Engineering Perspectives in Filtration and Separation, Vol. 4, No. 3, September 2026
ISSN:3107-5290

Experimental Investigation of Corrosion Resistance and Mechanical Properties of Nanoparticle-Reinforced Aluminum Matrix Composites

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Abstract--- There has been growing interest in using aluminum matrix composites in various applications because of their lightweight nature, mechanical properties, and enhanced capability to resist corrosion. Ceramic nanoparticles can be incorporated into aluminum alloys, which will help modify mechanical strength, surface properties, and corrosion resistance. In this experiment, the corrosion resistance and mechanical properties of AA6061 aluminium matrix composites reinforced with silicon carbide (SiC) nanoparticles are studied. The percentage of reinforcement with different levels of 0%, 2%, 4%, and 6% of nanoparticles will be used to analyze the effect of nanoparticles on the composite. The mechanical characterization includes hardness tests and tensile tests to establish the effect of reinforcement concentration on the strength and deformation behavior of the material. The corrosion performance is tested using weight loss measurements and electrochemical testing to understand the behavior of the material in terms of corrosion. The correlation between nanoparticle concentration, microstructure, mechanical properties, and corrosion properties is analyzed through experimentation. The effect of reinforcement concentration and the nature of the interface on the properties of the composites is studied. The aim of the study is to identify the reinforcement concentration that achieves a good balance between mechanical performance and corrosion resistance.

Keywords--- Aluminum Matrix Composites, AA6061 Aluminium Alloy, Silicon Carbide (SiC) Nanoparticles, Mechanical Properties, Corrosion Resistance, Nanocomposite Reinforcement.

Received: 18 - 06 - 2026; Revised: 09 - 07 - 2026; Accepted: 18 - 08 - 2026; Published: 30 - 09 - 2026

I. Introduction

Aluminum metal and alloys have gained popularity in engineering due to their low weight, formability, strength, and applicability to different engineering processes. The extensive use of aluminum alloys in the automotive industry, aircraft construction, and structural applications is largely linked to the need for light-weight materials that ensure satisfactory mechanical behavior during their service life. One of the most attractive aluminum alloys for commercial use is AA6061 owing to its high strength/weight ratio, machinability, weldability, and heat treatability. Nevertheless, traditional aluminum alloys possess several disadvantages in the context of demanding engineering conditions when an increase in strength, wear resistance, and corrosion resistance is needed (Abdullah et al., 2025).

In this context, aluminum matrix composites (AMCs) may be a rational approach to address these problems by adding suitable reinforcing elements to the aluminum matrix (Kumar et al., 2024). The ceramic materials have numerous possibilities of modifying the aluminium material's properties. In connection with hardness and wear resistance, thermal stability, and good mechanical properties, the use of silicon carbide (SiC) looks quite reasonable. The use of SiC particles in the aluminum matrix will increase the load-bearing and local deformation resistance (Bhoi et al., 2020). However, the properties of the resulting composite depend strongly on the concentration of the reinforcing element.

Importance of Nanoparticle Reinforcement in Aluminum Matrix Composites

Nanoparticle reinforcement is an effective technique for enhancing the properties of aluminum matrix composites. The high surface-to-volume ratio of nanoparticles offers chances for better interactions with the

matrix and material deformation mechanisms. Nanoparticles of silicon carbide are especially useful owing to their high elastic modulus and hardness (Maddaiah et al., 2024). They can affect grain size, dislocation motion, and load transfer mechanisms in the aluminum matrix. On the other hand, high concentrations of particles can lead to particle clustering, poor bonding at the interface, and fabrication defects. Therefore, choosing the right concentration of reinforcement particles is vital to ensure uniform composite properties (Yolshina et al., 2022).

Influence of Fabrication Conditions on Composite Characteristics

The fabrication procedure plays an important role in determining the structural homogeneity and performance of nanocomposites made from aluminum alloys reinforced with nanoparticles. Stir casting is a general liquid-state fabrication method that is based on mixing the reinforcement particles in molten aluminum alloy by using mechanical stirring. Stir casting procedure provides benefits in terms of simplicity of procedure, accessibility of materials, scalability, and cost of production. However, some processing parameters such as stirring velocity, processing temperature, pre-heating of particles, rate of addition of the particles, and stirring time have effects on the dispersion of the particles and the interface properties. Improper mixing may lead to agglomeration of the reinforcements, while improper processing conditions may cause porosity in the structures.

