Evaluation of Tribological properties of Hybrid MMC by varying weight percent of $B_4C$and TiC

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Abstract

Innovative materials are utilized in, flight and marine industry for this reason another class of materials known as composites have come into picture .Over the most recent two decades this field have risen as of indispensable significance. Right now conversation of characterisation and mechanical properties of one such half and half MMC have been examined. An Aluminum combination 2011 has been produced for study and the results of two fortification in that base material have been talked about. The fortification that are considered are B4C and Titanium Carbide and their variety in level have been analysed on Al-2011. The SEM, optical micrographs, alongside that hardness test and wear investigation have been performed. Vickers hardness,and Pin-on disc arrangement.

Keywords: Stir Casting, Composite, SEM, Vickers micro hardness, Charpy Test, Pin-on-disc.

1. Introduction

Aluminum is has gotten an essential material in Aerospace industry, one of its significant composite of utilized is grade Al-2011 this combination is a copper based compound for example the major alloying component is copper. So as to outfit this amalgam with all the more better properties composites can be created out of this evaluation, which will prompt the expansion of fortifications into the network material in this manner helping in upgrade of mechanical properties. Composites of Aluminum has increased more acknowledgment in composites industry as a result of its light weight and simple accessibility [1, 2].

Flying and current airplanes are utilizing aluminum for making numerous parts of Aluminum on account of its non-destructive properties [3]. The dispersal of unbending particles of earthenware production into the effectively deformable Aluminum framework empower us to builds the elasticity, hardness, thickness and wear obstruction of Al and its composites [4]. The elements of the particulates assume a significant job in building up the properties of material. The key component of Boron Carbide B4C is to improve hardness of the composite by halting the development of edge separations [5]. While Titanium Carbide, Al2SiO5 is a silicate mineral.Titanium Carbide has a high softening point and incredible stubborn properties alongside that it likewise assists with improving consumption opposition and has high jerk obstruction . Barbara Previtali et al. [5] created composites utilizing conventional lost wax throwing methods and found that Silicon Carbide gives more scraped spot obstruction when contrasted with Boron Carbide. S.Rama Rao et al. inspected the properties (mechanical) [6] in the Al 6061 delivered by two stage mixing. K. Kalaiselvan et.al [7] saw that B4C particles diffuse into the lattice of aluminum effectively on account of the similitudes in densities and therefore it additionally prompted legitimate blending of the paticulates into the liquid metal which prompted powerful mixing and by utilization of proper procedure parameter composite was manufactured.

2. Experimental Procedure

Different methods can be executed out of which right now based Stir cating course have been picked, the heater is warmed to a temperature of around 750 Degree Centigrade to dissolve the aluminum. Aluminum is included the heater by in type of little blocks known as ingots of Al-2011.. Fortifications are warmed in advance for better bond with the lattice .Mechanical blending is done for a time of 7 minutes at 640 rpm of normal mixing speed. After the finish of the procedure the liquid metal has been poured a bite the dust. The temperature at which it is administered was held at 680 degree Centigrade. The dissolve is then permitted

to cement in the form. Therefore the Metal Matrix Composite is created. This analysis is rehashed for two diverse rate structure of fortification. The size of fortification is 200 work size of Boron Carbide and Titanium Carbide of 74 micrometer size into the liquid metal.

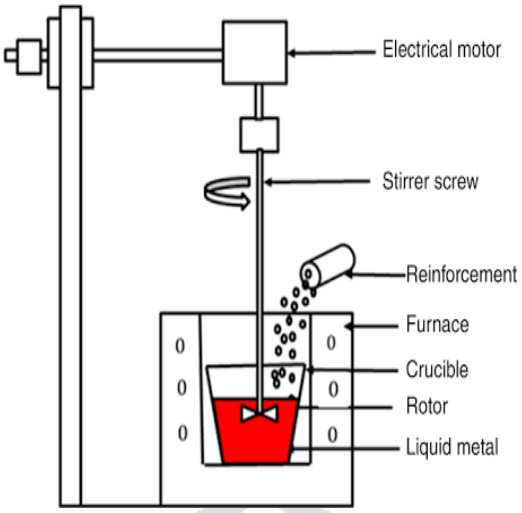

Figure 1. Set up for Stir casting Equipment

Casted Specimens are as follows :

