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Comparative Analysis of Corrosion Behavior of Dual and Single Phase Reinforcementfor Aluminum 2014 Alloy

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Abstract

The corrosive behaviour of Aluminium composite have been investigated in this study, for this two different types of composites have been fabricated via stir casting route. The effect of Kyanite on Al-2014 and effect of Kyanite with B_4C together on Al-2014 have been examined to understand the individual and combined effect of both the particulate reinforcement on corrosion characteristicsof the base metal. The weight percent is varied and one specimen with 5% Kyanite and another with 5% Kyanite and 5% B_4C together are fabricated. The optical micrograph and corrosion study is performed of the samples via potentiodynamic polarization technique.

Keywords: Stir Casting, Composite, Optical Micrograph, Potentiodynamic polarization technique

Introduction

The aluminium grade that has high copper content is 2XXX series,one of the major alloy of this series is grade Al-2014 which is very good strength but poor in corrosion characteristics. The application of this grade is mostly in aerospace sector. In order to make this base metal more effective composites can be fabricated out of this grade,which will lead to the infusion of reinforcements into the matrix material thus helping in enhancement of mechanical, and corrosive properties. Matrix of Aluminium has gain popularity in compositesindustry 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 diffusion of hard ceramic particles into the soft Aluminium matrix enable us to increases the tensile strength, hardness, density andwear resistance of Al and its alloys [3]. The particledispersal and size plays a key role in determining the characteristics of Al MMC.The main characteristics of Boron Carbide B_4C are to improve hardness of the composite by impeding the movement of dislocations [4]. While the Kyanite is a silicate mineral and has with the chemical formula of Al_2SiO_5.It has Kyanite has a high melting point and excellent refractory properties along with that it also helps to improve corrosion resistance and has high creep resistance .Barbara Previtali et al. [4] fabricated composites using traditional lost wax casting techniques and found that Silicon Carbide gives more abrasion resistance as compared to Boron Carbide.S.RamaRao et al.examined the properties (mechanical) [5] in the Al 6061 produced by two step stirring. K.Kalaiselvan et.al [6]detected that B_4Cparticlesinfuse into the matrix of aluminium very easily because of the identical densities and thus it also led to proper mixing of the paticulates into the molten metal which led to effective stirring and by use of appropriate process parameter composite was fabricated.

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Experimental Procedure

Temperature of the furnace was keptinitially at 800 Degree Centigrade to melt the aluminium. At this stage the preheated reinforced Particles were added and mixed with Matrix material Al-2014. A small amount of approximately 1- 1.5% of Magnesium and little quantity of coveral is added as a supplementaryto increase the wettability, remove impurities and reduce porosity. Mechanical mixing is carried out for a period of 6-7 minutes at 630 rpm of average stirring speed. After the completion of the process the molten metal has been poured into a pre-heated (200°C) cast iron mould of 50mm diameter and 300 mm length. The pouring temperature was maintained at 680 degree Centigrade. The melt is then allowed to solidify in the mould. Thus the Metal Matrix Composite is fabricated. This experiment is repeated for two different percentage composition of reinforcement.The size of reinforcement are 200 mesh size of Boron Carbide and kyanite of 74 micrometer size into the molten metal.

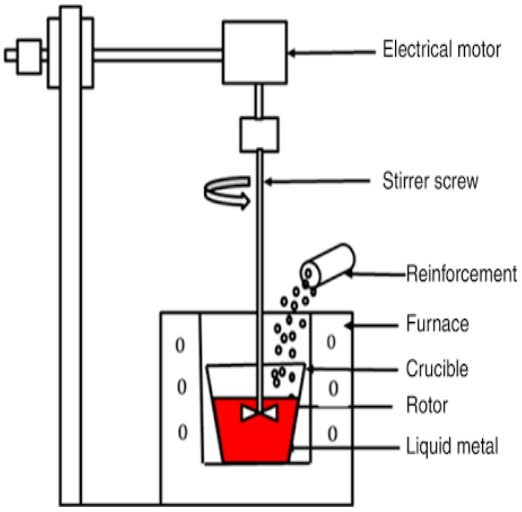

Figure 1.Set up for Stir casting Equipment

Casted Specimens are as follows :

- With 5% Kyanite in Al-2014
- With 5% Kyanite and B_4C in Al-2014

Table 1: Shows various parameters of stir casting route

Parameters	**Value**
Temperature of furnace	800°C
Temperature of preheated of reinforcement	350°C
Temperature of preheated die	200°C
Spindle speed	630 rpm

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Stirring time	7 minutes

Figure 2. The casted specimen

Figure 3.Powder Kyanite 74 µm

Figure 4. Powder Boron Carbide 200µm

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.

