



Article Comparison of Corrosion Resistance of the AA2524-T3 and the AA2024-T3

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Abstract: The 2XXX Al alloys are characterized by their superior mechanical properties resulting from alloying elements and precipitation hardening treatments. The AA2524-T3 alloy was developed to replace the AA2024-T3 alloy in the aerospace industry. However, both alloys present many intermetallic particles (IMCs) in their microstructure, and this is the main reason for their high susceptibility to localized corrosion (such as pitting and stress corrosion cracking). Despite the similarities between these alloys (e.g., chemical composition and type of intermetallics) the literature comparing their properties is scarce and focuses mainly on their mechanical properties, not their corrosion resistances. In this investigation, the corrosion resistance of the AA2524-T3 alloy was compared to the AA2024-T3 alloy. The microstructure of both alloys was analyzed by Scanning Electron Microscopy before and after immersion in the test electrolyte, and the number and area fraction of intermetallics of each alloy was determined. The corrosion resistance of both alloys was monitored as a function of exposure time by electrochemical impedance spectroscopy and the results were fitted using electrical equivalent circuits. The AA2524-T3 alloy.

Keywords: 2XXX aluminium alloys; intermetallics; aircraft industry; corrosion

1. Introduction

The 2XXX Al alloys are largely used in the aircraft industry due to their superior mechanical properties resulting from alloying elements addition, mainly Cu and Mg, and precipitation hardening treatments. The AA2524-T3 alloy is a relatively new alloy (formerly known as C188-T3) developed by ALCOA to replace the AA2024-T3 alloy in fuselage skins. It is currently used in the Boeing 777 aircraft [1,2]. It presents high damage-tolerance and excellent fatigue properties [1]. However, both the AA2024-T3 and AA2524-T3 alloys possess a large amount of intermetallic particles (IMCs) in their microstructure, and this is the main reason for their high susceptibility to localized corrosion such as pitting and stress corrosion cracking [3-8]. Localized corrosion in aluminium alloys uses to be caused by microgalvanic effects between IMCs and the matrix [7–10]. This generally results in pitting corrosion, which is considered to be one of the main microstructure dependent damage mechanisms of high strength aluminium alloys [7]. Particles constituted by the alloying elements present different electrochemical activity from the matrix and, therefore, represent preferential sites for pitting nucleation. In potential-controlled conditions, pitting is characterized by two types of events, metastable and stable, which occur before and after the pitting potential, respectively [11].



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According to Birbilis and Buchheit [12], three main types of IMCs particles can be found in high strength Al alloys: precipitates, dispersoids, and constituent particles. The first ones are formed by nucleation and growth from a supersaturated solution and their diameters are around few tenths to hundreds of nanometers. They contribute to an increase in the mechanical resistance of the alloy when they are coherent and homogeneously dispersed in the matrix [13]. It is reported that they can initiate intergranular corrosion and stress corrosion cracking when clustered near grain boundaries [12,14,15]. While dispersoids are typically bigger than the precipitates, they are still within the submicrometric to micrometric range. Their main role is to control recrystallisation and grain size [12,13]. Since they are mostly passive in environments where Al alloys are usually used and are uniformly distributed, they rarely increase corrosion susceptibility [12]. Finally, the constituent particles, in the present work denominated intermetallics (IMCs), are the largest ones. Its size range is from a few tenths of a micrometer to up to 10–20 micrometers. They tend to break down during mechanical treatments [12] and are frequently noticed in clusters [16]. They are enriched in different alloying elements and there is a universal agreement that pitting corrosion of high strength Al alloys is associated with these particles, mainly in chloride containing media.

