CORROSION STUDY ON AL-MG ALLOY REINFORCED WITH MICRO TITANIUM AND BORON CARBIDE PARTICULATE HYBRID METAL MATRIX COMPOSITES

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ABSTRACT: The Aluminium-Magnesium alloy is most widely used in construction aircraft structure such as wings and fuselages, automobile parts and bodies and also using marine applications. The hybrid composite was prepared by most commonly use stir casting methods and this alloying is reinforced with constant Micro-Titanium (Ti) and varying Boron carbide (B_4C). The corrosion behavior of prepared hybrid composite was studied by salt spray test. The evaluated corrosion rate by calculating the weight loss in the material and also observed the hybrid composite excellent corrosion when immersed in 5% NaCl solution. The SEM image of the composite also shown that the particle gets corroded surrounding the reinforced particles

Keywords: corrosion, Aluminium-Magnesium alloy, Ti, B_4C, less weight, salt spray test.

1. INTRODUCTION:

Aluminum is the most popular matrix for the MMCs Aluminum alloys which are quite attractive due to their low density, good corrosion resistance, high thermal and electrical conductivity and high damping capacity [1]. Aluminium alloy composites (AACs) are becoming potential engineering materials offering excellent combination of properties such as high specific strength, high specific stiffness, electrical and thermal conductivities, low coefficient of thermal expansion and wear resistance. Because of their excellent combination of properties, AACs are being used in varieties of applications in automobile, mining and mineral, aerospace, defense and other related sectors [2]–[5]. In the automobile sector, Al composites are used for making various components such as brake drum, cylinder liners, cylinder blocks, drive shaft etc. In aerospace industries, Al composites are used essentially. In structural applications such as helicopter parts (parts of the body, support for rotor plates, drive shafts), rotor vanes in compressors and in aero-engines. Ehsani and Seyed Reihani [6] [2004] produced Al 6061/SiC composites using squeeze casting method. SiC preforms were manufactured by mixing SiC powder having a 16 and 22µm particles size, with colloidal silica as a binder. 6061 Al melt was squeeze cast into the pores of the SiC perform to manufacture a composite containing 30 vol. % reinforcement. The results showed that the hardness, yield point and tensile strength increase with addition of SiC particles to 6061 Al alloy.

Bupesh Raja v k corrosion behavior of boron carbide reinforced Aluminium MMC's, it absorbed that A356-B4C composite. Exhibited excellent corrosion when immersed in 5%NaCl solution. [7] Muna.K. Study of Corrosion Resistance of Aluminum Alloy 6061/SiC Composites in 3.5% NaCl solution Corrosion behavior of aluminum matrix composite in sea water (3.5% NaCl solution) was examined using potential statically polarization measurements. The corrosion rate was calculated by Tafel equation and from the achieved polarization results. It was found that adding of SiC particles to the aluminum alloy matrix increases the corrosion rate. It was shown that the corrosion resistance decreases with increasing of SiC particles as compared of base alloy. [8]

The aim of the present work is to study the corrosion resistance of Al-Mg alloy matrix composite reinforced constant Ti with 1%, 2% and 3% B4C particles in 5% NaCl solution.

2. MATERIALS AND EXPERIMENTEL DETAILS

2.1 MATERIAL

The material used in this study is Aluminium- Magnesium alloy, having the chemical composition as shown in Table-

Component	Weight%
Silicon	0.4
Iron	0.4
Copper	0.1
Manganese	0.4-1.0
Magnesium	4.0-4.9
Zinc	0.25
Titanium	0.15

Chromium	0.05-0.25
Aluminium	Balance

2.2 BORON CARBIDE (B4C)

Boron carbide, (B4C), crystalline compound of boron and carbon. It is an extremely hard, synthetically produced material that is used in abrasive and wear-resistant products, in lightweight composite materials, and in control rods for nuclear power generation. Boron Carbide (B4C) particle of size 250 micron was used as the reinforcing material.

