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Corrosion Resistance and Performance of Al2014-B_4C Composites: A Comprehensive Study

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Abstract

The corrosion characteristics of Al2014-B_4C Metal Matrix Composites (MMCs) are examined through weight measurement techniques and SEM studies. The specimens containing B_4C contents between 3 % and 12 % were soaked in a 3.5 wt. % NaCl solution for durations from 20 to 120 hours. The investigation studied the corrosion rates through weight measurements of the test samples from before and after immersion, then compared pure Al2014 to its B_4C-reinforced composites. Al2014 pure showed the highest corrosion speed, yet adding B_4C reduced this value in the materials. The results indicated that a 12 % B_4C composite displayed the minimum corrosion rate at every time, both before and after heat treatment. The overall corrosion rates declined after heat treatment for all alloys, in which the 12 % B_4C composite showed improvement. SEM studies confirmed that B_4C addition led to Al2014 alloys initiating superior corrosion protection by making the surfaces smoother and showed reduced signs of damage. The results exhibit that the addition of B_4C to Al2014 alloys makes an excellent corrosion protection system, which heat treatment manages to improve even further.

Major Findings: *Addition of B_4C to Al2014 reduces corrosion rates, with the 12% B_4C composite showing the lowest rate. Heat treatment further improved corrosion resistance, and SEM analysis showed smoother surfaces and better protection.*

Keywords: *Al2014 Alloy, B_4c Reinforcement, Corrosion Behaviour, Heat Treatment, Metal Matrix Composites, Microstructure, Sem Analysis*

1.0 Introduction

Composite materials achieve their diverse set of characteristics by belonging to specific categories. The formation of these materials follows systematic classification according to matrix-reinforcement combinations used in their production methods[1]. Materials receive reinforcing elements that give mechanical strength and stability through three different forms: fibres enhance directional strength, particles enhance uniform properties, and structural reinforcements support complex load-bearing needs. Both mechanical strengths and heat resistance and wear resistance benefits accrue because of these reinforcement methods. The matrix functions as the material binding agent, passing load stress between the reinforcements and shielding them from environmental threats[2]. Each matrix utilises one of three material categories, including metals, polymers, and ceramics, for fundamental advantages that include stable thermal characteristics and a lightweight design, along with robustness. Engineering composites through the precise combination of fibres and matrix

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allows developers to shape these materials for demanding industrial uses; thus, they find wide use in aerospace applications alongside automotive production and structural engineering[3]. Consumers value Metal Matrix Composites (MMCs) because they represent the leading category of composite materials, which deliver exceptional mechanical property enhancements. Metal Matrix Composites achieve their improved mechanical properties through the combination of ceramic particulates embedded in metallic matrices. The improved properties of MMCs make them the top selection for vital applications which demand robustness and efficient operation. The matrix role in MMCs mostly falls to aluminium alloys since they possess inherent benefits[4,5]. Automobile engineers value these cost-effective metallic alloys because they demonstrate outstanding strength and excellent corrosion resistance properties, which make them ideal for engineering applications. Processing techniques available for aluminium alloys include casting, along with heat treatment, as well as wrought processes which permit customisation for different applications. Composites built from aluminium and ceramic reinforcement material yield superior structures which benefit aerospace as well as automotive and structural engineering fields that demand reduced weight and exceptional strength properties[6]. The research focuses on Al2014 aluminium alloy within the Metal Matrix Composite (MMC) framework because of its remarkable mechanical and thermal properties. The high-strength alloy shows excellent machinability while maintaining outstanding thermal stability because of which it a strong engineering solution for advanced applications. The natural properties of Al2014 material have made it the industry standard in aviation applications as well as automotive and structural engineering because of its critical performance and reliability needs[7]. Al2014 retains its properties well during demanding operating conditions while offering compatibility with ceramic reinforcements that strengthen its mechanical design. Engineers achieve optimal performance results through Al2014 incorporation within MMCs, which satisfies the modern engineering requirements of industrial applications. The superior properties of Al2014 aluminium alloy serve as a basis for additional improvements, which can be achieved through advanced reinforcement methods. Among a vast range of reinforcement materials, boron carbide (B_4C) emerges as an exceptional choice because it offers exceptional ultra-high hardness joined with superior wear resistance, along with exceptional chemical inertness and low-density properties[8,9]. The mechanical properties of Al2014 matrices receive significant augmentation when B_4C is included because B_4C enhances both load-bearing ability and thermal behaviour and dislocation mobility, and chemical stability. Strategic reinforcement of B_4C particles allows the creation of composites that reduce weight while attaining enhanced mechanical characteristics that include improved hardness and tensile strength, and enhanced wear resistance[10]. The incorporation of B_4C particles into Al2014 satisfies the engineering requirements of lightweight materials required in aerospace and automotive sectors because of their strict present-day demands. The combination of Al2014 matrix and B_4C reinforcement represents future-oriented material development for modern technological needs. The fabrication process of these composites requires an efficient and scalable manufacturing approach because of the exceptional matrix-reinforcement synergy in Al2014 with B_4C. The manufacturing method of stir casting stands out because it offers economic value and broad applicability in Metal Matrix Composite (MMC) production[11]. Molten aluminium alloy receives B_4C particles through a stepwise stirring process, which leads to uniform distribution of the reinforcement within the matrix. The uniform distribution simultaneously prevents particle clumping and creates better matrix-reinforcement attachment[12]. The superior mechanical properties of the composite material result from these improvements, which include better hardness and enhanced wear resistance and stronger tensile strength. The stir casting method provides adaptability, which enables its use in industrial-scale production for aerospace and automotive sectors where performance alongside cost-effectiveness matters the most[13]. Al2014-B_4C composite production through stir casting has proven popular, but maintaining a high-quality product requires dealing with various manufacturing difficulties which emerge from this method. The creation of voids along with particle agglomeration constitutes major fabrication problems[14]. Optimal reinforcement distribution in stir casting requires finding the best parameters between the stirrer speed and temperature, together with the particle size of B_4C. Research indicates that using small B_4C particles leads to improved distribution inside aluminium matrix structures, which strengthens and stabilises the composite

