

Influence of TiC particulate reinforcement on the corrosion behaviour of Al 6061 metal matrix composites

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ABSTRACT

Aluminum matrix composites (AMCs), reinforced with ceramic particulates, have significant applications in the field of aerospace, marine, automobiles, sports and recreation. Al-TiC particulate composite has better potential for high-temperature applications. The corrosion behaviour of Al 6061-TiC particulate composites prepared by stir casting route, has been explored in chloride medium using electroanalytical techniques such as Tafel, Cyclic polarization and Impedance measurements (EIS). SEM and EDX analysis of the microstructures obtained in both matrix alloy and reinforced composites were performed in order to know the effect of titanium carbide on the corrosion resistance of composites. The polarization studies reveal an increase in the corrosion resistance in composites compared to the matrix alloy. The observed increase in corrosion resistance of TiC particulate reinforced composites is attributed to excellent bond integrity of TiC particulates with aluminium and possible electrochemical decoupling between TiC particles and Al 6061 matrix alloy. The EIS study reveals that the polarisation resistance (R_p) increase with increase in TiC content in composites and the corrosion process is mainly charge transfer controlled. Titanium carbide is proved to be a potential reinforcement for improved corrosion resistance in Al MMCs. Copyright © 2015 VBRI Press.

Keywords: Particulate composites; corrosion; SEM; EIS.

Introduction

Aluminium and its alloys with copper, zinc, manganese, silicon, or magnesium are the most popular non-ferrous matrix materials for the fabrication of metal matrix composites (MMCs). They are much lighter and more corrosion resistant than plain carbon steel. Particulate reinforced aluminium metal matrix composites (Al MMCs) and other aluminium based materials having huge applications in diverse fields such as light weight automotive structures, forgings for suspension, chassis, as well as advanced automotive components are exposed to a wide variety of corroding environment [1]. Alloys of Al reinforced with ceramic oxides, carbides, nitrides and mineral silicate particulates possess attractive characteristics such as high specific modulus, high specific strength, low thermal expansion coefficient, light weight and low cost and superior corrosion resistance [2]. Al-TiC composites are highly expensive, because of tedious production process [3]. Studies on aluminium alloys reinforced with SiC [4], Si₃N₄ [5], Al₂O₃ [6], TiC [7] and ZrB₂ [8] report lower corrosion resistance for the composites compared to matrix alloys, owing to galvanic corrosion. On the other hand, Al composites reinforced

with garnet [9], albite [10], quartz [11] and glass fibre [12] exhibited higher corrosion resistance compared to their matrix alloys. Recent studies on the corrosion resistance of TiB₂ particulate reinforced A356 alloy show a marked decrease with increase in TiB₂ content [13]. In the case of TiC-Al 2024 composites the TiC reinforcement is reported to decrease the anodic current density as well as amount and size of the pit. AlN particles which are highly insulating is reported to increase the susceptibility to pitting attack attributable to microgalvanic coupling between the matrix and the reinforcement and hydrolysis of AlN particles [14]. The corrosion resistance of Al-Mg and Al-Cu composites is found to be higher than that of composites reinforced with mica particles [15]. The conflicting results can possibly be explained by differences in fabrication methods and composition which yield dramatically different electrochemical behavior [16]. The observed variation of corrosion resistance in Al MMCs is attributed to chemical or mechanical factors such as composition of the matrix alloy, nature of reinforcing particles, fabrication methods, chemical or mechanical factors such as alloying, segregation, interfacial reactions, oxidized layers, residual stress around reinforced particles in the matrix and galvanic coupling between matrix and reinforcement. The

corrosion behaviour of reinforced Al composites investigated in acidic, neutral, alkaline and various salt media reveal that Al composites suffer greater localized pitting corrosion in chloride ion environment compared to other media. In general particulate reinforced Al MMCs provide a good combination of electrical and mechanical properties. However these composites are known to exhibit increased corrosion resistance as compared to the matrix alloy. Titanium carbide, TiC is an extremely hard refractory material with low electrical resistivity ($\sim 10^{-4}$ ohm cm). Titanium carbide is an attractive reinforcement for aluminum composites because of its high elastic modulus, grain refining effect, high hardness, stiffness and wear resistance [17]. TiC particles possess good wettability in the Al matrix which results in clean and strong interface. These Al MMCs lose their mechanical properties due to corrosion and lead to failure during service. Hence research on the corrosion behaviour is equally important as the fabrication and mechanical behaviour of Al MMCs. The present investigation involves the study of corrosion behaviour of unreinforced Al-6061 matrix and its TiC particulate composites in different concentrations of aerated NaCl medium. The main objective of present work is to establish the role and effectiveness of titanium carbide particles on the corrosion behaviour of Al 6061 composites in chloride environment.

Experimental

Materials

Commercially available aluminum Al 6061 was selected as the matrix material. The chemical composition of Al 6061 rods is presented in **Table 1**. The reinforcing particle was titanium carbide (100 nm) supplied by Sigma-Aldrich. Sodium chloride was purchased from Merck. The chemicals were of analytical grades and used without further purification.