Relationship Between Mechanical Properties and Corrosion Behavior

The mechanical and corrosion properties of aluminum matrix composites depend on the interaction between the particles and the surrounding metal matrix. SiC nanoparticle addition can influence the hardness, tensile strength, and deformation behavior due to strengthening, grain size reduction, and transfer effect. In this case, the influence of the reinforcement material on the corrosion behavior is more complicated since the distribution of the particles, interface, porosity, and surface conditions can influence the electrochemical degradation process. The difference in the local electrochemical behavior can influence localized corrosion and durability properties of the material. This means that mechanical property improvements cannot be considered as an indication of the overall applicability of the composite. Both tests are needed to reveal the correlation between strength and corrosion behavior.

Research Motivation and Experimental Objectives

The attainment of enhanced mechanical properties as well as corrosion resistance at the same time is an issue to be addressed during the development of aluminum matrix composites. Different concentrations and dispersions of nanoparticles lead to different properties; hence the need to conduct experiments. In particular, it is important to look at the correlation among reinforcement concentration, microstructure, mechanical, and corrosion properties.

In the current study, the manufacture and characterization of SiC nanoparticle-reinforced AA6061 aluminum matrix composites through the stir casting method will be carried out. The reinforcement concentrations to be used are 0%, 2%, 4% and 6%. The major goals of the study include characterization of microstructure, assessment of hardness and tensile properties, examination of corrosion behavior under specified conditions, and identification of appropriate reinforcement concentration with a favorable balance between mechanical and corrosion properties.

II. Literature Review

Development of Nanoparticle-Reinforced Aluminium Matrix Composites

Aluminium matrix composites have been introduced into engineering due to the combination of metal matrices with ceramic or other non-metallic reinforcements. Research on such composites is oriented mainly towards increasing strength, hardness, wear resistance and stability in structure at maintaining aluminium low weight (Venkatesan et al., 2022). Classic aluminium alloys have good processibility and mechanical characteristics; however, under some loading and environmental conditions their behaviour may be unsatisfactory. Reinforcing particles can serve as a convenient tool for altering the matrix characteristics and widening its functional abilities.

Some ceramic materials like silicon carbide, aluminum oxide, titanium oxide and zirconium oxide were chosen as aluminium matrix reinforcements in view of their hardness, high temperature resistance and strength. Of these materials silicon carbide demonstrates good characteristics in cases of the need to increase hardness and deformation resistance. At the nano-scale the rather high specific surface area of SiC particles can affect matrix-reinforcement interaction and composite structure formation. Composite characteristics depend

on particle characteristics, the volume fraction of reinforcement, dispersion, and processability (Goswami et al., 2024).

Influence of Nanoparticles on Microstructural Characteristics

The microstructure plays a vital role in determining the mechanical and corrosion properties of reinforced aluminum alloys (Sonker et al., 2023). The addition of nanoparticles has the potential to affect the grain structure, particle distribution, interface properties, and defects in the metal matrix (Singhal et al., 2025). Proper particle distribution helps achieve consistent performance of the material, while particle aggregation results in localized stress concentration and defects (Surakasi et al., 2022).

The interface between the silicon carbide nanoparticles and the aluminum matrix determines the load transfer and resistance of the material (Bharat & Bose, 2023). Good interface bonding allows for proper mechanical interaction of the reinforcing phase with the matrix. Poor bonding, particle aggregation, and porosity could affect the reinforcement efficiency. It is important to examine the microstructure for better understanding of the correlation between fabrication and material properties (Tan et al., 2021).

Mechanical Performance of Reinforced Aluminum Composites

Mechanical properties form key performance criteria for assessing the applicability of aluminum matrix composites in structures and industries (Ahmed et al., 2025). Hardness and tensile strength form relevant performance parameters since they give data on local deformation resistance and ability to resist applied loadings. Silicon carbide particles used as reinforcements in the composite structure will enhance the mechanical properties of the composite through load transfer, grain size reduction, and dislocation movement restriction.

The amount of reinforcement is very critical in terms of its impact on the mechanical properties of the composite. Addition of particles in high concentrations may enhance mechanical properties like hardness and tensile strength, but only when there is sufficient dispersion and good interface bonding. Otherwise, addition of a high number of particles may lead to agglomeration, porosity, and early crack formation. Such mechanical problems might affect tensile and ductility behavior of the material.