material. The greatest challenge comes when using ultrafine particles because they make the molten metal more viscous, although smaller particles enhance dispersion[15]. The raised viscosity creates challenges for the uniform distribution of particles throughout the composite material, which affects its mechanical properties. The flowability of metal material improves at higher stirring speeds and elevated temperatures, thus reducing the formation of pores by achieving better particle wetting. The degradation of B_4C particles occurs when the temperature reaches excessive levels, which decreases their capacity to act as a reinforcing element[16-18]. The mechanical structure of composites suffers from improper suspension of particles during cooling, since inadequate control of such settlements results in poor distribution patterns. Understanding how to control the specified factors effectively leads to obtaining the best possible results in Al2014-B_4C based composites[19,20]. The research examined aluminium alloy-B_4C composite development alongside their properties during corrosion exposure through an extensive review of the literature. The following summary shows how Boron Carbide (B_4C) reinforcement improves aluminium alloy performance when exposed to corrosive conditions. The research conducted by Zhang *et al.*,[21] examined Al6061-B_4C composite corrosion resistance through exposure to NaCl solutions in prolonged testing. When B_4C was added to the material, its corrosion resistance decreased substantially compared to stand-alone aluminium. The surface of aluminium composites containing higher B_4C concentrations showed reduced pits and enhanced smoothness based on SEM examination. Research by Kumar *et al.*,[22] related to Al7075-B_4C composites, which showed enhanced corrosion resistance because B_4C content improved both matrix porosity reduction and reinforcement dispersion uniformity. Patel *et al.*,[23] investigated Al2014-B_4C composites through stir casting fabrication to test their resistance against saline conditions. The research showed that B_4C particles introduced into the material structure reduced their corrosion rate and simultaneously strengthened their mechanical capabilities. Sharma *et al.*,[24] examined the relationship between heat treatment and corrosion protection of aluminium MMCs through their research on Al5083-B4C composites. Research findings showed that heat treatments led to decreased corrosion rate levels when compared to untreated aluminium MMCs. The research by Lopez *et al.*,[25] studied how different amounts of B_4C affected Al2024 alloy outcomes. The study revealed that when B_4C concentration increased, together with heat treatment, the corrosion rate showed its most significant reduction. Surface defects decreased while overall composite surface integrity improved according to SEM images. The research by Yang *et al.*,[26] evaluated how changing reinforcement particle size affects the corrosion resistance of Al6061-B_4C composites. The research showed that B_4C particles of smaller sizes produced uniform distribution patterns while minimising galvanic corrosion effects, thus improving the composite's resistance to corrosive environments. Narayan *et al.*,[27] examined Al2014-based composites reinforced to different extents with B_4C. The experiments verified that increasing the reinforcement ratio in B_4C/Al2014 composite materials decreased the amount of weight loss while immersed in NaCl solutions. In addition, Bhat *et al.*,[28] studied both tribological performance and corrosion resistance of Al7075-B_4C composite materials. The research team demonstrated that B_4C acts as a dual component which both increases wear resistance and minimises corrosion rates, thus being suitable for automotive and marine use. Venkatesh *et al.*,[29] investigated how B_4C content, together with exposure time, influences Al2024 composite corrosion resistance. The corrosion rate decreased as the B_4C content increased, while the reinforced samples showed fewer corrosion products under scanning electron microscopy analysis. Multiple research findings demonstrate that B_4C reinforcement proves efficient for improving aluminium alloy corrosion resistance. The research details Al2014-B_4C composite production through stir casting and investigates their corrosion behaviour. The investigation determines how different levels of B_4C reinforcement influence corrosion behaviour in Al2014-B_4C composites using gravimetric tests before and after heat treatment. The analysis incorporates mass loss assessment, together with corrosion rate determination, along with SEM-based microstructural examinations. The corrosion resistance of Al2014-B_4C composites significantly increases with higher B4C content, especially after heat treatment and the 12% B_4C composite showed the best results. Research indicates that Al2014-B_4C composites present excellent applicability potential for high-performance automotive applications as corrosion-resistant components such as cylinders, brake drums and pistons.

