan S, Murugan N (2012),Production and wear characterization of AA6061 matrix titanium carbide particulate reinforced composite by enhanced stir casting method ,Composite part B; vo.l43,pp.302-308.

[7] Malek Ali, Fadhel M.I, Alghoul M.A, Zaharim A, Sopian K,(2012),Synthesis and characterization of aluminum matrix composites reinforced with various ratio of TiC for light devices, International Journal of Models and Methods in Applied Science,pp.169-174.

[8] Mallesh G, Manjunatha H. S, Pradeep Kumar V. G, Rakesh D. R,(2015),Mechanical and tribiological properties of aluminium A16061 alloy reinforced with SiCp, International Journal of Emerging Technology and Advanced Engineering Technology,vol. 5,pp.111-117.

[9] Mohsen Barmouz, Mohammad Kazem Besharati Givi,(2011),Fabrication of in situ Cu/SiC composites using multi-pass friction stir processing: Evaluation of microstructural, porosity, mechanical and electrical behavior Composites Part A: Applied Science and Manufacturing, Vol.42(No.10),pp.1445- 1453.

[10] Nami, H. Adgi, M. Sharifitabar, H. Shamabadi, (2011), Microstructure and mechanical properties of friction stir welded Al/Mg2Si metal matrix cast composite, Materials & Design, Vol.32(No. 2), pp.976-983.

[11] Pardeep Sharma, Dinesh Khanduja, Satpal Sharma,(2015),Dry sliding wear investigation of Al6082/Gr metal matrix composites by response surface methodology ,Journal of Materials Research and Technology,

[12] Rajeshkumar Gangaram Bhandare, Parshuram M. Sonawane,(2014),Preparation of aluminium matrix composite by using stir casting method and it's characterization, International Journal of Current Engineering and Technology; (no.3),pp.148-155.

[13] Ramesh D, Swamy R.P , Chandrashekar T.k , (2010),Effect of weight percentage on mechanical properties of frit particulate reinforced Al6061 composite , Journal of Engineering And Applied Sciences;Vol.5(No.1),pp. 32-36.

[14] Shubham Mathur, Alok Barnawal , (2013),Effect of process parameter of stir casting on metal matrix composites, International Journal of Science and Research; Vol.2,pp.395-398.

[15] Siddesh Kumar N.G, Ravindranath V.M, Shiva Shankar G.S , (2014),Mechanical and wear behavior of aluminum metal matrix hybrid composite, Procedia Materials Science; Vol.5,pp. 908 -917.

[16] Surya Sulaiman, Shamsuddin Sulaiman, Nur najmiyah Jaafar , Nor imrah Yusoff, (2014),Studies on tensile properties of titanium carbide (TiC) particulates composites Journal of Advanced Materials Research ; Vol.903,pp. 151-156.