Corrosion Behaviour and Environmental Degradation Mechanisms

Resistance to corrosion is one of the major factors in assessing the service durability of aluminum composites in wet and corrosive environments and under industrial working conditions. Naturally, aluminum forms a thin protective oxide film contributing to corrosion resistance properties. However, the stability of such a protective film might be affected by different factors connected with surface conditions, electrolyte composition, and microstructure of materials.

The addition of ceramic nanoparticles to an aluminum alloy matrix can change the corrosion behavior due to modifications in the continuity of the matrix, interface properties, and surface topography (Kumaresan & Arul Kumar, 2022). The distribution and concentration of particles can affect the formation of local electrochemical zones in aluminum-based composites. Poor interfacial bonding and porosity in the materials due to fabrication can cause specific zones suitable for corrosion initiation. Electrochemical investigation and the weight loss method represent two methods for assessing corrosion performance. Corrosion potential, corrosion current density, and material weight loss give a more comprehensive evaluation of corrosion behavior.

Literature Search Strategy and Research Scope

The literature review will focus on the main technical issues concerning nanoparticle-reinforced aluminum matrix composites and will pay special attention to material selection, manufacturing methods, mechanical testing, and corrosion analysis. The scope of the search includes experimental research on AA6061 aluminum alloy, SiC nanoparticle reinforcement, stir casting, microstructure, tensile properties, hardness, and corrosion.

The search terms that can be used are aluminum matrix composites, SiC nanoparticle reinforcement, AA6061 composites, stir casting manufacturing, mechanical testing, electrochemical corrosion, and reinforcement concentrations. The criteria include research concerning material composition, processing parameters, distribution of the reinforcement, mechanical testing methods, and corrosion studies. More weight will be given to experimental research that analyzes the correlation between reinforcement concentrations, microstructure development, and performance of the composite materials.

The review structure will differentiate between the factors affecting fabrication, mechanical strength, and corrosion degradation of the material. Such differentiation provides a systematic approach to evaluate the composite properties and find areas for further experimental research.

Research Gap and Contribution of the Present Investigation

Performance of aluminum metal matrix composites reinforced with nanoparticles can be attributed to several key factors such as the reinforcement percentage, dispersion of particles, interfacial bonding, fabrication process, and environmental effects. Mechanical strengthening properties and corrosion resistance are key characteristics of a composite that should be studied individually; however, combined assessment is required to evaluate the performance of the material in engineering applications.

Key emphasis should be placed on the effect of variation in silicon carbide percentage on hardness, tensile behavior, and corrosion resistance of the aluminum matrix composites. At the same time, the microstructure of the material is also required for proper interpretation of the results obtained in terms of both mechanical performance and corrosion behavior.

This study seeks to address the stated problem by fabricating and studying AA6061 aluminum matrix composites reinforced with silicon carbide nanoparticles of varying concentrations. Evaluation of mechanical behavior, microstructure, and corrosion behavior allows establishing an integral approach to selecting the suitable reinforcement percentage and evaluating the performance of the fabricated composites.

III. Materials and Methodology

Selection of Aluminium Matrix and Nanoparticle Reinforcement

The choice of AA6061 as the matrix material has been influenced by the excellent ratio of strength to weight, machinability, corrosive properties, and suitability of the alloy for the purpose of structure. Nanoparticles of silicon carbide (SiC) have been chosen as the reinforcing agent owing to the properties of high hardness, elastic modulus, thermal stability, and mechanical stability. Thus, the material system AA6061+SiC is suitable for investigation of the effect of incorporation of ceramic nanoparticles on mechanical and corrosion properties.

Four composite alloys have been chosen for examination of the effect of reinforcement content. Unreinforced AA6061 is the reference material, while the other alloys include 2%, 4%, and 6% of SiC by weight, respectively. The reinforcement agents have been characterized by the parameters of particle size, surface state, and material purity prior to fabrication.