Table 1. Chemical composition of aluminum alloy Al 6061.

Element	Wt. %
Magnesium	0.8
Silicon	0.6
Copper	0.3
Iron	0.1
Manganese	0.02
Chromium	0.01
Zinc	0.01
Aluminum	Balance

Preparation of composite materials

The liquid metallurgy route using vortex technique (Stir Casting) is employed to prepare the composites. The composites were prepared with 2, 4 and 6 percentage by weight of TiO₂ using Crucible furnace fitted with a mechanical stirrer. Addition of reinforcement particulates in to the molten Al 6061 (800°C) was carried out by creating a vortex in the melt using a mechanical stainless steel stirrer coated with alumina (to prevent migration of ferrous ions from the stirrer material to the alloy). The stirrer was rotated at a speed of 450 rpm in order to create the necessary vortex. The ceramic particles were pre-heated to 400°C and added in to the vortex of liquid melt at a rate

of 20 g/min. The ceramic particulates were of size ~ 100 nm. The composite melt was thoroughly stirred and subsequently degasifiers were added. Castings were produced in permanent moulds in the form of cylindrical rods.

Preparation of specimens

Cast material was cut into 20 x 20 mm cylindrical pieces using an abrasive cutting wheel. The matrix alloy was also cast under identical conditions as the composites, for comparison. For polarisation studies, the samples were cut as cylindrical rods (Diameter 1.128 cm) welded with brass rod (Diameter 4mm) for electrical connection and insulated on the outside using acrylic rubber mould to offer an active flat disc shaped bottom surface of 1cm². These working electrodes were polished using 240, 320, 400, 600, 800, 1000, 1500 & 2000 grade emery papers and were polished according to standard metallographic techniques and degreased in acetone and dried.

Characterizations

Polarisation measurements were carried out on Model 600 C series, Electrochemical Analyzer / Workstation, CH Instruments, USA. All Experiments were carried out using a three electrode cell with saturated calomel electrode (SCE) and platinum electrode as reference and counter electrode respectively. Open Circuit Potential (OCP) measurements were recorded for 60 minutes, followed by polarisation measurements at a scan rate of 1mV/s for Tafel plots. Following the polarization studies, the corroded samples were subjected to energy dispersive x-ray analysis using model Oxford Link ISIS, UK, to gain more insight on the composition of the corrosion products formed at the tested Al matrix and composites. The morphology of the passive layer and the corrosion products formed on the electrode surface was examined by scanning electron micrograph (SEM) using model JSM-840A SEM, JEOL, Japan.

Results and discussion

Polarisation studies

The evolution of the open circuit potential (OCP) was recorded for Al 6061 matrix alloy and its TiO₂ composites (2, 4 and 6 wt %) in different concentrations of neutral aerated NaCl medium, viz., 0.1N, 0.5N and 1.0N. The plots for the matrix alloy and the composites in decinormal NaCl medium are shown in **Fig. 1** and the evaluated open circuit potentials in all the three concentrations of NaCl are given in **Table 2**. It is observed that the OCP values increases in the positive direction with increase in the TiC content, from -0.7738 V for Al matrix to -0.7362 V for the highest reinforced composites in 0.1N NaCl medium.

Good wetting of TiC in Al can be attributed to more metallic nature of TiC as well as the possibility of formation of Al₃Ti an inter metallic compound, by the chemical reaction between TiC and Al. In general carbide ceramics have properties such as low density, wide range of electrical and thermal conductivities, good tensile strength, excellent wear resistance and good corrosion resistance [18]. The positive shift of OCP values after the

reinforcement with ceramic TiC is a clear indication of improved corrosion resistance in Al 6061- TiC composites. Galvanic coupling occurs between the Al matrix and conducting ceramic reinforcement TiC particles. But the extent of galvanic coupling becomes unclear with the electrical resistivity of TiC approaching that of semiconductors [19]. This increase in OCP value of 170 mV is higher when compared with those of Al-TiO₂ (140 mV) and Al-TiN (90 mV) composites [20]. This would suggest the greater degree of wettability of TiC in Al matrix alloy and conductivity as compared with TiO₂ and TiN particulates.

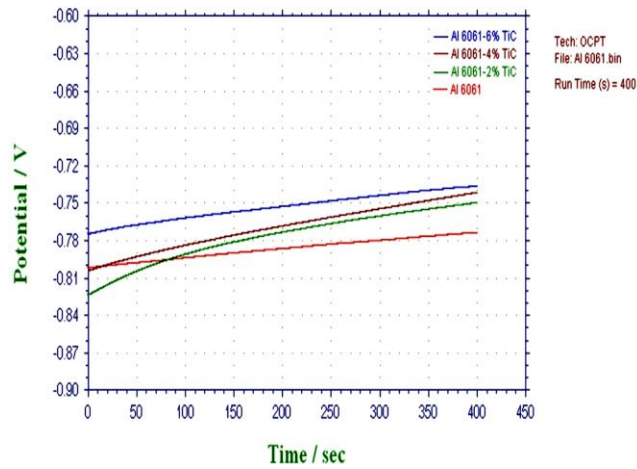


Fig. 1 Open circuit potentials for Al 6061 matrix alloy and its TiC (2, 4 & 6 wt %) composites in 0.1N NaCl medium.