2.0 Experimental Details

2.1 Materials

The present investigation uses Al2014 alloy as the matrix composition, while Boron carbide particulates are used as reinforcement material. Table 2 describes the constituents of Al2014 alloy. This aluminium series achieves optimal strength through copper addition as the main alloying component. The alloy shows exceptional suitability for machinability because it allows easy processing through machine tools. The material maintains suitable heat treatment properties to enhance its strength levels. B_4C boron carbide particles are used as reinforcement in this study. This material stands out because of its high hardness, together with decreased density, alongside better thermal and chemical stability characteristics. Detailed composite development is studied in our previous study[30].

2.2 Gravimetric Corrosion Test

The gravimetric corrosion test is conducted as per ASTM G31 standards. In the current test, 3.5 wt. % NaCl solution is used as an electrolyte. The pre-weighed samples (W_1) are fully immersed in 250 mL NaCl in sealed containers for a duration of 20 to 120 hours, respectively, in steps of 20 Hrs each. After each time interval, remove samples and rinse with deionised water. Clean corrosion samples using Clark's solution. Dry and reweigh samples (W_2) to calculate mass loss. A total of 10 mm x 10 mm x 2 mm polished test samples received a double-distilled water wash followed by air-drying. The sample cubic pieces remained submerged inside a 250 mL NaCl solution jar containing a 1 M 3.5 wt % % solution at room temperature for 20, 40, 60, 80, 100, and 120 hours. The beaker received a paraffin coating to stop solution vaporisation, along with solution contamination. Evaluation of the immersed weight change relied on a digital balance with a precision of 0.1 mg for both pre-immersion and post-immersion measurements. The research subject underwent washing with Clark's solution, then received cleaning by scrubbing, before receiving air-drying, followed by weighing. The experiments were carried out three times to verify reliability, along with repeatable results. The standard formula produced the corrosion rate calculation during the analysis[31].

2.3 Corrosion Rate Calculation

Corrosion Rate (MPY)

- W_1 - W_2: Weight loss in mg
- D: Density of composite (g/cm^3)
- A: Exposed area in cm^2
- T: Exposure time in hours

Corrosion rate assessed in mils per year (mpy), w is the weight loss in mg, D is the density in g/cm^3, and T refers to disclosure time in hrs, while A is the surface in inch^2.

Table 2. Elements of Al2014 matrix materials[30]

Elements	Cr	Mg	Zn	Si	Fe	Ti	Cu	Mn	Al
Wt. %	0.02	0.68	0.18	0.8	0.3	0.05	4.8	0.84	Balance

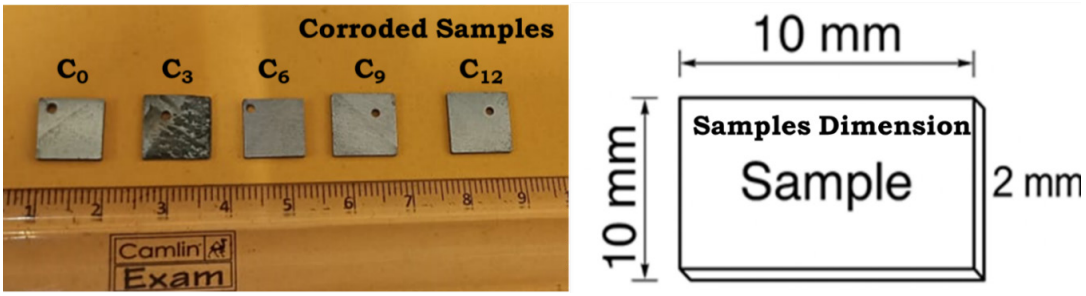


Figure 1. Corroded test samples and their dimensions of Al2014 alloy and its B_4C MMCs.

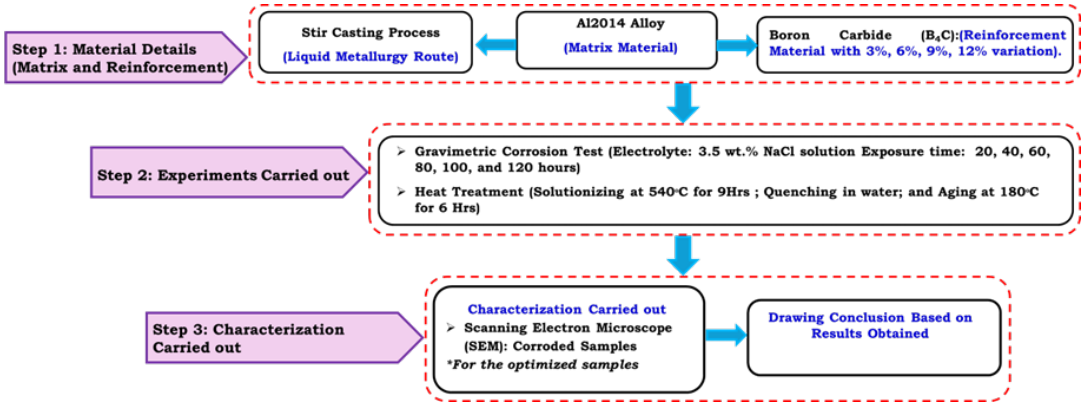


Figure 2. Flowchart displaying the experimental procedure of Al2014 alloy and its B_4C MMCs.