In 2XXX series aluminium alloys, θ' (Al₂Cu) and S (Al₂CuMg) are two of the most important types of coarse IMCs particles. The S phase is associated with pitting nucleation [17] and some mechanisms have been proposed in the literature [18]. According to Moreto, et al. [19] the AA2524-T3 aluminium alloy presents two types of coarse intermetallics particles (Al-Cu-Fe-Mn) and incoherent S (Al₂CuMg) precipitates, which are also found in AA2024-T3 alloys [9,20]. The corrosion behaviour of these intermetallic particles has been largely investigated in the literature [17,21–27]. The effect of coarse Al-Cu-Mg IMCs on the localized corrosion behaviour of the AA2024-T3 alloy has been investigated by Buchheit, et al. [17] and Zhu, et al. [28]. Both authors [17,28] have noticed that this phase is an anodic site, favouring pitting nucleation. According to the literature [17,24], at an initial stage, anodic dissolution occurs on S phase particles. During this period, the Mg is preferentially oxidized, resulting in Cu-rich remnants. This leads to potential change into the nobler direction, promoting anodic dissolution of the alloy matrix at its neighbouring boundary. Zhu, et al. [28] proposed a "cathodic corrosion" mechanism to explain the localized corrosion in 2XXX alloys, which was in disagreement with Buchheit's proposal [17]. According to Zhu, et al. [28], during the anodic reaction of S phase particles, cathodic reactions of water and/or oxygen reduction occur at the neighbouring sites of the matrix, generating hydroxyl ions (OH⁻) [28]. Accordingly, local alkalization occurs around the S phase remnant and, once the local pH exceeds 9, chemical dissolution of the surrounding aluminium oxide layer takes place. Subsequently, the bare aluminium matrix would be oxidized to form a new oxide layer. On the other hand, the Al-Cu-Fe-Mn IMCs are usually cathodic sites, which are more stable and have less effect on the AA2024-T3 alloy's corrosion resistance than the Al-Cu-Mg ones [25,29–32].

Very few studies can be found concerning AA2524 [4,33–37], and only a few studies compare this alloy to the AA2024, focusing on its mechanical properties [2,38]. Although it is generally accepted that the localized corrosion caused by the IMCs is the nucleation site for other types of corrosion in high strength Al alloys [23,24], the role of the IMCs on these alloys' corrosion initiation has not been well established yet. This is mainly due to their small size, their chemical and microstructural complexity, and the dependence of reactivity to the environment [24]. This paper aims to evaluate the corrosion resistances of both AA2024 and AA2524, to compare the results, and to correlate them with their microstructure.

2. Materials and Methods

The materials studied in this work were the AA2524-T3 and the AA2024-T3 alloys produced by ALCOA, both provided as 1.6 mm sheets. Their chemical compositions are shown in Table 1 and their main mechanical and corrosion properties are shown in Table 2.

The AA2524-T3 alloy has lower amounts of Fe and Si, which are considered as deleterious to the corrosion resistance, and a narrower range for the main alloying elements Cu and Mg [32].

Table 1. Analyzed and nominal chemical composition (wt %) of the AA2024-T3 and AA2524-T3 alloys [39].

Elements	AA2024-T3	AA2524-T3
Cu	4.06 (3.8-4.9)	3.84 (4.0-4.5)
Mg	1.77 (1.2–1.8)	1.31 (1.2–1.6)
Mn	0.63 (0.3–0.9)	0.56 (0.45–0.7)
Si	0.11 (0.5 max)	0.04 (0.06 max)
Fe	0.14 (0.5 max)	0.06 (0.12 max)
Ti	-(0.15 max)	0.029 (0.10 max)
Zn	0.02 (0.25 max)	0.01 (0.15 máx)
Al	Balance	Balance

Table 2. Mechanical and corrosion properties of the AA2024-T3 and AA2524-T3 alloys.

	Tensile Strength (MPa)	Yield Strength (MPa)	Elongation (%)	Electrical Conductivity % IACS	Open Circuit Potential (V _{SCE})		
AA2024 [40]	435	290	10–15	30	-0.722 [41]		
AA2524 [42]	445.4	340.3	19	34	-0.590 [43]		

Samples of 400 mm² were cut from the sheets. Their surfaces were prepared by grinding them with silicon carbide paper up to # 4000, followed by polishing with a diamond paste (up to $0.25 \,\mu$ m) to a mirror surface, degreasing in ethyl alcohol, washing with deionized water, and drying under a hot air stream. The corrosion resistance of both aluminium alloys was monitored in 0.01 mol L⁻¹ NaCl as a function of exposure time by immersion tests and electrochemical impedance spectroscopy (EIS).

Experiments were performed using a Solartron 1287 electrochemical interface coupled to a Solartron 1260 frequency response analyser (FRA), which was used to obtain the electrochemical impedance spectroscopy (EIS) diagrams. The perturbation range was 20 mV (rms). The acquisition rate was 10 points per decade in a frequency range from 10 mHz to 100 kHz for all samples. The electrochemical tests were performed using a three-electrode setup configuration with the aluminium alloys as working electrodes and an exposed area of 1.0 cm^2 (Figure 1). The reference electrode used was an Ag/AgCl, 3 mol L⁻¹ KCl, and a platinum wire was employed as an auxiliary electrode. The electrochemical experiments were carried out in naturally aerated solution at room temperature. Each test was performed six times to ensure their reproducibility.

