THINK INDIA JOURNAL

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Effect of Boron Carbide and Kyanite on The Corrosive Properties of Aerospace Based Aluminum-Copper Alloy

Sayantan Bhattacharya[1]

[1,] School of Mechanical Engineering, Lovely Professional University, Punjab, India

bhattacharya.sayan91@gmail.com

Abstract

The most significant matrix material for fabricating composite is aluminium as it has a vital role in each and every industry i.e. marine, automobile, nuclear industries due to its low density and good mechanical properties. To enhance the strength and mechanical properties of aluminium matrix composites, it is reinforced with different reinforcement. This research is focused on fabricating and comparing single and dual reinforcement inaluminium MMC with B_4C and Kyanite via stir casting route. The weight percent are varied and single and dual reinforcement have been introduced in Al 2014. The optical micrograph and corrosion analysis is done.

Keywords: Stir Casting, Composite, Corrosion Testing

Introduction

The 2XXX series of aluminium alloys are copper based,i.e.the major alloying element is copper though traces of other elements like magnesium and other elements may be present.Aluminium grade 2014 is an alloy which require improve corrosion resistancethis series of alloys are widely used in aircraft where their high strengths.The infusion of the reinforcement into the matrix material helps in enhancing mechanical, thermal, corrosive etc. properties of base metal. Out of many engineering metals aluminium has become the most vital metal for fabricating metal matrix composites because of its light weight and easy availability [1]. Aluminiummetal based compositeshave a wide application in aircraft, aerospace, auto-mobiles and various other fields [2]. The stability of the reinforcements is an important criterion or else it will decompose and the required result cannot be obtained from the respective composite. In metal matrix composite we generally add ceramics as reinforcement in order to obtain a miscellaneous property of both metal and ceramics together.The different reinforcements offer different mechanical properties to the base metal like SiCincreases the tensile strength, hardness, density andwear resistance of Al and its alloys [3]. The particledistribution plays a very vital role in the properties ofthe Al MMC and is improved by intensive shearing.When the major focus is on increasing the hardness rather than wear the principle material of choice should be Boron Carbide [4].Barbara Previtali et al. [4] inspected the results of use of Lost wax casting techniques in aluminium metal matrix composites. When B4C and SiC are embedded in the aluminium matrix it was seen that SiC gives more resistance to wear than the B_4C composite.S.RamaRao et al.assessing mechanical properties of B_4Cp reinforced [5] in the aluminium grade 6061 produced by two stage metal

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

stirring. K.Kalaiselvan et.al [6]it is observed that micro sized B_4Cparticles diffuse into the matrix evenly because of the densityare alike that of the B4C particle and base aluminium alloy. From the micro-structures it is clear that the dispersal of the B_4C particles appears to be uniform throughout the aluminum matrix. This can be attributed to the effective stirring action and the use of appropriate process parameter.

Experimental Procedure

Stirringby mechanical stirrer of the molten metal with dispersions of reinforcement and then bottom pouring of the cast into the mould is themost simple, less expensive, technique. Stir casting route is simple, less expensive, and used for mass production. To enhance the properties of aluminum metal matrix, reinforcement B4C is added and a hybrid composite is also casted to compare the properties i.e.B_4C and kyanite mineral, selection is done of aluminum series graded matrix (2014) which was 98% pure to enhance the various mechanical properties of the aluminum such as corrosion resistance, hardness, impact etc.

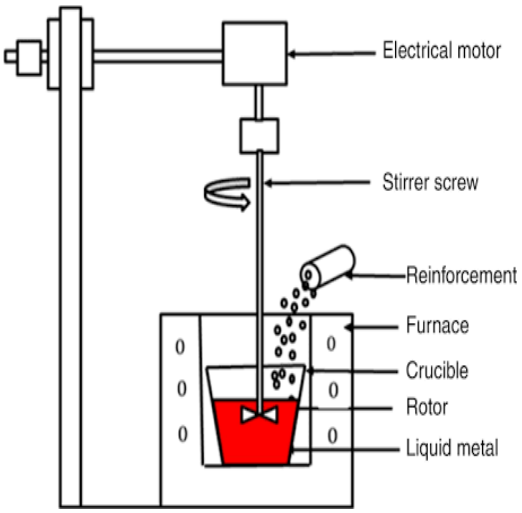


Figure 1. Typical Experimental Setup for Stir Casting

In stir casting the first step was to melt the aluminum grade (2014) in the furnace at 800 degree Celsius temperature, and mean while we preheat the reinforcements into the other crucible at a temperature range between 350 degree Celsius in order to increase the wettability of B_4C and kyanite particles. Along with the melting of aluminum alloy 2014 we supply argon gas continuously in the aluminium furnace in order to protect reaction between molten aluminium and the atmosphere gases.Now put the preheated reinforcement that was boron carbide powder of 200 mesh size and kyanite of 74 micrometer mesh size into the molten metal with weight percentage of boron carbide (5%) and kyanite (5%) in the initial stage of fabrication of aluminum meat matrix composites.The stirrer was coated with nonstick paste in order to avoid corrode of the stirrer into the mixture of aluminium and reinforcement.The cylindrical die of 700 gram weight and 30mm diameter was used in our fabrication process of aluminium metal matrix composites. IN this work a two different composition has been used. One is with the composition of 5% B_4C reinforcement and another is with 5% B_4C and 5% Kyanite reinforcement.