3.0 Results and Discussion

3.1 Corrosion Results

The graph in Figure 3 illustrates how different concentrations of B_4C reinforcement contribute to weight-based corrosion rates (in mils per year, MPY) of Al2014 alloy during time-testing. The figure displays exposure time in hours through the x-axis from 20 to 120 hours and shows corrosion rate in MPY through the y-axis. Throughout the entire duration, the corrosion rate showed a downward tendency for every material composition. Al2014 alloy (blue colour) exhibits the maximum corrosion rate of 30 MPY before its rate declines throughout the measurement period. All corrosion rates in aluminium alloys containing B_4C at 3 % to 12 % proved lower than rates for pure Al2014. The Al2014/12 % B_4C alloy (cyan colour) exhibits the lowest corrosion rate throughout all periods as the B_4C content grows in the material composition. The corrosion rates of all tested alloys decrease progressively with each passing hour, revealing their reduction in degradation speed. The added B_4C reinforcement produces enhanced corrosion resistance properties in Al2014 alloy[32].

The gravimetric corrosion rates (in MPY) of Al2014 alloy with different B4C additions, receiving HT (Heat Treatment) displayed in Figure 4. Corrosion rates are presented on the y-axis as MPY, while the exposure duration from 20 to 120 hours appears on the x-axis. Heat treatment of the entire alloy range produced lower corrosion rates than what was observed previously when heat treatment was not used. The corrosion rate of pure Al2014 (blue colour) remains highest in this figure at 22 MPY, yet shows a decrease from its initial measurement in

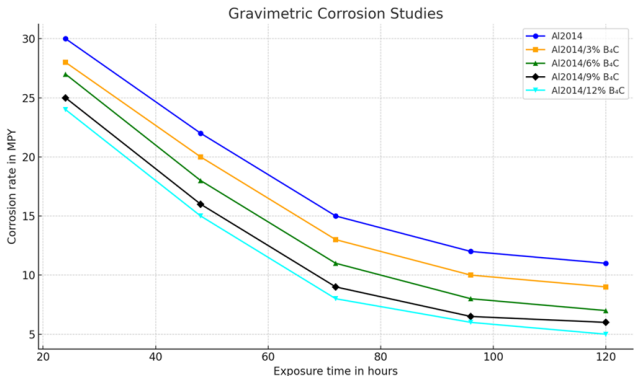


Figure 3. Gravimetric Corrosion Test Results of Al2014 alloy and its B_4C MMCs (Before Heat Treatment).

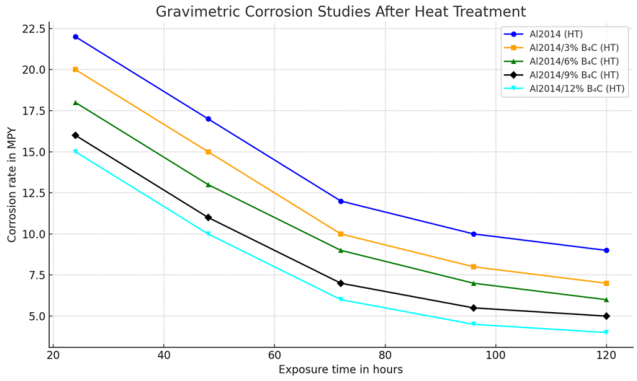


Figure 4. Gravimetric Corrosion Test Results of Al2014 alloy and its B_4C MMCs (after heat treatment).

the earlier figure. Heat-treated specimens containing B_4C at concentrations of 3%, 6%, 9% and 12% present even lower corrosion rates, where the 12% B_4C (cyan colour) exhibits the minimum corrosion rate, like the prior figure. An improvement in corrosion resistance occurs with

rising B_4C concentration among the tested materials. The degradation rates of every alloy lower progressively as the period of outdoor exposure extends. Heat treatment enhances the corrosion resistance of Al2014 alloys, especially in specimens containing higher percentages of B_4C, according to this graph[33].

After heat treatment, the gravimetric corrosion rates of Al2014 alloys reinforced with B_4C showed considerable variations in their corrosion performance as presented in Figure 4. The corrosion rates of untreated Al2014 alloy reached a peak value of around 30 MPY initially and progressively decreased. Heat treatment reduced the Al2014 alloy corrosion rate to 22 MPY, which demonstrates that the process decreases its vulnerability to corrosion. The corrosion rate of Al2014 alloy decreased substantially when B_4C content increased from 3% to 12% before the heat treatment process, leading to the lowest corrosion rate of 12% B_4C alloy. Heat treatment of the alloys reduced their corrosion rates while preserving the same general trend. The 12% B_4C alloy retained its status as the most corrosion-resistant material after heat treatment, although it experienced an additional reduction in its rate. An observation reveals that the corrosion rate decreased after longer exposure periods for the complete set of samples, while the corrosion intensity evolved into less harmful conditions during extended durations. Heat treatment improved the material's resistance to corrosion by reducing overall corrosion amounts while lowering the corrosion rates across every test sample. Heat treatment increases the corrosion resistance of Al2014 alloys while benefiting Al2014 alloys reinforced with B_4C. Heat treatment reduces the corrosion of Al2014 alloys plus B_4C samples by making them more corrosion-resistant throughout their lifespan[34].