The microstructures of the aluminium alloys were analyzed by a Field Emission Gun Scanning Electron Microscope FEI Quanta 650 (FEG–SEM) prior and after different exposure periods to the test electrolyte.



Figure 1. (a) Specimen of AA2524 in as-received condition and (b) three-electrode setup configuration cell. The reference electrode (RE) was an Ag/AgCl, 3 mol L^{-1} KCl, and a platinum wire was employed as an auxiliary electrode (EC). The sample was the working electrode (WE).

3. Results and Discussion

The surface of both the AA2024-T3 and AA2524-T3 alloys were observed by SEM after 2 h exposure to the 0.01 mol.L⁻¹ NaCl solution. A general view of the microstructures of the AA2024-T3 and AA2524-T3 alloys are shown in Figure 2a,b, respectively (both in an as-received condition). The two main types of coarse IMCs particles (Al-Cu-Mg (Figure 2c,d) and Al-Cu-Mn-Fe-(Si) (Figure 2e,f)) were identified by EDX, and they are in agreement with the literature [9,10,19]. However, in the AA2524-T3 alloy, the Al-Cu-Mn-Fe-(Si) particles were present in a lower amount and with different morphologies from those found in the AA2024-T3 alloy, whereas the Al-Cu-Mg are more numerous, smaller, and more uniformly distributed. The AA2024-T3 alloy is characterized by a smaller number of IMCs, which, however, are generally larger than those found in the AA2024-T3 alloy (Figure 3). Consequently, the area fraction of the AA2024-T3 IMC's is higher than the AA2524-T3 (Table 3).

Table 3. Comparison of IMCs area fraction of AA2024 and AA2524 alloys.

Material	IMCs Area Fraction (%)					
AA2024-T3	2.52 ± 0.42					
AA2524-T3	1.64 ± 0.14					

The general analysis of the micrographs (Figure 4) show that the corrosive attack is more evenly distributed on the AA2524-T3 alloy (Figure 4b), whereas for the AA2024-T3 alloy (Figure 4a) it is mainly concentrated around larger IMCs, including the dark areas around the bigger Al-Cu-Mg precipitates (indicated by arrows). On both alloys, the Al-Cu-Mn-Fe precipitates showed a rather random behaviour with some of them remaining intact after 2 h of immersion, likely due to a protective oxide film that hinder the cathodic reaction, as suggested by Birbilis, et al. [12] (Figure 4a,b).

After 7 h of testing of the AA2024-T3 alloy, the corrosive attack was mainly concentrated at the interface between the matrix and the larger intermetallic particles. No localized corrosion at the grain boundaries was detected. (Figure 4c). Figure 4d shows that most of the smaller precipitates had been removed from the surface of the AA2524-T3 sample by the corrosive attack, resulting in a "cleaner" surface in comparison with 2 h of test, even though some local activity remained around large IMCs. On the other hand, the corrosive attack of the AA2024-T3 continued to be mainly concentrated at the interface between

the matrix and the larger intermetallic particles (Figure 4c), which, as previously showed, were more numerous in this material. For longer immersion times the "cleaning" effect on the AA2524-T3 surface is even more pronounced than that of the AA2024-T3 (Figure 4f,e, respectively).



Figure 2. Microstructures of AA2024-T3: (a) general view; (c) Al-Cu-Mg; and (e) Al-Cu-Mn-Fe-(Si) particles. Microstructures of AA2524-T3: (b) general view; (d) Al-Cu-Mg; and (f) Al-Cu-Mn-Fe-(Si) particles. As-received condition. SEM–BSE.

After 11 h of exposure to the test electrolyte, most of the small precipitates were removed from the surface of both alloys (Figure 4e,f). Additionally, Figure 4g,h show the selective attack near the IMCs for longer exposure periods.

The results showed that IMCs' area fraction of the AA2524-T3 is lower in comparison with the AA2024-T3. More than 94% of these IMCs of the first alloy are smaller than 10 μ m, and only 82% of the latter, confirming the theory that the corrosion attack on the AA2524-T3 alloy surface was faster due to its larger number of small particles.