Preparation and Fabrication of Nanoparticle-Reinforced Composites

The composite samples are made using the stir casting method, which entails introducing reinforcing particles into melted aluminum through mechanical agitation. First, the AA6061 alloy is cleaned and put in a crucible for melting. Melting is done at a proper processing temperature above the liquidus temperature to facilitate full melting and fluidity. Before being mixed with the molten aluminum, the SiC nanoparticles are first pre-heated to reduce moisture and improve compatibility with the molten metal. The particles are slowly added to the molten aluminum while mechanical agitation is continuously applied to enhance mixing. Mechanical agitation ensures proper particle incorporation and distribution in the molten metal. Once the mixing process is over, the molten composite is poured into the molds where it solidifies. The same process is repeated in making other samples with varying concentrations of the reinforcement. Once the samples have solidified, they are removed and machined for characterization tests.

Experimental Workflow

The experiment involves a series of steps that include material preparation, composite manufacturing, sample characterization, mechanical testing, and corrosion testing. This whole sequence of experimental process steps, which also includes composite manufacturing and sample characterization steps, is shown in figure 1. It ensures a consistent way of studying the effect of the concentration of SiC reinforcement in AA6061 Al-MMCs.

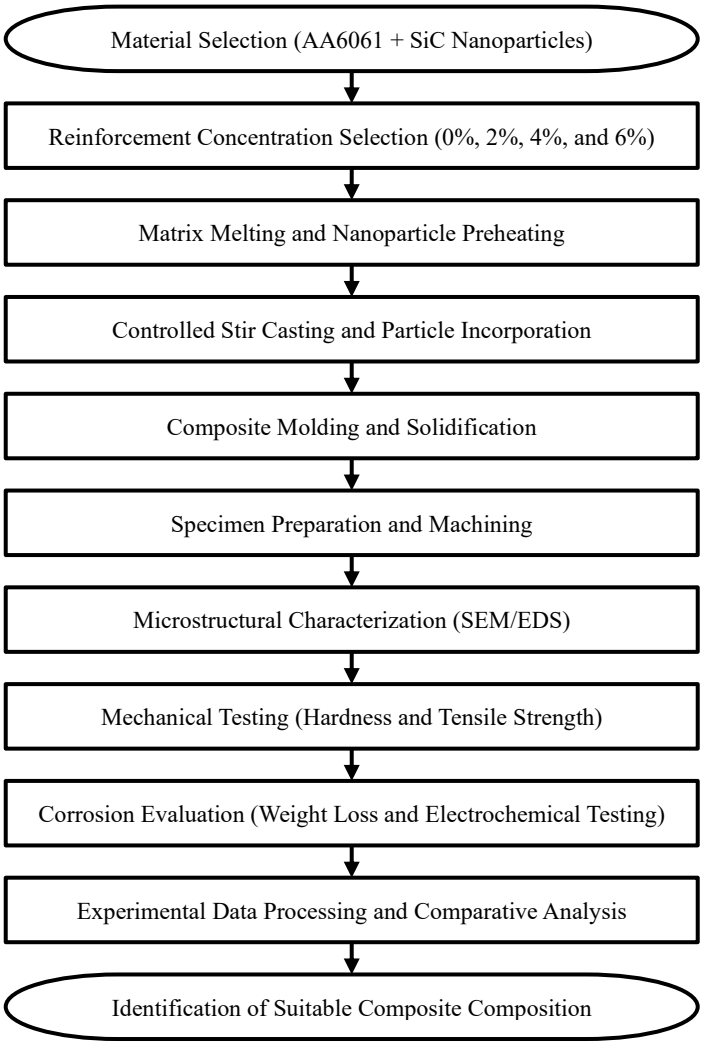


Figure 1: Experimental Workflow for Fabrication and Characterization of SiC-Reinforced AA6061 Aluminum Matrix Composites

Microstructural Characterization

Microscopic analysis is carried out to determine the distribution of SiC nanoparticles and the microstructure of the prepared aluminum matrix composites. Scanning Electron Microscopy (SEM) is utilized for the study of surface topography, reinforcement distribution, interface, and any defects that may be present in the material due to the fabrication process. The analysis is mainly aimed at detecting agglomeration, porosity, and changes in the matrix structure.

Energy Dispersive X-ray Spectroscopy (EDS) is utilized to carry out an elemental analysis of the reinforcing material in the aluminum matrix. The elemental analysis yields further insight on the presence and distribution of silicon and carbon in relation to the SiC reinforcement. Microstructural analysis is carried out at different reinforcement concentrations to determine the effect of particle addition on composite microstructure.