Boron carbide properties

Density 2.52gcc
Melting point 2445^{0}C
Young's Modulus 450-470GPa

Figure: Boron Carbide powder.

2.3 TITANIUM POWDER

Titanium powders vary in terms of size and purity and can alloyed with several other kinds of other metal additives producing powders such as titanium iron alloy and titanium aluminium alloy. Titanium is also a key material in powder metallurgy and used extensively in filters, machinery, and components are used extensively in the medical industry, being used in heart pacemakers and cranial shells. More recently it has seen a rise in demand due to the rise in popularity of 3D printing and the ideal properties of the material.

Properties of Titanium

Density- 4.506gcc
Melting point -1668^{0}C
Young's Modulus -116GPa
Color – Gray

3 FABRICATION OF COMPOSITES

Furnace and heated up to 650^o .The metal was stirred with the help of mechanical stirrer to form a fine vortex. The boron carbide powder (250 micron) along with Ti powder is preheated at about 250^{0}C and it is added with the molten metal. The molten mixture is then stirred continuously at 320 rev/min. The molten liquid metal is poured into the permanent mould which has preheated at 250^{o}C. By varying the weight percentage of the boron carbide (1%, 2%, 3%,) the material has been fabricated.

4 SALT SPRAY TEST

The corrosion tests was carried out in 5 % NaCl mixed with 95% of distilled water The specimen of size 20mm diameter and 20mm length were cut as per ASTM B117 standard and it was polished by 1200 grit size emery sheets. The cut samples were degreased with acetone and then rinsed in distilled water before it gets immersed in the solution. The specimen is then tied in a nylon wire and immersed in the salt spray chamber and it should be closed. The salt water is sprayed continuously for 24hrs and the fog developed inside the chamber. The NaCl reacts with aluminium metal and the white rust forms on the surface. The results were evaluated by weight loss and the corrosion rate was measured by immersing the specimen in an interval of 1 days. Figure shows the salt spray chamber in which the specimens were immersed.

Figure 4.1: Salt spray Testing Equipment

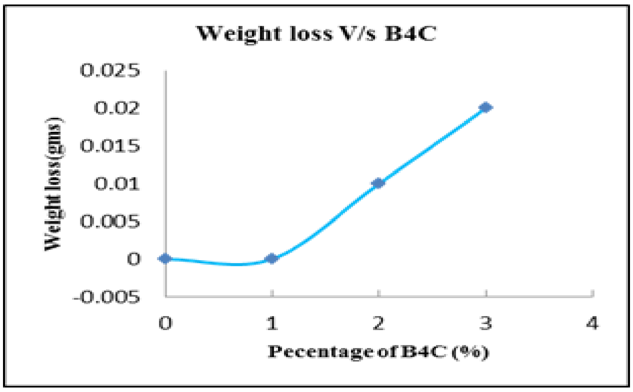
Figure 4.2: Salt spray Testing specimen.

5 RESULTS AND DISCUSSIONS

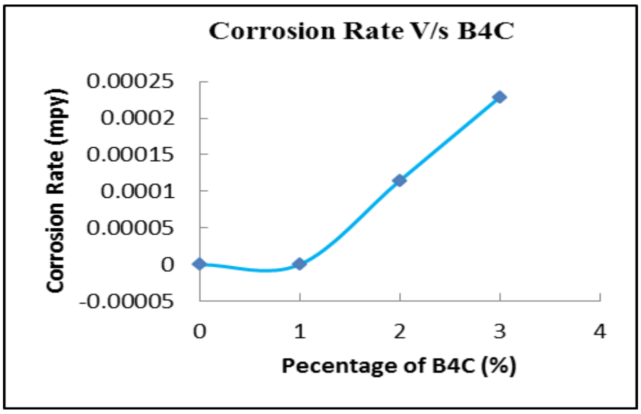
Graph-5.1 and Graph-5.2 shows the weight loss and the corrosion rate of the composite. From Figure-6 it clearly indicates the weight loss increases as the reinforcement increases. The carbon particle in the boron carbide reacts with the NaCl solution and forms rust surrounding the particle. It is due to the presence of small amount of iron present in the aluminium matrix alloy. Since boron carbide is highly resistance to corrosion, the corrosion rate is more when compared to other reinforcing particle.