- With 0% Titanium Carbide and 5% B_4C in Al-2011
- With 5% Titanium Carbide and 0% B_4C in Al-2011
- With 10% Titanium Carbide and 10% B_4C in Al-2011
- With 5% Titanium Carbide and 5% B_4C in Al-2011
- With 10% Titanium Carbide and 0% B_4C in Al-2011
- With 0% Titanium Carbide and 10% B_4C in Al-2011

Table 1: Shows various parameters of stir casting route

Parameters	**Value**
Temperature of furnace	750˚C
Temperature of preheated of reinforcement	350˚C
Temperature of preheated die	200˚C
Spindle speed	640 rpm
Stirring time	6 minutes

Figure 2. The casted specimen

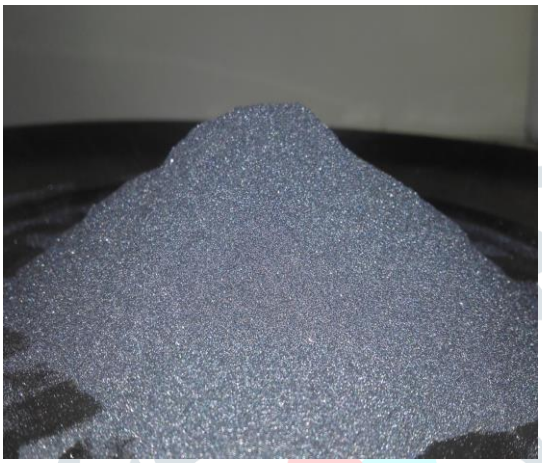

Figure 3.Boron Carbide particles of 54 micro-metre

Figure 4. TiC Particle of 64 micro-meter

3. Results

Optical Micrograph

The structure is analyzed under optical microscope and it has been observed that particles are fairly distributed in the matrix thus resulting to good wettability and adhesion of the particle to the matrix.

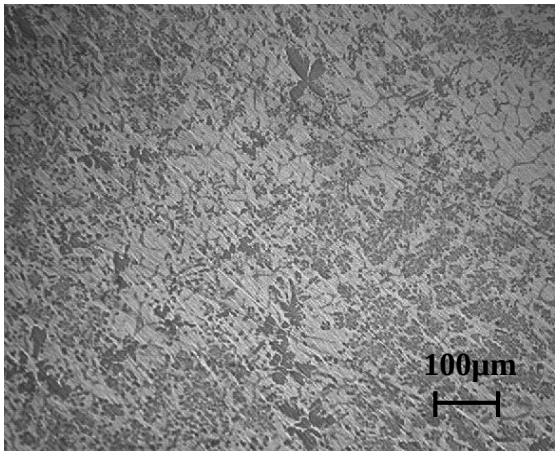

Figure 5. shows optical image of Al 2011 With 5 % B_4C reinforcement

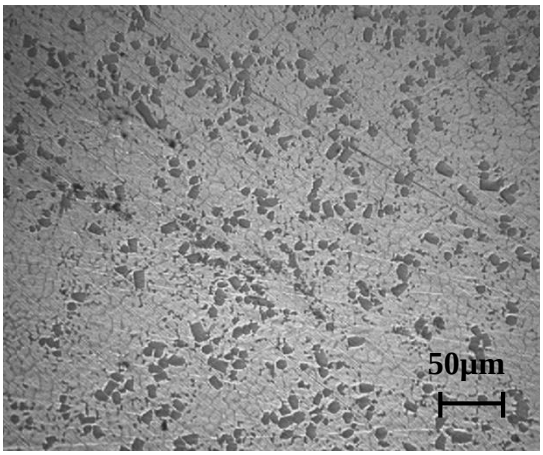

Figure 6. shows optical image of Al 2011 with 5 % B_4C and 5% Titanium Carbide

4. SEM Images

Samples are fabricated with sample size of 5mm thickness and 20mm diameter and with the help of emery paper of different grade they are polished i.e. 150,220,400,600,1000,1500 and 2000 grit size after that disc polishing with diamond paste is done followed by etching process,with a freshly prepared keller reagent that was made of distilled water and hydrofluric acid.