Table 2. Open circuit potentials of Al 6061 matrix alloy and its TiC composites in various concentrations of NaCl media.

TiC content in composites	OCP (E_{Corr}) values (in Volts) in various NaCl media		
	0.1N	0.5N	1.0N
0%	-0.7738	-0.8122	-0.9473
2%	-0.7496	-0.7861	-0.8960
4%	-0.7416	-0.7458	-0.8686
6%	-0.7362	-0.7415	-0.8531

TiC has the strongest interfacial bond with Al yielding intermetallics like Al₄C₃ and Al₃Ti which are more conductive [21]. Further, TiC was also found to lead to better mechanical properties like modulus and yield strength due to excellent bond integrity with Aluminium which in turn improves the corrosion resistance.

With an increase in the concentration of the chloride medium from 0.1N to 0.5N to 1.0N NaCl, OCP values shift considerably towards negative direction for both Al 6061 matrix and its TiC composites, as shown in **Fig. 2** and **3**. The increase in the corrosion susceptibility of both Al 6061 matrix and the composites at higher concentrations of aggressive chloride ions is probably due to the breakdown of stable oxide film on Al matrix as a result of increased adsorption of chloride ions on the Al surface or its oxide layer.

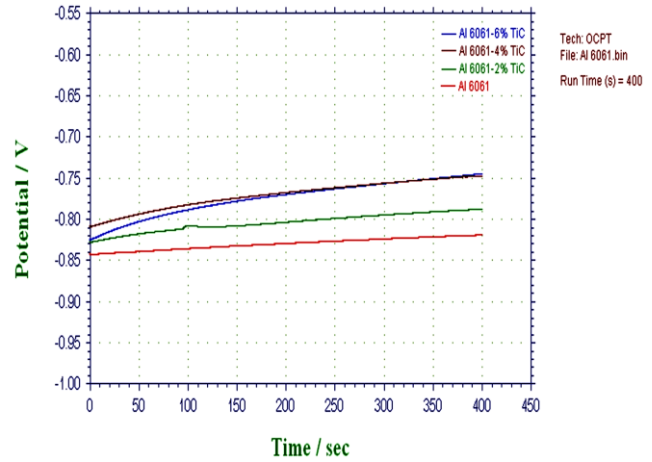


Fig. 2 Open circuit potentials for Al 6061 matrix alloy and its TiC (2, 4 & 6 wt %) composites in 0.5N NaCl medium.

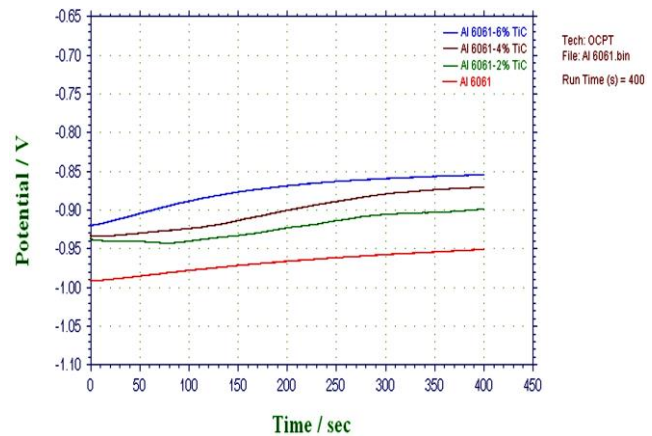


Fig. 3. Open circuit potentials for Al 6061 matrix alloy and its TiC (2, 4 & 6 wt %) composites in 1.0 N NaCl medium particles.

Typical polarisation curves for Al 6061 matrix alloy and the composites containing 2, 4 and 6% by weight of TiC particulates, in different concentrations of NaCl are shown in **Fig. 4, 5** and **6**. The evaluated electrochemical corrosion parameters for the matrix alloy and the composites are given in **Table 3** and **4**. It can be observed from the Tafel plots and the associated data that the corrosion current (I_{CORR}) values and the corrosion rates decrease with increase in TiC content in the composites, in each of the concentrations of NaCl. The corrosion parameters, corrosion current density and corrosion rate were obtained from the Tafel polarization measurements. These observations show that both the I_{CORR} values and the corrosion rate decrease with increase in the content of TiC and increases with an increase in concentration of the NaCl medium. These results point to the fact that TiC reinforced composites have higher corrosion resistance as compared to Al matrix alloy. The observed increase in corrosion resistance for composites is assigned to possible electrochemical decoupling between TiC particles and Al 6061 matrix alloy.

It has been observed [22] that increasing amounts of TiC content in the Al-Cu (5 wt %) alloy matrix reduces the pitting potential and increases the corrosion current density indicating an increase in the pitting susceptibility of the composites and that pitting principally occurs at Al/TiC interfaces.