Mechanical Property Evaluation

The mechanical properties of the fabricated composites will be investigated using hardness and tensile tests. The results obtained from the testing procedure will offer data about the ability of the materials to withstand localized deformation and the influence of the reinforcement content on the mechanical behavior.

1) Hardness Test: A hardness test will be conducted to evaluate the resistance of the composite specimens to localized indentation. The surfaces of the specimens will be polished for consistency in the testing process. Several measurements will be taken at different points on the specimen to minimize the effect

of local variation in reinforcement content. The average hardness result will be obtained for each composite composition.

2) Tensile Behavior: A tensile test will be done to evaluate the ultimate tensile strength, yield strength, and percentage elongation of the fabricated composites. The specimens will be machined to a specific geometry for the tensile test and loaded uniaxially. The load-deformation characteristics will be used to investigate the tensile behavior of the composite compositions. The differences in tensile properties will be examined based on the reinforcement content, particle distribution, and interface properties.

Corrosion Resistance Evaluation

The evaluation of corrosion behavior is based on weight loss and electrochemical test methods. This allows providing information on degradation of materials and electrochemical properties of the produced composites during artificial environmental exposure.

1) Test Medium and Preparation of Specimens for Testing: Specimens are made to have same surface condition and exposure area before performing corrosion test. For the corrosion medium, 3.5 wt.% sodium chloride (NaCl) solution is chosen because this solution provides the chloride-containing environment. The surfaces of the specimens are cleaned, dried and weighed before exposure. During the whole comparative study, the same solution concentration, temperature and exposure conditions are maintained.
2) Corrosion Assessment by Means of Weight Loss Method: Specimens are immersed into the prepared corrosive medium for the predetermined exposure time period. After the exposure is completed, specimens are cleaned from the corrosion products without causing excessive loss of the underlying metal. Then the final mass is measured after drying and the material loss is calculated as a difference of initial and final masses of the specimen.
3) Electrochemical Corrosion Studies: Electrochemical study is done to analyze the behavior of the composite sample under the selected NaCl environment. Open circuit potentials are measured to observe the stabilization of the sample surface. Potentiodynamic polarization is done to measure the corrosion potential and corrosion current density. These are some parameters that give an idea about the corrosiveness and corrosion kinetics. The data obtained from this test will be compared to analyze the effect of SiC reinforcement on the electrochemical behavior of the aluminum matrix.
4) Corrosion Rate Evaluation: Corrosion rate is evaluated by weight loss method through initial and final weights of the samples, density, exposed surface area, and the time period of exposure as mentioned in equation (1).

$$CR = \frac{K \times W}{\rho \times A \times t} \qquad (1)$$

where CR represents the corrosion rate in mm/year, K is the conversion constant (87.6), W denotes weight loss in milligrams, ρrepresents material density in g/cm^3, A denotes exposed surface area in cm^2, and t represents exposure duration in hours. Lower corrosion-rate values indicate improved resistance to material degradation under the selected exposure conditions.

Experimental Data Processing and Performance Comparison

The experimental data that were gathered through microstructure observation, hardness test, tensile test, and corrosion test are classified in terms of the amount of reinforcement used. Several readings are taken for each type of sample in order to ensure accuracy of measurement and make the comparative analysis possible.

The mechanical properties are assessed through the average hardness, ultimate tensile strength, yield strength, and percentage elongation. The corrosion performance is evaluated based on the weight loss, corrosion rate, corrosion potential, and corrosion current density. This will assess how reinforcement concentration affects the composite properties.

Both mechanical and corrosion properties are assessed in order to determine the appropriate reinforcement concentration. Attention will be given to the effect of the particle distribution, interface, and defects in the manufacture of the samples on the properties measured. The final analysis will establish the relationship of the reinforcement concentration to structure and performance.

IV. Results and Discussion

Microstructural Characteristics of the Fabricated Composites

The microstructure features of the produced AA6061–SiC composites have been investigated in order to study the impact of nanoparticle addition on matrix homogeneity, reinforcing phase distribution, and interface properties. The unreinforced AA6061 matrix is used as a standard structure in order to evaluate the impact of SiC addition on microstructure modifications. The SEM images given in figure 2 can be used for a comparative analysis of the reinforcing phase distribution and microstructure changes depending on the concentration of SiC. Reinforcing phase distribution inside the aluminum matrix is an important factor that affects the structure and mechanical properties of the obtained composites.