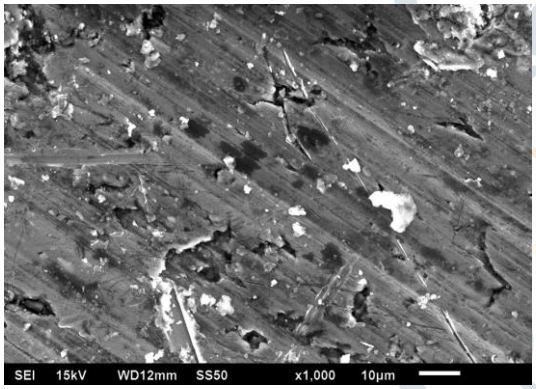

Figure 7. shows SEM image of Al 2011 With 5 % B_4C and 5 % Titanium Carbide

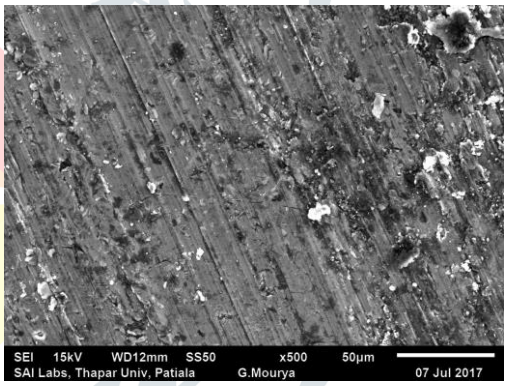

Figure 8. shows SEM image of Al 2011 with 10 % B_4C and 10% Titanium Carbide

Different methods can be executed out of which right now based Stir cating course have been picked, the heater is warmed to a temperature of around 750 Degree Centigrade to dissolve the aluminum. Aluminum is included the heater by in type of little blocks known as ingots of Al-2011.. Fortifications are warmed in advance for better bond with the lattice .Mechanical blending is done for a time of 7 minutes at 640 rpm of normal mixing speed. After the finish of the procedure the liquid metal has been poured a bite the dust. The temperature at which it is administered was held at 680 degree Centigrade. The dissolve is then permitted to cement in the form. Therefore the Metal Matrix Composite is created. This analysis is rehashed for two diverse rate structure of fortification. The size of fortification is 200 work size of Boron Carbide and kyanite of 74 micrometer size into the liquid metal.

5. Hardness Test

The Hardness of the threw example is assessed by Vickers miniaturized scale hardness. The small scale hardness of cleaned tests was estimated utilizing vickers hardness analyzer. Vickers miniaturized scale hardness test were performed by ASTM E384 (American Society for Testing and materials) standhard on

the created test. For vickers microhardness test we arranged example by cutting little example from created cylinderical bar then with the assistance of emery paper of diiferent grade 150,220,400,600,1000,1500 and 2000 we clean the example afterand mount in the barrel shaped glass with the assistance of mounted machine by keeping up the weight of between 100-120 and subsequent to mounting accomplished for cleaning with assistance of plate cleaning machine at 345 rpm for 15 minutes mean while we splash the jewel shower on the disc.The vickers microhardeness test were performed on totally manufactured example at a heap of 100g and a stay time 10seconds we take 3 perusing for each example.

Table 2: Vickers hardness sample reading

Titanium Carbide	Boron carbide	First reading	Second reading	Third reading	Forth reading	Fifth Reading	Final reading
0%	5%	195	162	286	275	245	232
5%	0	132	129	115	130	132	127
5%	5%	277	111	233	258	129	201
0%	10%	175	280	298	248	285	257
10%	0%	111	112	116	105	110	110
10%	10%	109	275	280	101	287	210
Al	2011	160	153	156	151	154	154