3.2 SEM Analysis of Corrosion Test Results (Before Heat Treatment--BHT)

Figure 6 shows the untreated or as-cast Al2014 alloy exposed to corrosive environments after its presentation. The surface texture of the alloy shows uniformity even though it presents rough characteristics. Damage from corrosion shows several deteriorating parts within the material that likely resulted from corrosion processes. Alloys without reinforcement experience corrosion by displaying a uniform distribution of damage on their exposed surface, which weakens the structure. The detected surface damage, together with the morphology, indicates that microstructural inhomogeneities establish locations from which corrosion starts. The dendritic microstructure that forms during solidification in cast parts enhances localised corrosion behaviour because different electrochemical potentials exist between dendrite segments and the area between them. Surface treatment and grain refinement absence in the as-cast alloy produce inferior corrosion resistance, which makes the material vulnerable to attacks from corrosive media. The observed pits, along with their crack-like formations, possess the potential to expand under stress, which could lead to early equipment failure during actual use[35].

Figure 7 shows an SEM micrograph of Al2014 alloy with 3 wt % B_4C existing as Al2014 and 3% B_4C within microstructural regions after corrosion tests. Although this material exhibits superior corrosion resistance

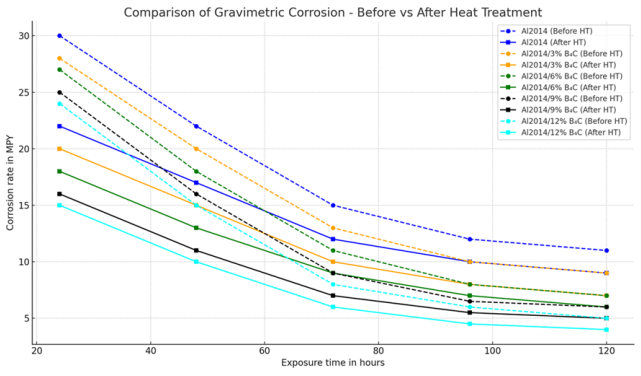


Figure 5. Gravimetric corrosion test results of Al2014 alloy and its B_4C MMCs (before and after heat treatment).

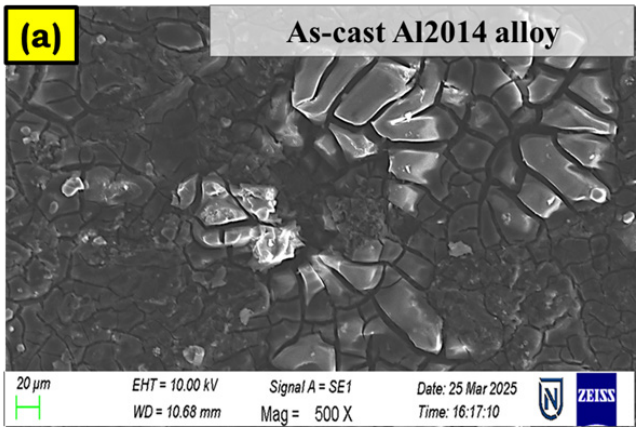


Figure 6. SEM morphology of As-cast Al 2014 alloy (Corroded samples-BHT).

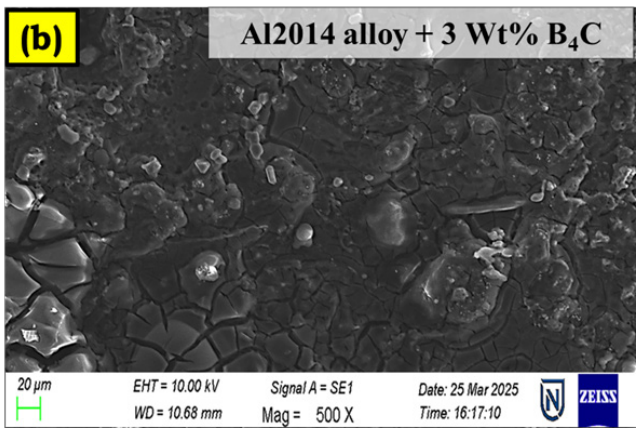


Figure 7. SEM morphology of Al 2014 alloy + 3 Wt% % B_4C (Corroded sample-BHT).

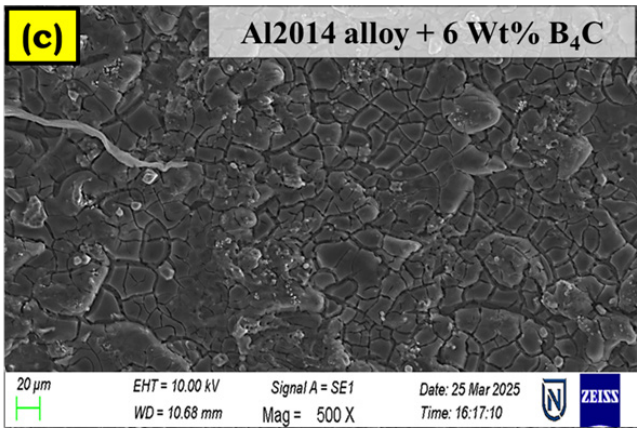


Figure 8. SEM morphology of Al 2014 alloy + 6 Wt % B_4C (Corroded sample-BHT).