The introduction of the SiC nanoparticles alters the microstructure features of the aluminum matrix. The low reinforcing phase concentrations allow obtaining a uniform reinforcement distribution due to proper particle dispersion. Higher reinforcing phase concentrations cause an increase in the number of particle-matrix interfaces and grain formation. However, poor dispersion and excess of the reinforcing phase concentration can cause their agglomeration and porosity.

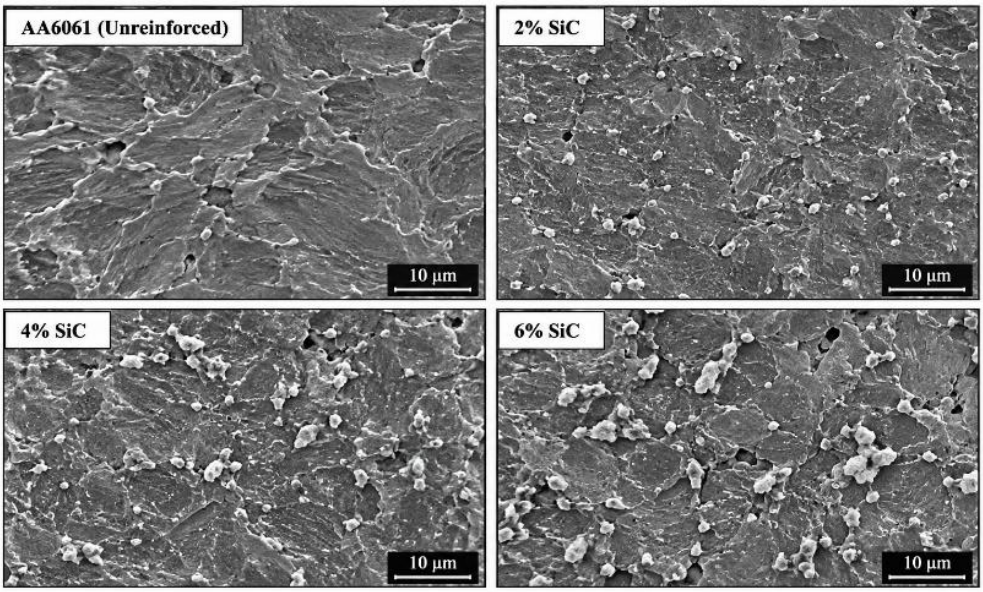


Figure 2: SEM Microstructural Examination of AA6061 Aluminum Matrix Composites at Different SiC Reinforcement Concentrations

SEM analysis takes into account the matrix without reinforcement and the reinforced samples with varying percentages of SiC ranging from 2%, 4% to 6%. It focuses on particle distribution, interfacial bonding, porosity, and homogeneity of the structure. EDS analysis helps provide information about element distribution and reinforcing material distribution. This helps determine the microstructure that affects mechanical and corrosion behavior.

Mechanical Property Evaluation

The performance of the produced composite materials is evaluated based on the determination of hardness and tensile properties.

1. Hardness Behavior: The hardness tests are performed to determine the influence of the addition of SiC nanoparticles on the resistance to indentation of the aluminum-based composites. Hardness of the material increases due to particle strengthening and restrictions of the localized deformation. Hardness depends not only on the number of reinforcements, but also on their distribution and interfacial behavior.
   Higher amounts of reinforcement may increase the resistance to indentation provided that particle distribution is uniform. On the other hand, particle clustering and some manufacturing artifacts may result in variation of hardness values. Thus, the correlation between hardness and concentration of SiC is determined along with microstructural studies.

2. Tensile strength and deformation properties: Tensile testing gives an idea about the ability of the material to withstand load and the behavior under deformation. Inclusion of SiC nanoparticles can lead to tensile strength improvement due to the transfer of loads between the aluminum matrix and ceramic particles. Also, tensile strength can be improved due to grain size reduction and limitations on dislocation movement.
   These characteristics depend on particle distribution, interfacial bonding, and the presence of defects. Even though high particle content might be effective for increasing strength, it can decrease ductility and lead to early crack formation. Thus, ultimate tensile strength, yield strength, and percent elongation are used in assessing the mechanical properties of materials.