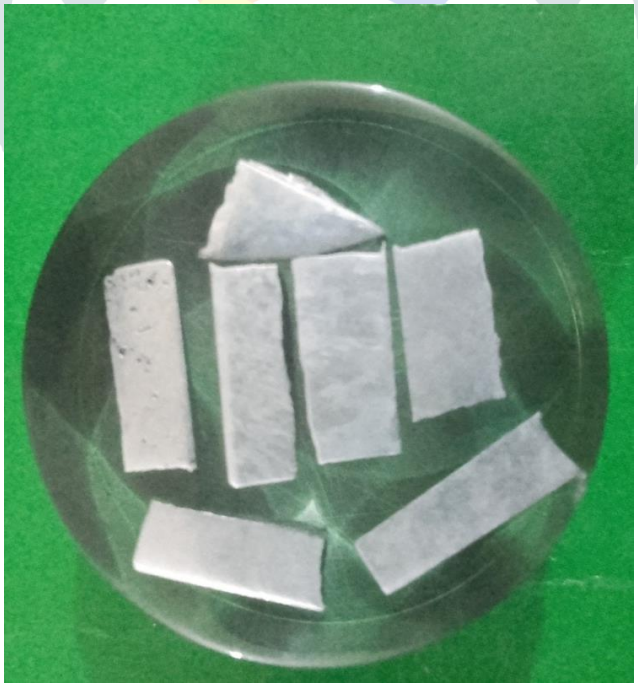

Figure 9. Specimen for Hardness sample

Be that as it may, if there should be an occurrence of created test of 50-50 gram boron carbide and Titanium Carbide and 100-100 gram of boron carbide and Titanium Carbide test the estimation of hardness is increment from the base combination because of more infulence of boron carbide of molecule on the example.. It was additionally seen that the estimation of hardness is decline as we increment the volume part of support if there should arise an occurrence of aluminum Titanium Carbide created test while on the

different handhardness there was noteworthy improvement in vickers hardness as we increment the volume division of reinforcemnt if there should be an occurrence of aluminum boron carbibe test. The hardness was incresed as level of boron carbide expansion expanded in the grid this might be credited in view of increment within the sight of hard boron carbide artistic particles in the base combination and lessen the grain limit of base lattice amalgam. Thus expanded substance of fortification in the 2011 combination prompts impedes the free development of disengagements and upgrades the hardness of the created aluminum boron carbide composites.

6. WEAR TEST

Wear test was conducted employing a pin on disc tribometerwith programmable closed furnace chamber. The sample were prepared according to ASTM G99 standhard. The fabricated sample were prepared on the CNC lathe machine with 30mm diameter and 10mm length and having a notch radius of 5mm. The specimen was hold on the pin disc holder and tested against the hardned EN32 steel having hardness of 65HRC.The wear tests of specimen had been carried out by varying the load from 2N, 4N, 6N, and keeping other parameter constant such as sliding distance 100mm speed 500 rpm and and tests were carried out at normal room temperature. The wear test was performed for each sample included base metal and test was performed for 2 minutes for each sample.

Figure 10. shows Pin on Disc

The cylinderical sample was hold in the pin on disc holder and tight with the help of key mean while we put weight of 2 kg in the initial stage of the of the test and the disc was rotating at 500rpm for 2 minutes time and wear graph continously show on the monitor for 2 minutes. As per our constrints we just focus on the effect of varing volume percentge of reinforcement and load.We take both parameters and analysis what was the affect of these parameters.