Figure 3. Frequency (%) and size distribution (μ m²) of IMCs for as-received samples. More than 94% of the AA2524-T3 alloy and 82% of the AA2024-T3 alloy IMCs are smaller than 10 μ m².

The corrosion resistance of both alloys was also evaluated by EIS with immersion time and the results are shown in Figures 5 and 6. It is clearly seen that the impedance modulus associated with the AA2524-T3 alloy was higher than that of the AA2024-T3 during the whole test period. Independently of the alloy brand, EIS diagrams are characterized by a broad high frequency depressed capacitive loop followed by a low frequency capacitive loop that evolves to a diffusion-controlled process after 11 h of exposure to the test electrolyte.

The EIS results for both alloys were fitted with the two/three-time constants equivalent electric circuits (EEC) shown in Figure 7. These ECC have been established in the literature on aluminium alloys EIS fittings and were also tested in previous works from our research group [9,44-46]. Table 4 presents the parameters obtained from the equivalent electrical circuit fitted to the AA2024-T3 and AA2524-T3 EIS data. The EEC of Figure 7a was used to fit the data acquired from the first hour until 9 h of immersion, whereas the diagrams obtained from 11 h until the end of the test were fitted with the EEC of Figure 7b. In this latter case, the low frequency R / / CPE element was substituted for a single CPE, meant to simulate a diffusion-controlled process. According to Campestrini, et al. [47], when the resistance associated with the diffusion becomes very large the R//CPE element may be replaced by a simple *CPE* element with the exponent " α " value of 0.5, which, in an ideal situation, is represented by a Warburg element. In the proposed circuits the pair $R_{ox}//CPE_{ox}$ stands for the capacitance of the oxide film in parallel with conductive pathways associated with defective sites created by the IMCs, which leads to the unprotected metal surface. $R_{ct}//CPE_{dl}$ refers to the charge transfer resistance coupled to the charging of the double layer, whereas CPEcor//Rcor is ascribed to the low frequency corrosion processes that kinetically control the alloys' deterioration, which gradually evolves to a diffusion-controlled process and is likely associated with the oxygen reduction reaction taking place in nobler IMCs.



Figure 4. Microstructures of AA2024-T3 after (**a**) 2 h, (**c**) 7 h, (**e**) 11 h, and (**g**) 20 h. AA2524-T3 after (**b**) 2 h, (**d**) 7 h, (**f**) 11 h, and (**h**) 20 h of exposure to the 0.01 mol.L⁻¹ NaCl solution. SEM–BSE. The micrographs show the evolution of the localized corrosion at the interface IMC/matrix (indicated by arrows).



Figure 5. Evolution of EIS results for the AA2024-T3 as a function time of exposure to 0.01 mol L^{-1} NaCl electrolyte. (A) Bode phase angle and (B) Nyquist diagram. Measurements were taken after 2, 5, 7 and 9 h of the experiment. (C) Bode phase angle and (D) Nyquist diagram. Measurements were taken after 11, 20, 48 and 72 h of the experiment.

Table 4 shows the evolution of the $R_{ox}//CPE_{ox}$ values. For both alloys, CPE_{ox} increased with exposure time. SEM analysis has shown that as the corrosive attack proceeded, holes were formed in the samples surface as a result of the dissolution/detachment of the IMCs particles increasing the effective area exposed to the electrolyte [10]. If pits did not progress in these regions, a fresh oxide layer was formed. However, it should be more defective. Both facts contribute to capacitance increase. In addition, from the beginning of the exposure period, and during the whole test, CPE_{ox} was smaller for AA2524-T3, indicating the presence of a thicker oxide layer in this alloy, in agreement with the results from previous studies in the literature [46,48].



Figure 6. Evolution of EIS results for the AA2524-T3 as a function time of exposure to 0.01 mol L^{-1} NaCl electrolyte. (**A**) Bode phase angle and (**B**) Nyquist diagram. Measurements taken after 2, 5, 7, and 9 h of the experiment. (**C**) Bode phase angle and (**D**) Nyquist diagram. Measurements taken after 11, 20, 48, and 72 h of the experiment.