Table 1: Mechanical Properties of SiC-Reinforced AA6061 Aluminum Matrix Composites

Composite Composition	Hardness (HV)	UTS (MPa)	Yield Strength (MPa)	Elongation (%)
AA6061 (0% SiC)	68	195	145	16.5
AA6061 + 2% SiC	76	218	162	14.8
AA6061 + 4% SiC	85	242	181	13.2
AA6061 + 6% SiC	91	251	188	10.6

The comparative analysis shown in table 1 determines the dependence of reinforcement concentration on mechanical properties. The hardness and tensile strength are analyzed in order to identify the effect of reinforcement on mechanical properties, and elongation is studied in relation to deformation ability.

Corrosion Resistance Evaluation

Corrosion resistance is tested through weight loss analysis and electrochemical investigations. Testing aims to investigate the variations in material deterioration as affected by SiC reinforcement content in the presence of chloride.

1) Weight Loss Approach to Corrosion: Weight loss testing gives an indication of the material lost as a result of the corrosive environment. The difference between the initial and final mass of the specimen gives an idea of how much material was lost. Variations in corrosion rate are analyzed to evaluate the effect of reinforcement on corrosion resistance in the environment.
   Corrosion is dependent on the matrix integrity, surface integrity, particle distribution, and interface features. It is possible for a uniform microstructure to result in uniform surface behavior, while others might have preferred sites for corrosion initiation.
2) Electrochemical Response: The electrochemical analysis is carried out to study the corrosion properties of the developed composite. The corrosion potential determines the electrochemical property of the material whereas the corrosion current density serves as a parameter that reflects the corrosion kinetics. The lower corrosion current density indicates the lower electrochemical corrosion rate.
   The correlation of both electrochemical analysis and weight loss results gives a complete picture of corrosion resistance. The differences in concentrations of reinforcement are studied to understand the effect of SiC addition on corrosion resistance of the aluminum matrix.

Table 2: Corrosion Performance of SiC-Reinforced AA6061 Aluminium Matrix Composites

Composite Composition	Corrosion Potential (mV)	Corrosion Current Density ($\mu A/cm^2$)	Weight Loss (mg)	Corrosion Rate (mm/year)
AA6061 (0% SiC)	-735	8.40	18.5	0.112
AA6061 + 2% SiC	-710	6.90	15.2	0.092
AA6061 + 4% SiC	-685	5.20	11.8	0.071
AA6061 + 6% SiC	-720	7.10	16.1	0.097

The comparative analysis shown in table 2 gives a quantitative way of analyzing corrosion behavior with respect to varying reinforcement concentration levels. The factors to be taken into account include corrosion potential, current density, weight loss, and corrosion rate.

Relationship Between Mechanical Properties and Corrosion Resistance

The mechanical and corrosion properties of the resulting composites are analyzed together to determine the general effect of SiC reinforcement. The concentration of the reinforcement will play a role in both its strengthening effect and the structure that will be relevant to the corrosion process. For this reason, the composition that achieves the highest hardness or tensile strength might not necessarily show the lowest corrosion rate.

The connection between the uniformity of the microstructure and the performance of the composite becomes especially significant. Proper dispersion of the particles and proper bonding at the interface could facilitate mechanical strengthening, while particle agglomeration and porosity could be detrimental to both tensile and corrosion performance.

1) Effect of Reinforcement Concentration on the Properties: Different concentrations of SiC will be investigated to observe concentration-dependent changes in properties such as mechanical and corrosion resistance. Low concentration serves as a control for determining the effect of incorporating the nanoparticles. Medium concentration serves for the investigation of the possibility of obtaining better dispersion and mechanical properties. High concentration requires special consideration of such factors as agglomeration, porosity, and decrease of ductility.
2) Determination of Appropriate Composite Composition: An appropriate reinforcement concentration is selected based on the values of hardness, tensile strength, elongation, and corrosion rate. The appropriate composition must have good mechanical properties but without significant deterioration of the corrosion resistance properties. Microstructure observations serve as an additional tool for evaluating the comparative properties of the investigated compositions.

Overall Comparative Performance Analysis

Performance analysis in general involves combination of mechanical and corrosive properties so that one can develop comparative knowledge about the developed composite materials. Hardness and tensile strength indicate mechanical performance, while corrosion rate indicates the effect of the environment. Percent elongation is another factor that has been used for assessing reduction in deformation capacity due to addition of reinforcement.