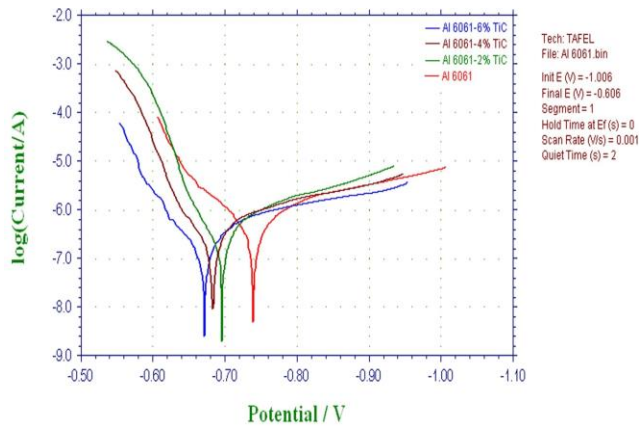


Fig. 4. Tafel polarisation plots for Al 6061 matrix alloy and its TiC (2, 4 & 6 wt %) composites in 0.1N NaCl medium.

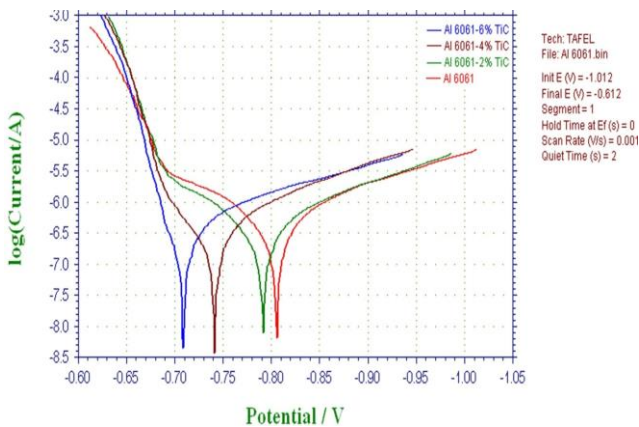


Fig. 5. Tafel polarisation plots for Al 6061 matrix alloy and its TiC (2, 4 & 6 wt %) composites in 0.5N NaCl medium.

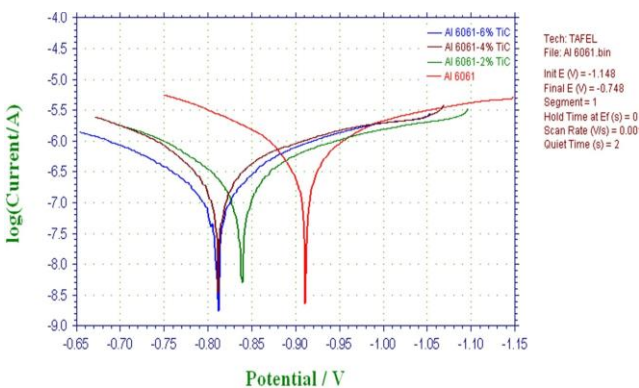


Fig. 6. Tafel polarisation plots for Al 6061 matrix alloy and its TiC (2, 4 & 6 wt %) composites in 1.0N NaCl medium.

Table 3. Corrosion current densities (I_{CORR}) of Al 6061 matrix alloy and its TiC composites in various concentrations of NaCl media.

TiC content in composites	Corrosion current density, I_{CORR} (Acm^{-2})		
	0.1N NaCl	0.5N NaCl	1.0N NaCl
0%	5.353×10^{-7}	6.559×10^{-7}	9.316×10^{-7}
2%	2.278×10^{-7}	3.250×10^{-7}	5.017×10^{-7}
4%	1.958×10^{-7}	1.492×10^{-7}	3.423×10^{-7}
6%	1.552×10^{-7}	1.302×10^{-7}	2.441×10^{-7}

Table 4. Corrosion rate of Al 6061 matrix alloy and its TiC composites in various NaCl media.

TiC content in composites	Corrosion Rate (mils per year)		
	0.1N NaCl	0.5N NaCl	1.0N NaCl
0%	0.2296	0.2813	0.3996
2%	0.0977	0.1394	0.2152
4%	0.0830	0.0983	0.1468
6%	0.0652	0.0808	0.1131

Similar increase in corrosion rate with TiC reinforcement in Al-Cu and Al-Mg matrices due to easier breakdown of passive oxide film in the voids at interfaces has been reported [7]. In these Al alloys, presence of intermetallics such as Ti_3Cu , Al_3Ti , Ti_3AlC and Ti_3Al which are cathodic with respect to metal matrix has been reasoned to be the contributing factor the enhanced pitting corrosion.

In contrast, our observation suggests the presence of lower amounts of these precipitates in composites which contain Mg and Si as major alloying elements. Thus the corrosion resistance of TiC reinforced composites is found to be higher than that of Al 6061 matrix alloy.