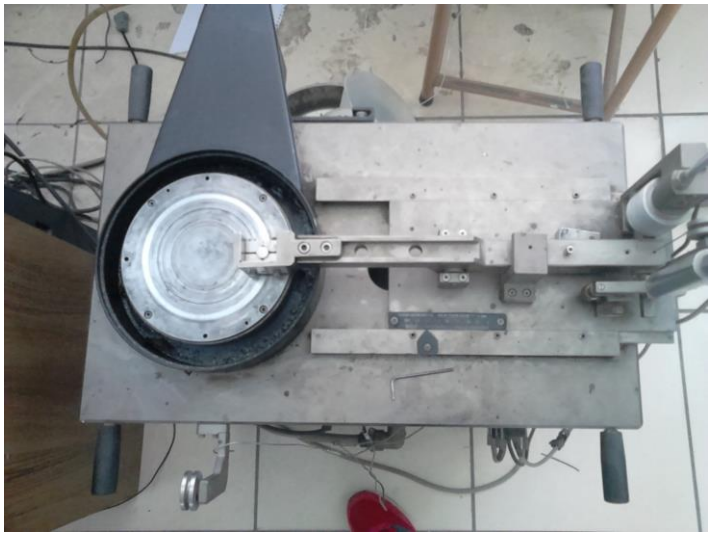

Figure 11. shows Pin on Disc setup

The wear rate wear is mainly depends on following parameters such as the volume percentage of reinforcement, applied load, sliding speed and sliding distance.It was also observed that as weight loss of specimen was depends on mainly two parameters that were weight and percentage of the reinforcement. In pin on disc test the weight loss of different sample was observed and found that the weight loss of all sample was less as compared to base metal.

Table 3: Weight loss in Wear Test

Titanium Carbide	Boron carbide	Initial weight	Weight loss after 2Kg	Weight loss after 4 Kg	Weight loss after 6 Kg
50	0	6.513	0.002	0.003	0.005
0	50	6.889	0.003	0.003	0.004
50	50	6.768	0.002	0.002	0.003
100	0	6.598	0.001	0.002	0.002
0	100	6.963	0.002	0.003	0.004
100	100	6.961	0.001	0.002	0.003
Base	Metal	6.974	0.003	0.005	0.007

It was clear from the given table that as we increase the weight percentage of reinforcement less will be material removal hence increase in weight percentage of reinforcement was inversely prepositional to weight loss. While as we increase in the load the material removal was increase, among the entire sample the sample that was made up of Titanium Carbide particle has less wear among the entire fabricated sample. The result revealed that as we increase the volume percentage of the reinforcement reduce the wear rate of the sample it is because as we increase the volume percentage of reinforcement increase the rigidity of the composites and reduce the wear rate. It was also observed that the presence of hard particle such as boron carbide particle in the aluminium metal matrix reduces the direct load between matrix portion of the sample and counter disc.

7. Conclusion

After fabrication of aluminum metal matrix composites via stir casting process we come to conclude that:-

1. The hybrid aluminum matrix composites can have high hardness value as compares to the base alloy due to presence of boron carbide particles.
2. AMCs can have high strength as compared to the base alloy.
3. The wear resistance of AMCs can also be increased with the proper distribution of reinforcement in matrix phase.
4. The fabricated aluminum matrix composites also increased the corrosion resistance properties due to the presence of Titanium Carbide particle as the reinforcement material.
5. Boron carbide particles increase the corrosion rate of the fabricated composites.
6. It can be found that a homogeneous spreading of Titanium Carbide and B_4C phase is present in hybrid AMC's.

Different procedure parameters impact the creation of the composites, for example, temperature of liquid metal, preheated temperature of support, preheated temp of pass on, shaft speed, blending time and powder feed rate. After manufacture of aluminum metal lattice composite by means of fluid mix throwing process we finish up the base mixing time is helpful of creation procedure and greatest temperature of heater can prompt greater porosity because of entanglement of encompassing gases in the liquid metal. Preheating of support was utilized to expel the dampness substance of fortification and preheating of pass on was utilized to keep away from the shrinkage. Magnesium is helpful to build the wettability of the aluminum metal grid composite in mix throwing process. After manufacture was finished the example goes under various test, for example, thickness, sway quality, hardness, wear and consumption test to look at the physical and mechanical properties of created example with the base grid composite. It was seen that the thickness of AMMC was diminished in the event of aluminum boron carbide test because of less thickness of boron carbide when contrasted with the base aluminium anyway there was marginally increment in the thickness of the composite if there should be an occurrence of aluminium Titanium Carbide test because of greater thickness of Titanium Carbide in contrast with base framework. If there should arise an occurrence of hardness it was discovered that the manufactured example made of boron carbide have high hardness esteem when contrasted with aluminum Titanium Carbide created test since boron carbide is third hardest material behind jewel and cubic nitrite. Optical magnifying lens result uncovered that there was legitimate dissemination of fortification in aluminum metal framework composite because of choice of appropriate parameters of the mix throwing course such blending time, mixing velocity and temperature of heater.

8. Reference

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