Table 3: Integrated Mechanical and Corrosion Performance of AA6061–SiC Composites

Composite Composition	Hardness (HV)	Tensile Strength (MPa)	Elongation (%)	Corrosion Rate (mm/year)
AA6061 (0% SiC)	68	195	16.5	0.112
AA6061 + 2% SiC	76	218	14.8	0.092
AA6061 + 4% SiC	85	242	13.2	0.071
AA6061 + 6% SiC	91	251	10.6	0.097

The integration of the comparison in table 3 is useful in determining the relationship between the reinforcement concentration and the performance of the composite as a whole. This is done by considering variations in hardness, tensile strength, elongation, and corrosion rate.

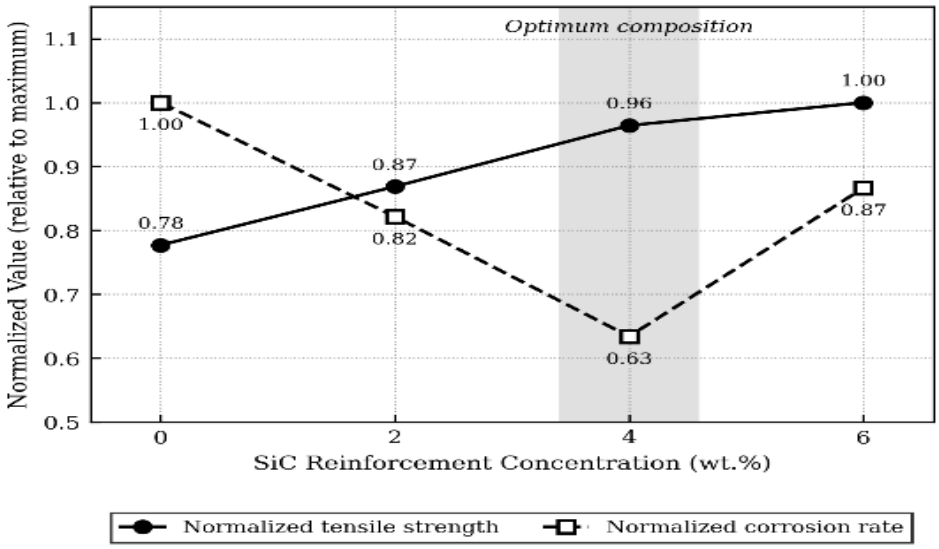


Figure 3: Comparative Variation of Mechanical Strength and Corrosion Rate with SiC Reinforcement Concentration

Trends in tensile strength and corrosion rate of SiC reinforced materials at various concentrations are illustrated in figure 3.

The graphical representation is performed in terms of SiC reinforcement concentration on the x-axis and normalized mechanical strength and corrosion resistance on the y-axis. Parameters of tensile strength and corrosion rate have been chosen as the indicators of comparison. The normalization procedure allows taking into account the different scale ranges, where smaller normalized corrosion rates stand for better corrosion resistance properties.

The results of graphical and tabular analysis give the opportunity to find out the concentration level of reinforcement providing a reasonable compromise of mechanical and corrosion resistance properties. Final choice is based on experimental data.

V. Conclusion

This study evaluates the effects of silicon carbide (SiC) nanoparticle reinforcement on the properties of AA6061 aluminum metal matrix composites prepared via stir casting process. The study uses 0%, 2%, 4%, and 6% by weight concentration of reinforcement to compare and analyze changes in hardness, tensile strength, ductility, and corrosion performance. It will evaluate the correlation of the concentration of nanoparticles, microstructure, mechanical behavior, and environmental resistance. The addition of SiC nanoparticles is anticipated to enhance hardness and tensile strength due to the mechanism of reinforcement and loading transfer. On the other hand, higher levels of reinforcement may decrease ductility as a result of particle agglomeration and non-uniform distribution. The corrosion performance is influenced by the reinforcing material distribution, interface properties, and the creation of localized electrochemical zones in the composite matrix. Thus, any enhancement in the mechanical performance of such composites does not automatically mean an improvement in their corrosion performance. This comparison highlights the need to determine a reinforcing content that ensures a desirable compromise between the mechanical performance and corrosion resistance of such materials. The microstructure investigation, mechanical tests, and corrosion tests serve as a foundation for judging whether aluminum nanoparticle-reinforced composites can be used in practice. The research sets up an experimental approach to developing the best SiC-reinforced AA6061 composites.

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