Concerning R_{ox} , Table 4, it also increased with immersion time, indicating that electrochemically active sites on both alloys' surfaces become less numerous and/or were less easily reachable. As already demonstrated in the SEM analysis (Figure 4), the selective attack near the IMCs results in surface "cleaning", leading to a lower number of active sites. In addition, deposition of corrosion products was frequently found above large IMCs. These features would hinder the access of aggressive species to the matrix surface and can contribute to the R_{ox} increase. Accordingly, as the surface of AA2524-T3 progressively became "cleaner" than AA2024-T3, the rate of the R_{ox} increase was much faster for the former alloy. Therefore, it is proposed that the attack of the small particles and their removal from surface are the main reasons for the R_{ox} increase, as this reduces the number of defective sites where electrochemical reactions could take place. However, blocking of active site by aluminium hydroxide precipitation may also have contributed to the R_{ox} increase.



Figure 7. Equivalent electrical circuits (EEC) proposed to fit the data of the AA2024-T3 and AA2524-T3 (**a**) until 9 h and (**b**) from 11 h of immersion in a 0.01 mol L^{-1} NaCl solution.

As mentioned earlier, the $R_{ct}//CPE_{dl}$ pair is associated with the charge transfer reactions (R_{ct}) occurring at the interface of the matrix at the defective sites of the oxide (near active IMCs). The evolution for the components R_{ct} and CPE_{dl} with exposure time to the 0.01 mol L⁻¹ NaCl electrolyte is shown in Table 4. For AA2524-T3, R_{ct} behaviour was significantly oscillating during the whole immersion period, which must has been a consequence of the detachment and outbreak of new IMCs as corrosion proceeded. For this sample, CPE_{dl} remained almost constant during the first 15 h, indicating that the electrochemically active surface area remained almost unchanged. However, from this period onwards the decrease in CPE_{dl} might be attributed to the formation of corrosion products on some active areas, clearly indicated on the AA2524-T3 surface, that partially blocked these sites.

Conversely, for AA2024-T3, after up to 40 h of testing, R_{ct} decreased continuously. This tendency may be explained by the enrichment in the more noble components of the remaining active IMCs. Therefore, even though in smaller number, due to detachment, enhanced galvanic activity would be expected between the matrix and the Cu-enriched IMCs. For longer immersion periods, an increase of R_{ct} was observed. This can be ascribed to the precipitation of corrosion products above the IMCs and their vicinity, which provided a barrier between the electrolyte and the metallic surface. Accordingly, CPE_{dl} initially increased, indicating that the electrochemically active surface augmented. However, for longer exposure times, it started to decrease due to active surface area reduction as corrosion products precipitated.

Finally, the low frequency time constant, corresponding to the rate-controlling step of the corrosion process, was mainly represented by CPE_{cor} and its " α_{cor} ", and R_{cor} were important only up to nine hours of exposure. During the initial immersion period, α_{cor} values ranged between 0.69 and 0.83, suggesting a mixed controlled process for both alloys, corresponding to the period where the EIS diagrams were fitted with the EEC of Figure 6. For longer immersion times, " α_{cor} " varied between 0.4 and 0.6, showing the main contribution of diffusive processes likely through the precipitated corrosion products.

Higher capacitance values were associated with the AA2024-T3 alloy comparatively to the AA2524-T3 (Table 4) after the first hour of immersion, although there was much larger variation in the CPE_{cor} values for this latter alloy, likely due to the stronger contribution of partially soluble corrosion products on active sites at its surface which were periodically removed.

The electrochemical results demonstrated that the corrosion resistance of the AA2524-T3 was higher than the AA2024-T3.