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Table 1: Experimental Parameters of Stir Casting

Parameters	Value
Temperature of furnace	800°C
Temperature of preheated of reinforcement	350°C
Temperature of preheated die	350°C
Spindle speed	500°C
Stirring time	6 minutes

Figure 2.shows the casted specimen

Experimental Results

Optical Micrograph

The optical micrograph shows the even distribution of the particles in the aluminum matrix.

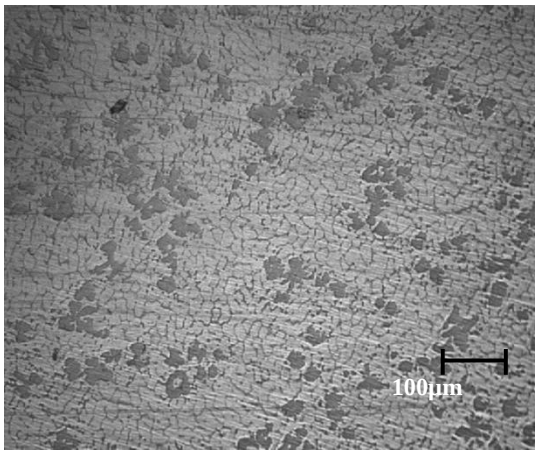


Figure 3. shows optical image of Al 2014 With B_4C reinforcement

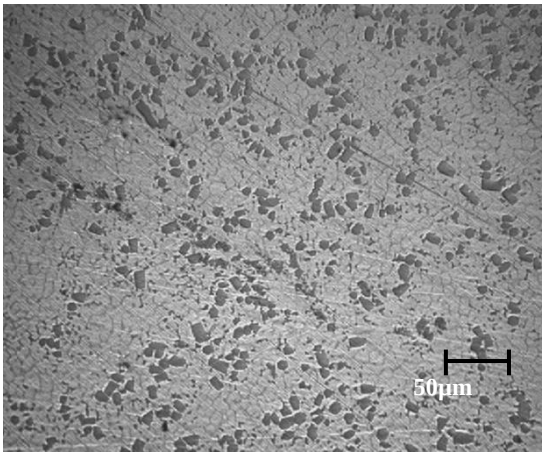


Figure 4. shows optical image of Al 2014 with B_4C and Kyanite

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

It is observed that at high stirring time might leads to entrapment of porosity after completion of solidification process.

Corrosion Test :

After that samples were clean using emery paper of different grades such as 220, 400, 600, 1000, 1500 and 2000, degreased with acetone and rinsed with deionized water. After that we drill the hole on the top side corner of the each specimen with the help of 1mm drill bit. Then cut the 0.8mm single core copper wire and insert into the drill hole that was used for making connection and to hang the sample in the electrolyte. Mean while we prepared 3.5 Wt% of NaCl solution in disstiled water that was used for corrosion test. A 3.5Wt% of NaCl aqueous solution was used as the electrolyte.

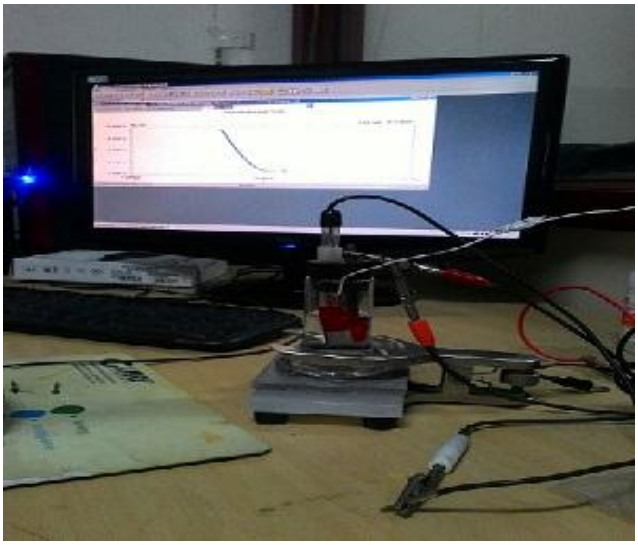
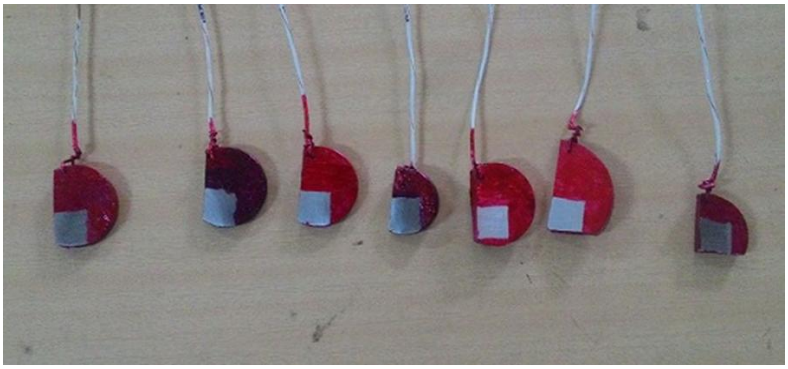