compared to its as-cast variant, it still displays selected features of localised pitting. B_4C distribution helps protect the material; however, the alloy reveals significant degradation that affects the area close to where the matrix meets reinforcement particles. Reinforcement particles function as locations which promote localised corrosion regarding corrosion resistance. The existence of B_4C particles creates barriers that restrict uniform corrosion from spreading. The B_4C ceramic nature contributes to enhanced performance because it performs well chemically and shows strong corrosion resistance. Inadequate interfacial adhesion between reinforcement particles, along with their agglomeration, creates micro-galvanic cells that lead to localised attack points between the Al matrix and ceramic sections. The SEM image displays tiny surface unevenness along with small gaps between particles because of inadequate wetting during manufacturing and possible particle agglomeration. Uncurbed microstructures function as stress-intensification zones that occur during both corrosive conditions and mechanical tensions. B_4C at a 3 wt % loading enhances corrosion resistance, whereas better distribution and interface bonding will maximise its corrosion protection potential[36].

Figure 8 shows an SEM micrograph of Al2014 alloy + 6 Wt % B_4C exceeds that of the 3% B_4C variant in this image. Less corrosion pitting harms the appearance, whereas the surface provides a smoother profile. The introduction of additional B_4C enhances the material structure density, which improves its resistance to corrosion attacks effectively. Although some matrix surface damage remains visible, the particles of B_4C prevent deeper penetration of corrosion within the material matrix. Improved performance originates from better distribution of B_4C particles that function as physical resistance against corrosive agents through their ability to reduce the amount of actively exposed aluminium surface. The SEM image provides us with a clear view of the compact microstructure that indicates uniform particle distribution, and this configuration minimises micro-galvanic effects and interfacial failure between components. The remaining surface imperfections reveal the need for precise processing parameter optimisation because residual stresses or particle-matrix mismatch could be factors in their persistence[36].

Figure 9 shows an SEM micrograph of Al2014 with 9 % B_4C reveals superior corrosion resistance because the surface exhibits better integrity and a lower number of surface defects than previous test samples. Prolonged and smoother protection against corrosive attacks results from the increased content of B_4C. Several isolated corrosion areas are possibly noticeable within the B_4C-added Al2014 alloy sample at the interface between particles and matrix, since different electrochemical properties may result in micro-galvanic effects between these areas[36].

Microstructural compactness demonstrates effective particle distribution and excellent bonding between particles and matrix, both of which work together to minimise corrosion progression. Excessive use of reinforcement leads to interfacial stress formation, including stress agglomeration that produces possible weak spots when exposed over time to corrosive environments. The protection advantage of 9 wt % B_4C

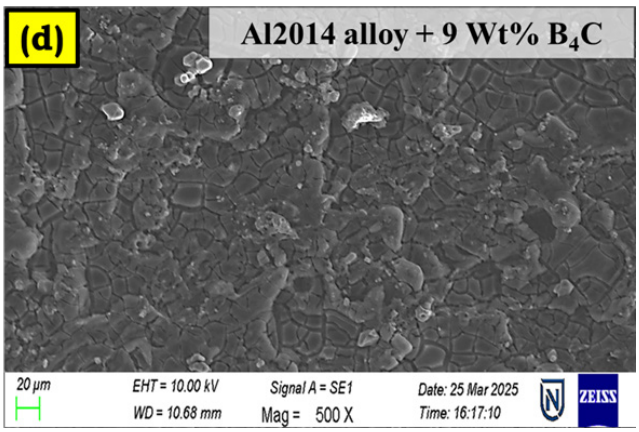


Figure 9. SEM morphology of Al 2014 alloy + 9 Wt% % B_4C (Corroded sample-BHT).

exists, yet the success of its final application depends on achieving optimal processing techniques[36].

Figure 10 shows a SEM micrograph of Al2014 alloy due to its 12 % B_4C composition, as this composition results in a smooth surface with few detectable pits alongside minimal cracks. The large quantity of B_4C reinforcement creates an effective stable microstructure which blocks corrosive elements from penetration. The reinforcement matrix interface contains detectable minor corrosion marks that might stem from regions with weak bonding elements. B_4C concentration increases in Al2014 alloy lead to better corrosion resistance through lowered damage features and improved structural stability when exposed to corrosive media. The higher reinforcement helps decrease micro-galvanic coupling in aluminium matrices by restricting anodic regions. Micro-voids and

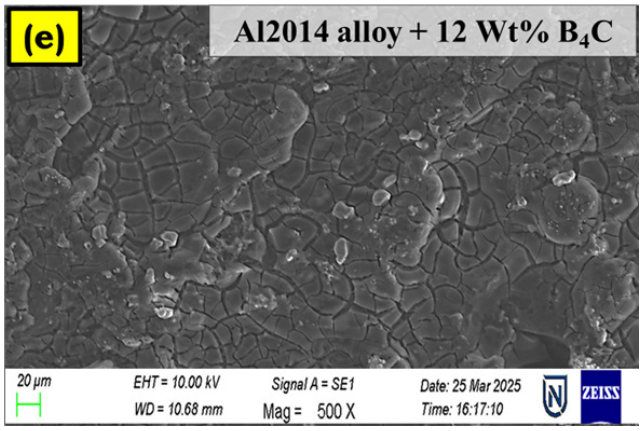


Figure 10. SEM morphology of Al 2014 alloy + 12 Wt % B_4C (Corroded sample-BHT).