Cyclic polarisation curves for Al 6061 matrix alloy and the composites containing 2, 4 and 6% by weight of TiC particulates, in 0.5N NaCl solution are shown in Fig. 7. The Pitting potentials (E_{PIT}), Repassivation potentials (E_{RP}) and ΔE_1 ($E_{PIT} - E_{RP}$) values obtained from the polarization plots are tabulated in Table 5. Cyclic polarization curves of the reinforced and unreinforced Al alloys were found to be similar in overall shapes. Cyclic polarization measurements show that the pitting potentials increases towards positive direction with increase in TiC content reinstating the results from other measurements that composites of TiC are more corrosion resistant than the matrix alloy.

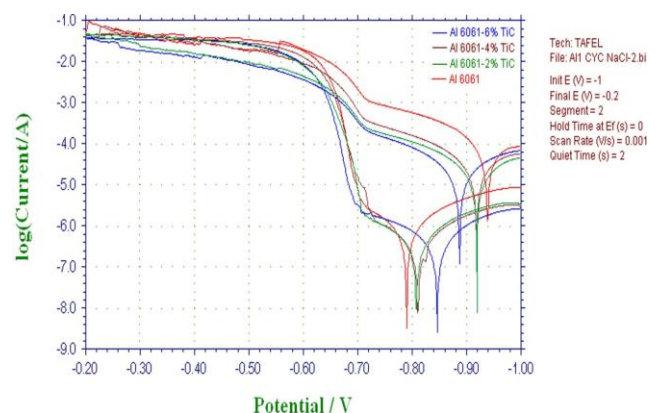


Fig. 7. Cyclic polarisation plots for Al 6061 matrix alloy and its TiC (2, 4 & 6 wt %) composites in 0.5N NaCl medium.

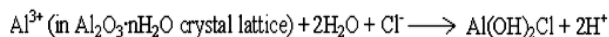
The Al-TiC composite is more resistant to pitting as evidenced by the less negative pitting potential, -0.6945 V for the composite as against -0.7297 V for Al 6061 matrix alloy. The more positive pitting potential of the composites indicates reduced driving force required for pitting. The

pitting loop given by ΔE_1 value decreases from the matrix alloy to the composites, with increasing TiC content showing decreasing tendency to pit in the TiC reinforced composites.

Table 5. Pitting potentials (E_{PIT}) and repassivation potentials (E_{RP}) of Al 6061 matrix alloy and its TiC composites in 0.5N NaCl medium.

TiC content in composites	E_{PIT} (V)	E_{RP} (V)	$\Delta E_1 = E_{\text{PIT}} - E_{\text{RP}}$ (V)
0%	-0.7297	-0.9393	0.2096
2%	-0.7241	-0.9183	0.1942
4%	-0.7213	-0.9140	0.1927
6%	-0.6945	-0.8859	0.1914

However, the magnitude of change in pitting potential was found to be small (35 mV) varying from -0.7297V for the matrix alloy to -0.6945 V in the composite with highest content of the TiC reinforcement. The pitting corrosion resistance of the TiC particle reinforced composites is observed to decrease with increasing TiC content. **Table 5** shows that E_{RP} values increases in the noble direction with increasing TiC content in composites. This indicates the fact that pit propagation in the composites is more retarded than in the matrix alloy. The superior repassivation potential exhibited by the TiC reinforced composites is attributable to the reduction in the pit dissolution kinetics by the oxides of metals. However, the repassivation potentials E_{RP} are more negative to the pitting potentials for each of the composites as well as the matrix alloy indicating a tendency to undergo pitting. When Cl^- ion concentration increases, corrosion potential of aluminium becomes more negative, and aluminum tends to be more sensitive to pitting corrosion. It is believed that competitive adsorption promotes Cl^- ions instead of O or oxide on the aluminum surface so that pitting corrosion gets induced. However, the competitive adsorption theory cannot explain satisfactorily the dissolving mechanism of oxide film. According to complexation corrosion theory, compact Al_2O_3 film is expected to form on the aluminum surface in neutral chloride medium offering good corrosion resistance. The Cl^- ions are adsorbed selectively on the crystal lattice of the oxide hydrate film under the effect of electric field. The complexation reaction of Cl^- with Al^{3+} hydrate ions occurs as given in Equation,



The above reaction results in activation of the aluminum crystallite boundary, so that crystallites break off from the film and become very resolvable and the thickness of the film decreases until local defects are formed. Cl^- ions erode the bare surface of Al matrix alloy easily. Once pitting corrosion occurs, the anode current density of small pits (or pit groups) would be much higher than that of a passive surface. Higher the Cl^- ion concentration, easier the complexation reaction occurs. That is to say that the dissolving velocity of pit becomes more rapid and therefore

the critical pitting potential tends to be more negative with the increase of Cl^- ion concentration.

The pitting potentials, corrosion potentials and ΔE_2 ($E_{\text{PIT}} - E_{\text{CORR}}$) values of Al matrix and its TiC composites are presented in the **Table 6**. The ΔE_2 value of 60.5 mV in Al matrix alloy is found to increase to 126.1 mV in Al-6 wt% TiC composites. It is observed that the addition of TiC to Al matrix significantly increases the passive range between the unreinforced matrix alloy and the reinforced composites. It can be concluded from the magnitude of ΔE_2 values that the corrosion resistance of Al-TiC composites is lower than that of Al-TiN composites. This may be attributed to the lower electrical resistivity of TiC particles.