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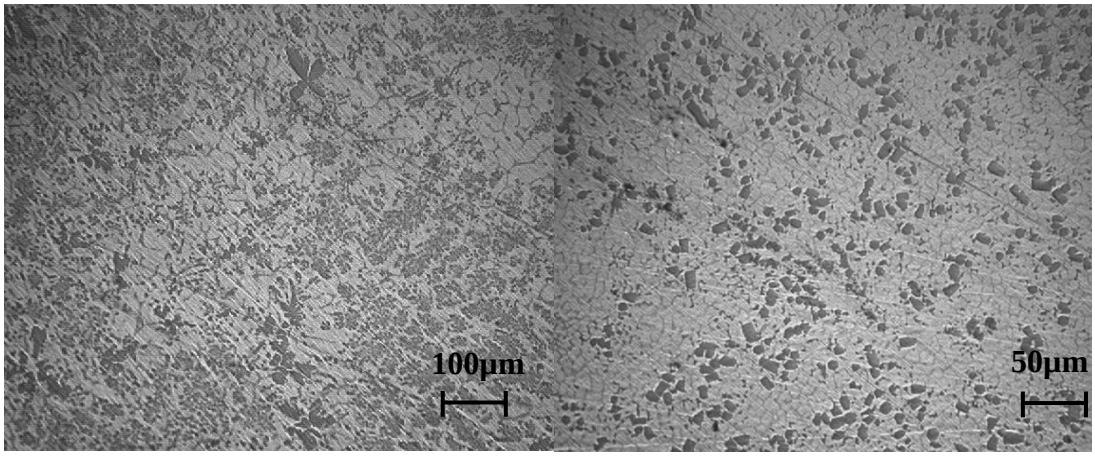

Figure 3. shows optical image of Al 2014 With 5 % B_4C reinforcement

Figure 4. shows optical image of Al 2014 with 5 % B_4C and 5% Kyanite

Corrosion Test

Polishing of the samples are done with differentsize emery paper such as 220, 400, 600, 1000, 1500 and 2000,after the degreased with acetone and rinsed with deionized water. A hole is drilled at the top side corner of 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. And salt bath is prepared by addidng 3.5 Wt% of NaCl solution in disstiled water that was used for corrosion test. This prepared soliution of 3.5Wt% of NaCl aqueous solution was used as the electrolyte.

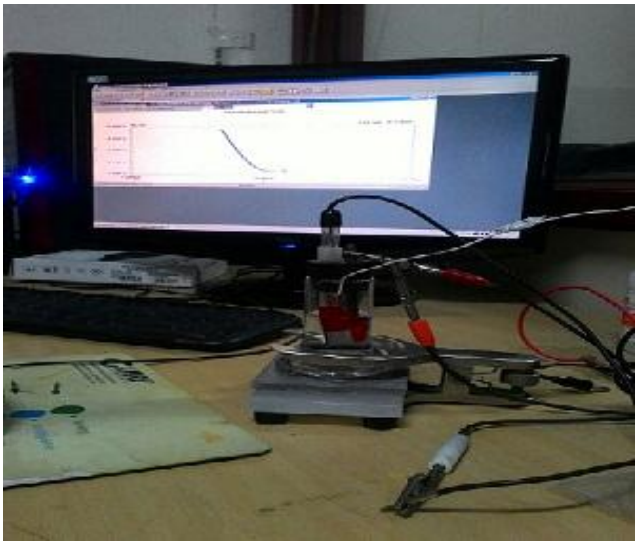

Figure 5. shows corossion test set up

Other than the area of only 1 cm^2 the rest of the sample was polished with nail paint and exposed to the electrolyte solution, allow 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.Elcam software is used to 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

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electrode (SCE) served as counter and reference electrodes respectively. Now with the help of Gamry instruments framework, we run the apparatus.

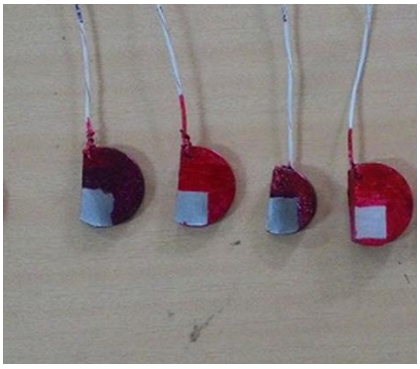

Figure 6.shows samples for corrosion

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**
0	50	9.2742	2.840
50	50	8.5845	2.826

Software is executed for a period of 1 hour,in that duration the formation of oxide layer and deformation of oxide take place continousuly and graphswere plotted between voltage and time.

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% Kyanite	-737.5	3.295	1.335
3	5% B_4C + 5% Kyanite	-629.1	5.061	2.128

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

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forming. These curves formed in about 20 minutes. These curves are the relationship between potential and current during open circuit stabilization period. A tangent drawn 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.

Conclusion

And it was detectedthat both the samples of kyanite 5 % and kyanite 5% added with boron carbide 5% in aluminium 2014 have been fabricated with a fair distribution of particles, as evident from the optical micrographs shown in figure

It has been found that the reinforcement had led to the grain refinement of the base material which will in return impede the dislocation movement leading to increase the hardness of the fabricated composite.

The Aluminium alloy used as a matrix is Al 2014,which is corrosive in nature. But onaddition of kyanite enhances the corrosive properties,as the corrosion rate reduces from 1.362 to 1.335 i.e. a change of 0.027 is detected.

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