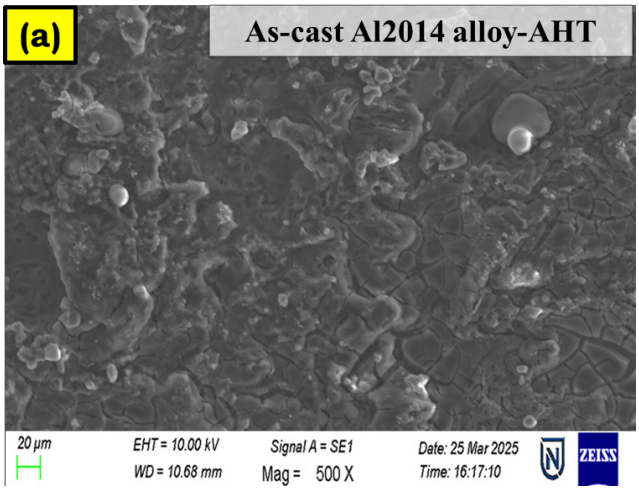


Figure 10. SEM morphology of As-cast Al 2014 alloy (Corroded samples-AHT).

surface defects are less likely to initiate corrosion because optimal filler content improves the packing density of particles[36].

3.3 SEM Analysis of Corrosion Test Results (After Heat Treatment--AHT)

Figure 10 shows a heat-treated as-cast Al2014 alloy exposed to corrosive environments after its presentation. Compared to Figure 6, the surface texture of the alloy shows less corroded surface, followed by waning areas at a few places. Also, without reinforcement leads to corrosion by displaying uniform distribution of damage on their

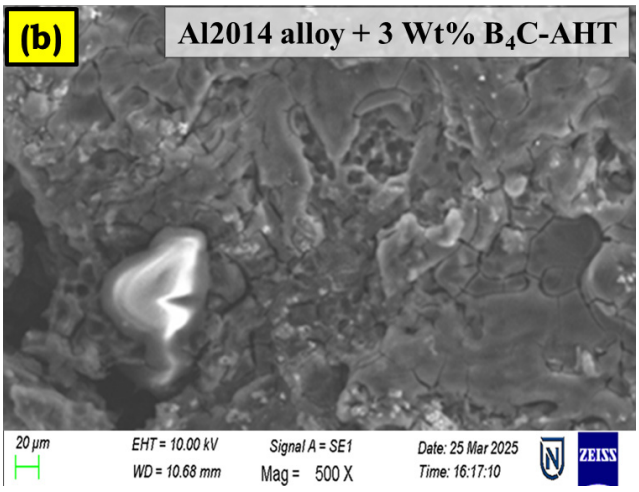


Figure 11. SEM morphology of Al 2014 alloy + 3 Wt % B_4C (Corroded sample-AHT).

exposed surface, which weakens the structure. The examined trenches, along with their crack-like patterns, possess the potential to expand under stress, which could lead to early equipment failure during actual use[37].

Figure 7 shows an SEM micrograph of heat-treated Al2014 alloy with 3 Wt % B_4C after corrosion tests. Though this material exhibits excellent corrosion resistance, it still displays selected features of localised pitting, which is less compared to Figure 7. B_4C spreading improves the material; conversely, the alloy shows major degradation that affects the area close to where the matrix and reinforcement particles are. Reinforcement gathers to promote localised corrosion regarding corrosion resistance[37].

Figure 12 shows a SEM micrograph of heat-treated Al2014 alloy + 6 Wt % B_4C MMCs. Less corrosion pitting appears on the surface, providing a smoother surface compared to Figure 8. The addition of B_4C improves the material structure density, which improves its resistance to corrosion attacks effectively. Though some matrix surface degradation is still apparent, the B_4C particles reduce corrosion penetration into the material matrix. Better dispersion of B_4C particles that operate as physical resistance to corrosive chemicals by their capacity to lower the quantity of actively exposed aluminium surface causes improved performance[38].

Figure 13 shows an SEM micrograph of heat-treated Al2014 alloy + 9 Wt % B_4C MMCs. The exceptional joining relating particles and matrix minimises corrosion succession. Undue use of reinforcement advances to

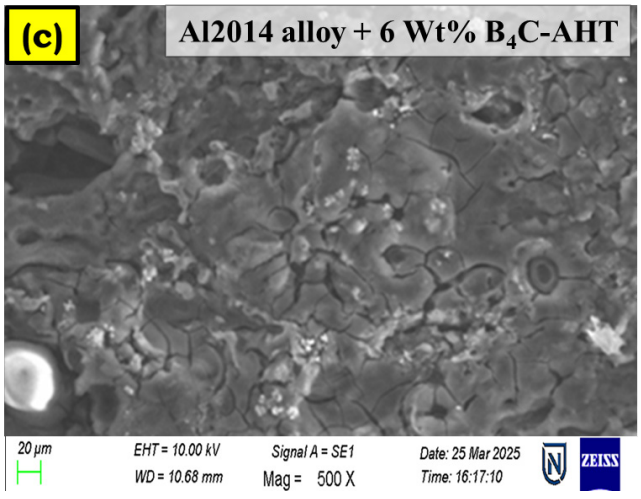


Figure 12. SEM morphology of Al 2014 alloy + 6 Wt % B_4C (Corroded sample-AHT).