Table 6. Pitting potentials (E_{PIT}) and corrosion potentials (E_{CORR}) of Al 6061 matrix alloy and its TiC composites in 0.5N NaCl medium.

TiC content in composites	E_{PIT} (V)	E_{CORR} (V)	$\Delta E_2 = E_{\text{PIT}} - E_{\text{CORR}}$ (V)
0%	-0.7297	-0.7902	0.0605
2%	-0.7241	-0.8098	0.0857
4%	-0.7213	-0.8101	0.0888
6%	-0.6945	-0.8206	0.1261

Morphological investigations using SEM

Scanning electron microscopy images of the Al 6061 matrix alloy before the corrosion test and reinforcement TiC particles are shown in **Fig. 8**. The particle size of reinforcement TiC particulates is about 2 to 10 microns as observed in the SEM image. The SEM images of Al 6061 matrix alloy and its TiC (2%, 4%, 6%) composites taken after the polarization studies in decinormal chloride medium, after usual pretreatment, are presented in **Fig. 9**.

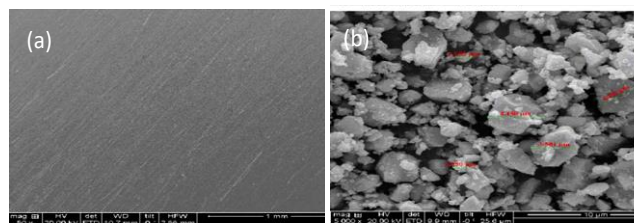


Fig. 8. SEM micrographs of (a) Al 6061 matrix alloy and (b) TiC particles.

A comparison of the SEM images of the samples before and after the polarization studies clearly indicate the severe surface deterioration due to pitting corrosion. The decrease in driving force required for localized corrosion of the TiC reinforced composite is attributable to the introduction of reinforcement / matrix interfacial products such as oxides of alloying elements (Mg & Si) and the possible refinement of microstructure [23]. The combination of reinforcement inclusions and structural flaws/ defects formed at the time of MMC fabrication decrease the susceptibility of Al-TiC composites to pitting by reducing the required driving force. It is observed that the matrix alloy and composites contain the Al-Fe-Si rich and Mg_2Si intermetallic phases. The elements in these intermetallic phases undergo

oxidation to yield their respective oxides such as SiO_2 , FeO and MgO which reduce the corrosion rate in composites by decreasing the microgalvanic coupling between conducting intermetallic phases and the matrix in composites. The effect is more pronounced in composites as they contain more amounts of intermetallic phases. The reinforcement TiC particles react with aluminum to give intermetallic compound like Al_4C_3 . Thus the corrosion resistance is enhanced in the case of TiC reinforced Al composites.

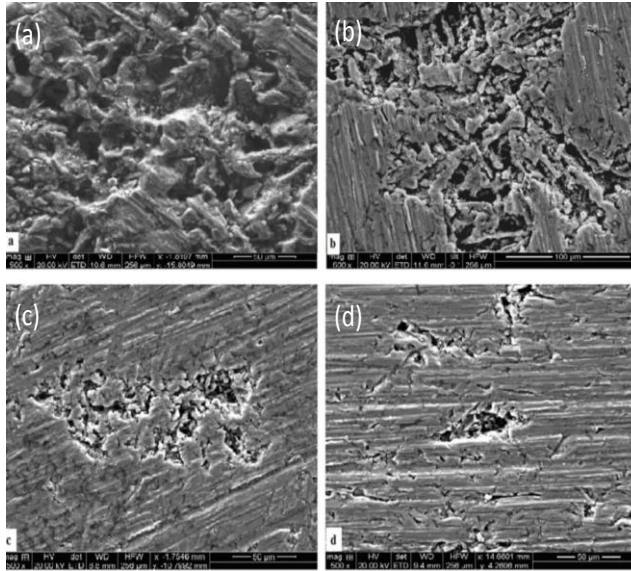


Fig. 9. SEM micrographs of corroded samples of Al 6061 matrix alloy (a), Al 6061-TiC (2 wt %) composite (b), Al 6061-TiC (4 wt %) composite (c) and Al 6061-TiC (6 wt %) composite (d).

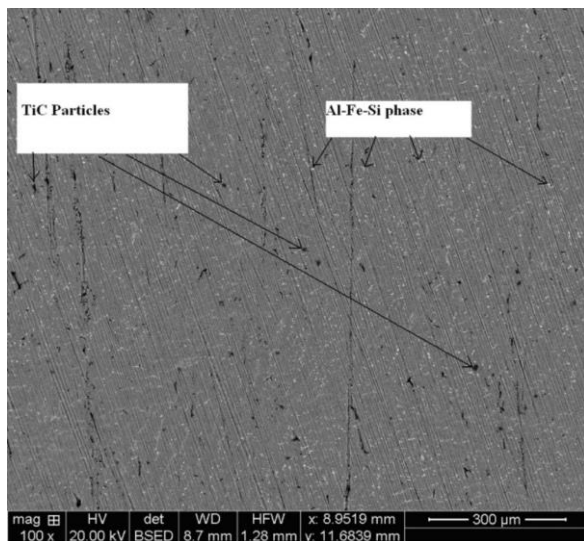


Fig. 10. Back-scattered electron SEM of Al 6061-TiC (6 wt %) composite showing regions of Al-Fe-Si rich phase and TiC particles.