Figure 5. shows corossion test set up

Now with the help of nail paint we paint the whole surface and only 1 cm^2 of the sample was exposed to the electrolyte solution, let the sample dry for 1 hour. After that we put the 60 ml NaCl solution into the beaker and dip the specimen into the solution.Then with the help of elcham software we run the apparatus. The electrochemical measurements were performed using a Gamry Framework and an electrochemical cell. The electrochemical cell used three electrodecells.The sample was the working electrode and graphite and saturated calomel electrode (SCE) served as counter and reference electrodes respectively. Now with the help of Gamry instruments framework, we run the apparatus.



ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Figure 6.shows samples for corrosion

The value of equivalent weight and density of specimen composite was entered in the software. The open circuit stabilization time provided as 3600s. During this 3600s, specimen was in the contact of corrosive media (3.5 wt% NaCl aqueous solution) and oxidation occurs on the surface of the specimen.

Table 2.shows equivalent weight and density

Boron carbide	Kyanite	Equivalent weight	Density
50	0	8.6107	2.786
50	50	8.5845	2.826

Then we run the software for 1 hour,in that particular time the formation of oxide layer and deformation of oxide take place continousuly and we can observed on the monitre screen in the form of graph between voltage and time. After some time stability was reached that mean equal number of electron rejected and electron deposition on the sample. After one hour, cathodic and anodic curves were started forming. These curves formed in about 20 minutes. These curves are the relationship between potential and current during open circuit stabilization period. Then draw tangent to the cathodic curve and using Elog I fit the values of corrosion current density (Icorr) and corrosion potential (Ecorr) was calculated. The software also gave us the value of corrosion rate. In this way all the samples were tested using Gamry framework and three electrode electrochemical cell.

Table 3.shows corrosion rate of fabricated sample and pure aluminium

S.No	Percentage variation of different reinforcements	Corrosion potential, Ecorr (mV)	Corrosion current density,Icorr (A/cm^2)	Corrosion rate (mpy)
1	Pure Al	-679.1	3.089	1.362
2	5% B_4C	-613.3	11.76	4.602
3	5% B_4C + 5% Kyanite	-629.1	5.061	2.128

Conclusion

And it was observed from the optical microscope the boron carbide and kyanite was uniformly distributed in the base metal.

It was observed that the distribution of particle were uniform at temperature of furnace 800 degree Celsius and 5 minutes stirring time.

As the concentration of reinforcement was less and there was proper selection of parameters such as temperature of furnace, stirring time and stirring speed the result revealed that the

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

selected parameters of the stir casting route was beneficial to achieve the desire casted product due to that very less porosities and particle agglomeration were observed in micrographs which is revealed in figure 3 and 4.

It is clear from the obtained data that corrosion rate decreases with increase in percentage of Kyanite mineral.

As we know that kyanite is a corrosion resistant mineral and alloy Al 2014 is highly corrosive material so on adding kyanite enhancement is achieved in the base alloy.On the other hand, increasing the boron carbide amount, results in increasing the rate of corrosion. Boron carbide increases the strength of alloy but increases corrosion rate of alloy by huge extent.

Reference

[1] D.L. McDanels // Metall. T rans. A 16 (1985) 1 105.

[2] B. Ralph, H.C. Y uen and W.B. Lee // J. Mater .Proc. T echnol.63 (1997) 339.

[3] S.V .S. NarayanaMurty , B. NageswaraRao and B.P . Kashyap // Composites science and technology 63 (2003) 1 19.

[4] BarbaraPrevitali, Dante Pocci and Cataldo T accardo // Composites: Part A 39 (2008) 1606.

[5] S.RamaRao and G.Padmanabhan, " Fabrication and mechanical properties ofAluminium-boron carbide composites," Int. J. Mat &Biomat App., ISSN 2249-9679, August 2012

[6] .K. Kalaiselvan, N. Murugan, Siva Parameswaran,"Production and characterization of AA6061–B4C stir cast composite,"Materials and Design 32 (2011) 4004–4009.