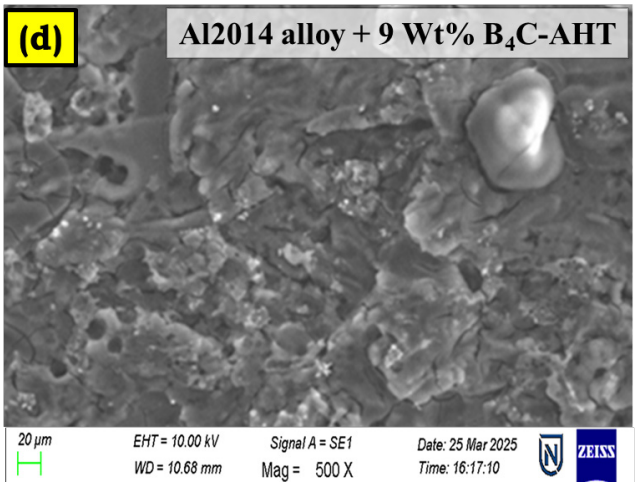


Figure 13. SEM morphology of Al 2014 alloy + 9 Wt % B_4C (Corroded sample-AHT).

interfacial stress setup leads to stress agglomeration that yields possible weak spots when exposed over time to corrosive environments. The protection of 9 wt % B_4C achieves optimal processing techniques[39].

Figure 14 shows an SEM micrograph of heat-treated Al2014 alloy + 12 Wt % B_4C MMCs. The MMCs displayed a smooth surface with few detectable pits alongside minimal cracks compared to Figure 10. B_4C reinforcement acts as an effective stable microstructure which blocks corrosive elements from penetration. Minor corrosion spots visible on the reinforcement matrix interface could come from areas with poor bonding components. Higher B_4C concentration in Al2014 alloy

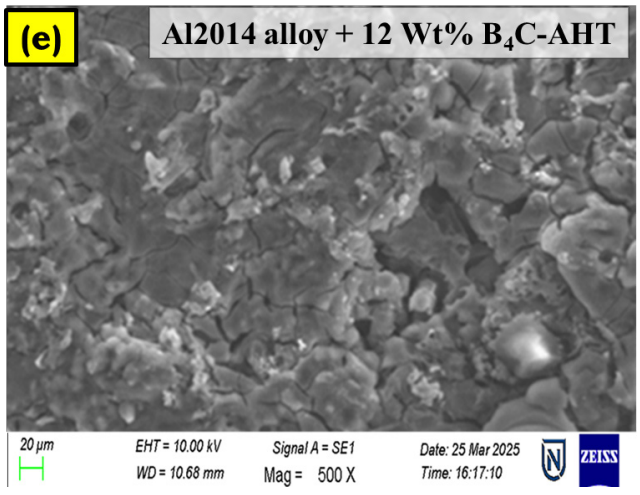


Figure 14. SEM morphology of Al 2014 alloy + 12Wt % B_4C (Corroded sample-AHT).

improves corrosion resistance by means of reduced damage characteristics and enhanced structural stability under corrosive conditions[40].

4.0 Conclusion

The study used gravimetric and performed SEM analysis to evaluate Al2014-B_4C composites while studying the corrosion resistance changes after adding different B_4C reinforcement levels (3%, 6%, 9%, and 12%). The results demonstrate that B_4C addition at 12% achieves the best corrosion resistance in Al2014 samples while decreasing the corrosion rate in 3.5 wt % NaCl solution for all experimental time periods before and after heat treatment.

1. The corrosion rates of Al2014 alloys backed by B_4C decreased directly corresponding to higher B_4C content additions. The corrosion rate for Al2014 (C0) exceeded 30 MPY, but 12 % B_4C (C12) exhibited the lowest rate at around 10 MPY, thus demonstrating optimum resistance. The resistance and surface integrity improved significantly when B_4C content rose in the samples, and C9 achieved the highest level of improvement.
2. The corrosion rates decreased by heat treatment across the entire range of Al2014-B_4C composites, y*et Al2014* (C0) experienced the highest susceptibility at 22 MPY. The corrosion resistance of the composites remained excellent when the B_4C reinforcement content reached 12 % (C12), particularly due to the added protective capability of B_4C.
3. SEM examination prior to and after heat treatment indicated that Al2014 (C0) experienced extensive surface damage, such as corrosion pits and cracks. Composites with higher B_4C content, particularly 12 % B_4C (C12), exhibited better surface smoothness and fewer defects, with 12% B_4C exhibiting the best overall corrosion resistance. The B_4C particles successfully improved corrosion protection, particularly at higher concentrations.

5.0 References

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