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Corrosion Behavior of Al-Mg-SiC Composite produced by Modified Stir casting method

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Abstract

Light weight and high strength properties materials like Aluminum-based metal matrix composites (MMCs) are used for structural applications as well as in automobile and aerospace applications. In the present work, aluminum alloy based -silicon carbide particulate composite (Al-1Mg-10SiC) is developed using the modified stir-casting technique and is subjected to study the corrosion behavior. The static immersion corrosion tests of Al/SiC MMCs in 5 wt.% NaCl aqueous solution showed that, at ambient temperature, the Al/SiC MMCs have better corrosion resistance than the commercially pure Al.

Keyword: Corrosion, Composite, Stir Casting, NaCl

INTRODUCTION

Aluminum- Magnesium alloys reinforced with ceramic particulates have significant potential for structural applications due to their high stiffness and specific strength as well as low density[1–3]. These properties have made particle-reinforced metal matrix composites (MMCs) an attractive candidate for the use in weight-sensitive and stiffness-critical components in aero-space, transportation and industrial sectors [4]. Corrosion behavior is very important parameter for assessing the application potential of composites as structural material[5-7]The investigation is intended to assess the corrosion resistance of the silicon carbide reinforced Al-Mg alloy matrix composites in acidic, salt water, and basic environments which are representative of typical industrial processing atmospheres [7,8].

MATERIALS AND METHODS:

Materials

The different materials used for MMC preparation are described below. Commercially pure aluminum is used to prepare the composite with the composition are shown in Table-1

Table 1: Chemical composition of commercially pure Aluminum ingot

Al	Si	Fe	V	Mn	Cu
99.76	0.08	0.15	0.006	0.003	0.001

Magnesium metal turnings are used for preparation of Al-Mg alloy. The composition Mg turning is given in Table 2

Table 2: Chemical Composition of Magnesium Turning Used for Alloying.

Mg	Al	cu	Fe	Pb	Mn	Ni	Si	Zn
99.68	0.05	0.005	0.05	0.005	0.1	0.005	0.1	0.005

Silicon carbide particles of 600 mesh size are used for MMC preparation. The chemical composition of silicon carbide is given in Table 3.

Table 3: Chemical Composition of Silicon Carbide particles

SiC	SiO2	Si	Fe	Al	C
98.8	0.41	0.3	0.09	0.1	0.3

Test Procedure

In the present work a laboratory model stir casting apparatus was improved upon to produce Al +1wt. %Mg +10wt. % SiC metal matrix composite(MMC). The basic arrangements of a laboratory scale stir casting apparatus with assembly modifications which has been used to prepare the aluminum metal matrix composites (AMMC) is described elsewhere[1,2]. The samples of required size are cut from Al and AMMC produced for different tests. First microstructure AMMC produced was taken to study the distribution of particles in the composite produced.

The corrosion tests were carried out in 5wt% NaCl (pH 8.37) which was prepared using standard procedures. The specimens for the test were cut to size 20×20×5 mm, after which the sample surfaces were mechanically polished with emery papers. The samples were de-greased with acetone and then rinsed in distilled water before immersion in still solutions of 5wt% NaCl in deionized water exposed to atmospheric air. The solution-to-specimen surface area ratio was about 150 ml/ cm^2.

The corrosion behavior of MMC with respect to aluminum was tested with 5 wt% of NaCl solution. The samples of Aluminum and (Al–1%Mg–10% SiC) AMMC prepared were immersed in NaCl solution in a beaker and the mass loss due to corrosion was measured periodically. The corrosion mass loss in mg/cm^2 for each sample was calculated using the following equation.

M.L = CW / A

M.L = Mass loss in mg/cm^2

CW = Cumulative weight loss of the sample

A = Total surface area of the sample (cm^2)

RESULT AND DISCUSSION

Microstructure

The optical microstructure of AMMC shows (Figure 1) that SiC particles are almost homogeneously distributed in the Al-1wt%Mg alloy matrix.

Figure 1: Optical microstructure of Al-1wt. %Mg-10 wt.% SiC

At some places, the SiC particles appear to be in the form of short fibers. This is because of the fact that the diffusion coefficient of Aluminum-aluminum and aluminum-magnesium is higher than the diffusion coefficient of SiC. Thus, the SiC forms clusters by the time the aluminum-magnesium matrix gets solidified, exhibiting an elongated type of appearance.