						I										
	2 h		2 h		2 h 5 h 7 h 9 h		11 h 20 h		h	48 h		72 h				
	2524	2024	2524	2024	2524	2024	2524	2024	2524	2024	2524	2024	2524	2024	2524	2024
Rsol $\Omega \cdot cm^2$	346.40	394.20	342.10	388.70	334.90	382.80	330	380.40	328.40	381.20	325.10	373.80	316.90	362.30	318.80	376.90
Error (%)	0.40	0.27	0.50	0.22	0.40	0.16	0.32	0.16	0.34	0.27	0.34	0.25	0.37	0.37	0.32	0.30
$CPEox \\ \mu F \cdot cm^{-2} \cdot s^{(\alpha-1)}$	6.27	16.60	5.99	16.30	6.07	14.90	6.39	15.30	6.84	19.20	8.58	20.80	13.80	34.70	18.00	43.30
Error (%)	2.44	8.14	2.36	5.84	1.75	3.88	1.28	3.52	1.29	4.57	1.27	3.41	1.39	4.28	1.44	3.63
$Rox \Omega \cdot cm^2$	327.10	57.15	351.60	56.04	413.10	57.71	479.10	64.06	541.80	79.83	752.30	107	954.50	210.20	761.40	239.70
Error (%)	6.18	9.32	4.53	5.17	3.78	3.02	3.15	2.77	3.37	3.78	5.21	3.33	7.58	9.46	7.78	10.02
$\begin{array}{c} CPEdL\\ \mu F \cdot cm^{-2} \cdot s^{(\alpha-1)} \end{array}$	14.80	58.90	16.40	75.40	16.60	89.30	16.10	91.50	14.40	83.50	11.50	80.80	8.85	44.00	13.10	50.20
Error (%)	3.23	3.39	3.26	2.19	3.13	1.40	2.53	1.35	2.84	2.06	4.65	2.14	6.20	6.93	4.73	6.19
α dL	0.86	0.89	0.88	0.88	0.88	0.87	0.87	0.87	0.89	0.89	0.90	0.90	0.97	0.99	0.94	0.96
Error (%)	0.81	0.66	0.81	0.49	0.83	0.35	0.71	0.36	0.78	0.50	1.33	0.57	1.74	1.79	1.40	1.69
R ct k $\Omega \cdot$ cm ²	7.37	4.66	7.73	4.37	6.98	4.28	7.27	4.06	7.88	3.16	6.26	3.48	5.43	2.47	6.54	3.50
Error (%)	2.09	2.94	2.89	2.78	2.61	2.20	2.01	2.11	2.88	2.61	3.79	3.43	4.30	5.09	3.03	5.48
$CPE cor \\ \mu F \cdot cm^{-2} \cdot s^{(\alpha-1)}$	174.00	180.04	187.70	241.00	239.59	313.00	274.00	358.00	204.00	341.00	283.00	327.00	199.00	352.41	275.00	295.00
Error (%)	1.95	1.00	3.31	1.28	3.05	1.38	2.88	1.44	3.07	1.16	4.46	1.87	2.65	1.75	2.71	1.98
α cor	0.76	0.81	0.63	0.74	0.65	0.69	0.64	0.64	0.45	0.54	0.46	0.50	0.42	0.59	0.57	0.60
Error (%)	1.77	1.00	2.78	1.42	3.26	1.51	2.72	1.43	2.25	0.79	3.84	1.26	1.70	1.33	2.16	1.56
$R \operatorname{cor} k\Omega \cdot \operatorname{cm}^2$	22.46	30.15	27.51	27.98	27.91	33.66	26.06	54.26								
Error (%)	3.36	1.93	5.35	3.70	8.76	5.49	6.94	7.53								

Table 4. Parameters obtained from the equivalent electrical circuit fitted to the AA2024-T3 and AA2524-T3 EIS data.

4. Conclusions

In this study, the corrosion resistances of the AA2024-T3 and the AA2524-T3 alloys were compared. The differences between these alloys are the number and the precipitates' area fraction. The AA2024-T3 alloy has a smaller number of IMCs, which, however, are larger than those found in the AA2524-T3 alloy. Therefore, the IMCs area fraction of the former is higher than the latter. The SEM results suggest that the rapid removal of active sites from the AA2524-T3 surface (smaller IMCs) promotes a cleaner surface.

The hypothesis that defective areas prone to electrochemical reactions were removed from AA2524-T3 was confirmed by the EEC fitting to EIS results, as AA2524 R_{ox} increases and CPE_{ox} decreases with immersion time. Additionally, the corrosion process of AA2524, represented by CPE_{cor} , " α_{cor} " and R_{cor} , are significant only up to nine hours of exposure and confirm the higher contribution of active sites of the surface, caused by partially soluble corrosion products.

The electrochemical tests also showed that the localized corrosion resistance of the AA2524-T3 was higher than the AA2024-T3 during the whole test period. This was indicated by the higher impedance values associated with the first alloy and confirmed by surface observation after various immersion periods in the tested electrolyte. On the other hand, SEM analysis showed that the corrosion attack on the AA2524-T3 alloy surface was faster due to its larger number of small particles.

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