Energy dispersive X-ray analysis

EDX spectra show the presence of various elements in the TiC-reinforced Al 6061 surface. The Back scattered SEM image of TiC (6 wt%) reinforced Al 6061 sample is shown in the **Fig. 10** and the EDX analysis of TiC rich phase is indicated in the EDX spectrum presented in **Fig. 11**. The presence of intense peaks for the elements Ti and C in the

EDX spectrum confirms the incorporation of TiC particles in to Al matrix, but to an extent greater than TiN which exhibits low wettability in Al. The presence of intermetallic phase of Al_4C_3 in Al-TiC composites is confirmed by the EDX spectrum shown in **Fig. 12**.

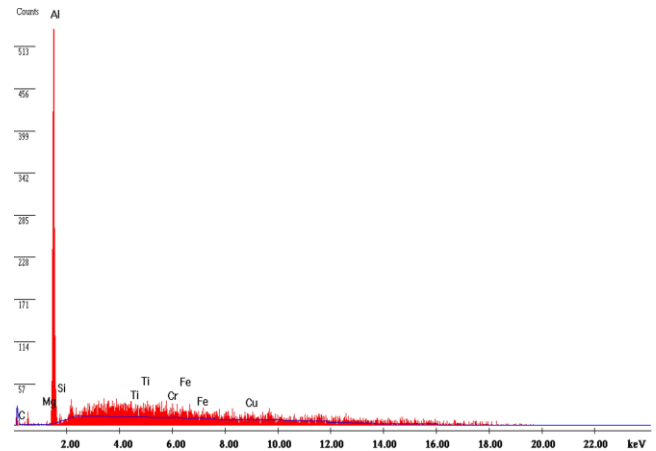


Fig. 11 EDX spectrum of TiC phase in Al 6061-TiC (6 wt %) composite.

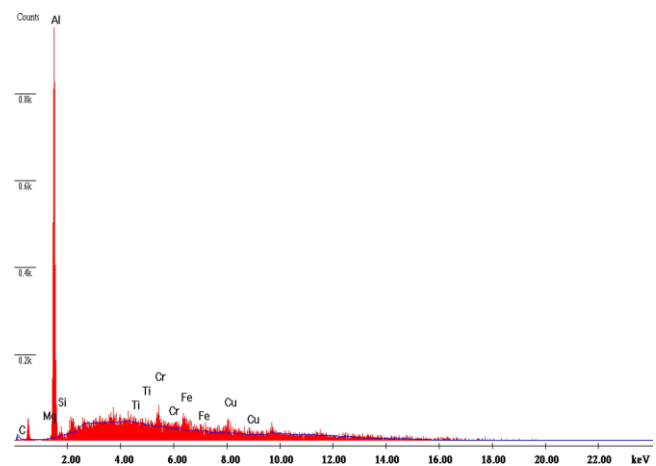


Fig. 12. EDX spectrum of Al_4C_3 phase in Al 6061-TiC (6 wt %) composite.

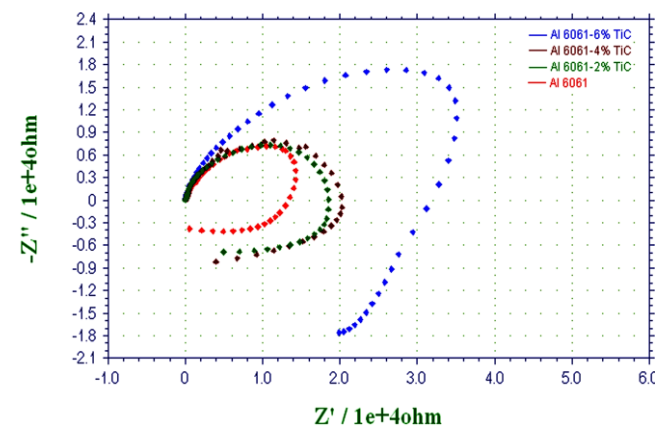


Fig. 13. Nyquist plots of the Al matrix alloy and its TiC composites in 0.5 N NaCl medium.

EIS studies

Nyquist plots of the Al 6061 matrix alloy and its TiC composites in 0.5 N NaCl solution is given in **Fig. 13**. The

HF capacitive loop is attributed to the presence of a protective oxide film on the surfaces of composites. The HF loop could be assigned to the relaxation process in the hydrated aluminium oxide film and its dielectric properties.