Corrosion Test

The results of the corrosion tests were evaluated by measuring the mass loss on every day for a period of 12 days. Mass loss (mg/cm2) for each sample was evaluated by dividing the weight loss (measured using a digit electronic weighing balance) by its total surface area which is in accordance with ASTM G31 standard recommended practice.

The corrosion mass loss on each day for AMMC and cast Al as per the equation was tabulated in the Table 4.

Table 4: Corrosive Mass loss per day

Days	Mass loss in mg /cm^2	
	AMMC	Al
1	0.023	0.036
2	0.039	0.046
3	0.043	0.051
4	0.05	0.059
5	0.056	0.064
6	0.071	0.089
7	0.092	0.16
8	0.11	0.091
9	0.089	0.084
10	0.085	0.082
11	0.085	0.082
12	0.085	0.082

The corrosion rate graph of MMC and cast Al was plotted in Figure 2.

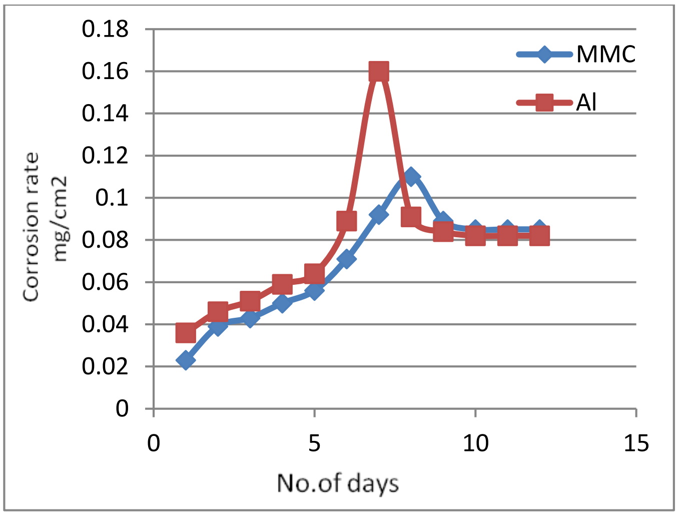

Figure 2: Corrosion rate Vs No. of days

Initially corrosion mass loss of as cast aluminum was more but after 7th day mass loss of MMC was more and after 10th day the corrosive mass loss was uniform.

CONCLUSION

The mass loss of the composites in comparison to the Al was higher by 3.53% indicating that the Al-SiC particulate composites can be utilized satisfactorily in marine/salt water environments.

REFERENCES

[1] B.P. Samal, A.K. Misra S.C.Panigrahi, S.C.Mishra, 2013, "A Novel technique for improved recovery of Mg--Analysis of the Microstructure and Physical properties, Journal of Materials and Metallurgical Engineering, Volume 3 , Issue 1 , pp.1-7.

[2] B.P. Samal, A.K. Misra S.C.Panigrahi, S.C.Mishra, 2013, "Plunger Technique: A New Approach to Stir Casting AMMC Preparation", Journal of Materials and Metallurgical Engineering, Volume 3 , Issue 2 , pp.26-32.

[3] Shivkumar S., Sravan kumar Thimmappa, Brahma Raju Gola, 2018, "Corrosion Behaviour of extremely hard Al-Cu/Mg-Sic light metal alloy composites", Journal of alloys and compounds, Volume 767, pp.703-711.

[4] J Moses, I. Dinaharan, S Sekhar, 2014, "Characterization of silicon carbide particulate reinforced AA6061 Aluminium Alloy Composites produced via stir casting" Procidia Material Science, Volume 5, pp.106-112.

[5] Md. Rehman, H Rashed, 2014, "Characterization of silicon carbide reinforced Aluminium Matrix composites" Procidia Engg., Volume 90, pp.13-109.

[6] T.G. Durai, D. Karabi, D Sidhartha, 2007, "Effect of mechanical milling on the corrosion behaviour of Al-Zn/Al2O3 composite in NaCl solution, Journal of material science, Volume 42, pp.8209-8214.

[7] I. Topcu, H Gulsoy, N. Kadiaoglu, A.Gulluoglu, 2009, "Processing and mechanical properties of B4C reinforced Aluminium matrix composites, Journal of alloys and compounds, Volume 482, pp. 516-521.

[8] H.M. Zakaria, 2014, "Microstructural and corrosion behavior of Al/SiCmetal matrix composites" Ain Shams Engineering Journal,Volume 5,pp.831-838.