Cast composite	Weight loss (gram)	Corrosion rate (mpy)
100%Al-Mg alloy+0%Ti+0%B_4C	0	0
94%Al-Mg alloy+5%Ti+1%B_4C	0	0
93%Al-Mg alloy+5%Ti+2%B_4C	0.01	$0.1147*10^{-3}$
92%Al-Mg alloy+5%Ti+3%B_4C	0.02	$0.2291*10^{-3}$

Table 5.1: the corrosion rate and weight loss in composite



Graph-5.1 Weight loss V/s B4C of the composite.



Graph-5.2 Corrosion rate V/s B4C of composite.

6. SCANNING ELECTRON MICROSCOPY (SEM) ANALYSIS

6.1 SEM structure of corroded composites,

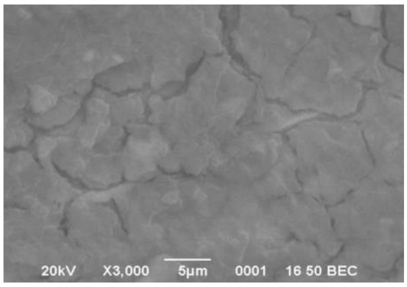


Fig (a): Al-Mg alloy

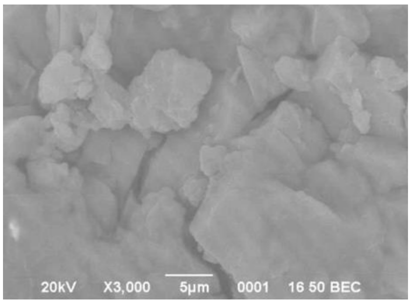


Fig (b): Al-Mg+5%Ti+1%B4C

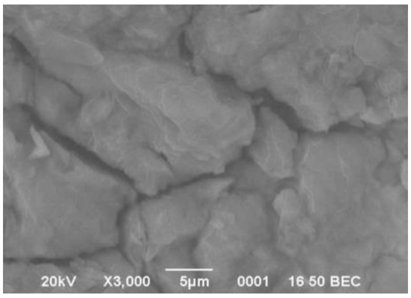


Fig (c): Al-Mg+5%Ti+2%B4C

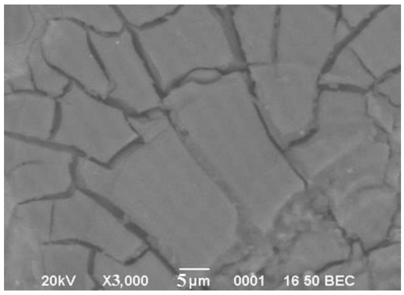


Fig (d): Al-Mg+5%Ti+3%B4C

Figure-6. SEM structure of corroded composite

Before subjecting the specimens for corrosion test by weight loss method they are subjected microstructural studies using scanning electron microscope. Figures-6 Show the microstructures of Aluminium Magnesium matrix alloy and the composites prepared as per above mentioned procedures. In the figures uniform distribution of boron Carbide is observed. Figure-(d) clearly shows that the boron carbide particle was corroded and it tends to get peal of from the matrix. It also identified that the particle gets corroded on its surroundings. From Figure (b) and (c) it is seen evidently the material get acts on the sodium chloride solution and tends to remove. Further if the immersion time has been increased the reinforcing material may remove completely by the action of NaCl solution.

CONCLUSION

Stir casting process were used in the preparation of AL-Mg hybrid composites containing varying % of Micro Ti and B4C particulates as reinforcement. And the test specimens were prepared according to ASTM standards.

The corrosion behavior was studied using salt spray test it was observed from the result that the composite has good corrosion resistance in sodium chloride medium.

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