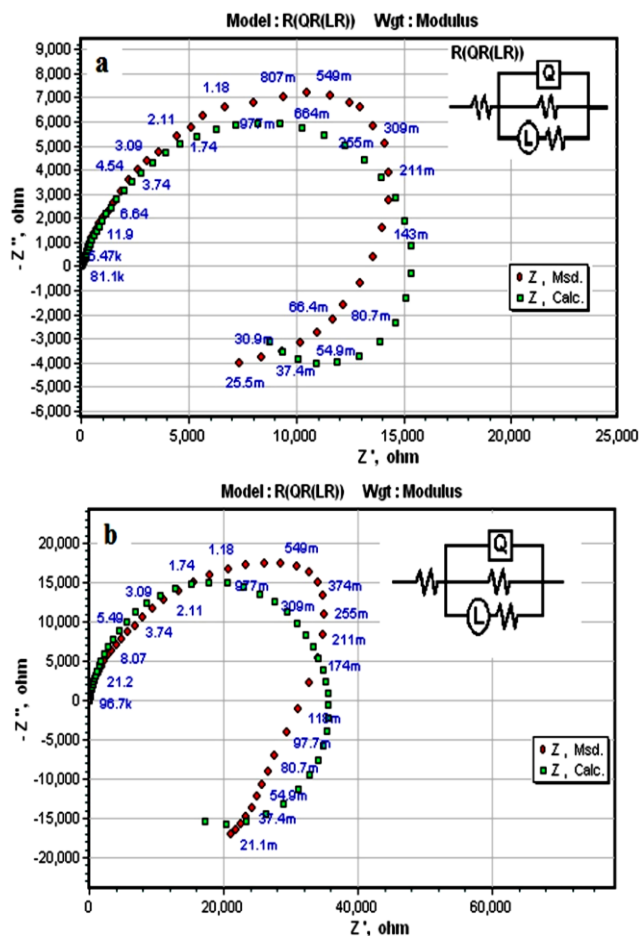


Fig. 14. Equivalent circuit model used to fit the experimental data of Al 6061 matrix alloy (a) and Al 6061-TiC (6 wt %) composite and (b) in 0.5N NaCl medium.

Table 7. Electrochemical parameters for Al 6061 matrix alloy and its TiC composites obtained from EIS studies.

TiC content in composites	Rs (ohm)	Rp (ohm)	CPE (F)
0%	3.154	14567	9.78×10^{-7}
2%	3.424	16502	8.22×10^{-7}
4%	3.889	25643	6.93×10^{-7}
6%	4.321	28456	1.80×10^{-7}

Impedance spectroscopic studies show increasing values of polarization resistance up on increase of TiC reinforcement. The EIS of the matrix alloy and its composites is measured after OCP recording for 60 minutes in order to speculate the contribution of oxide film on Al to the corrosion resistance of the composites. It can be observed from the Nyquist plots, that the radius of the capacitive loops above the real axis increases with increase in TiC content for composites. The electrochemical

parameters obtained in EIS studies for Al 6061 matrix alloy and its TiC composites are given in **Table 7**.

The origin of the inductive loop has been attributed to surface or bulk relaxation of species in the oxide layer. The LF inductive loop can be related to surface or bulk relaxation process obtained by adsorption and incorporation of chloride ions into the oxide [24]. Based on the analysis of the impedance spectra, an equivalent circuit model R [QR [LR]] was proposed for both the matrix alloy and composite (**Fig. 14**), simulating their electrochemical behaviour.

It can be found that the EIS spectra of all the samples are dominated by capacitance of the oxide film, but the diameters of the capacitance arcs increase with increase in TiC content, which means that the resistance of the surface oxide film on the composites increases with increase in TiC reinforcement. This can be perceived as due to the fact that the hydroxide formed by the oxides of Si, Mg and Al play an inhibitive role around the conducting TiC and intermetallic phases. The measured value of polarization resistance R_p increases while the CPE value decreases with increase in TiC content. This implies that the corrosion rate decreases with increase in the content of TiC reinforcement. It is also observed that the R_p value increases with increase in TiC content in composites confirming improved corrosion resistance in composites.

Conclusion

The corrosion behaviour of unreinforced Al 6061 matrix alloy and its composites reinforced with TiC (2, 4 and 6 Wt %) were studied in chloride medium. With increase in the TiC particulate reinforcement content in the Al composites, the OCP values increase in the noble direction indicating higher corrosion resistance imparted by the TiC particulates probably due to the breakdown of stable oxide film on Al matrix as a result of increased adsorption of chloride ions on the Al surface or its oxide layer. The increased corrosion resistance in composites is believed to be due to reinforcement particulates modifying the microstructure of matrix and also acting as physical barrier to the initiation and development of pitting corrosion. The XRD and EDX analysis of all the composites confirm the positive inclusion of the reinforcement particulates in the matrix alloy and also the presence of intermetallic phases. SEM pictures reveal severe deterioration of the surface of both matrix alloy and its composites of all the reinforcements. The measured value of polarization resistance R_p increases while the CPE value decreases with increase in content of the reinforcement in all the cases. The Nyquist plots of the matrix alloy and the composites in NaCl medium show semicircles indicating that the corrosion process is mainly charge transfer controlled. Al 6061-TiC composites were found to exhibit improved corrosion resistance as compared to the matrix alloy but there is a lot of scope for future research to explore the physical and mechanical properties of these composites.

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