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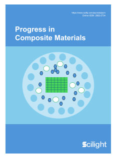

Review

Processing, Microstructure and Performance of Aluminium Metal Matrix Composites for Engineering Applications—A Review

Penchal Reddy Matli [1,*], Manohar Guttikonda [2], Kotalo Rama Gopal [1] and Siva Sankara Reddy Lingala [1]

[1] Department of Physics, Sri Krishnadevaraya University, Anantapur 515003, India
[2] Department of Mechanical Engineering, CVR College of Engineering, Vastunagar, Hyderabad 501510, India
* Correspondence: drlpenchal@gmail.com

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Abstract: Metal Matrix Composites (MMCs) stand at the forefront of materials science, offering a revolutionary blend of metallic matrix with a diverse array of reinforcements, tailored by type and geometry to deliver unparalleled physical, mechanical, thermal, and corrosion-resistant properties. These advanced materials have become the backbone of high-performance applications across industries such as aerospace, automotive, defense, electronics, and space exploration, where their exceptional strength, toughness, and adaptability meet the demands of cutting-edge engineering challenges. Researchers and engineers are working tirelessly to develop MMC production technologies in order to reduce costs and make them more affordable. This review delves into the state-of-the-art fabrication technologies shaping MMC production, from traditional casting and powder metallurgy to emerging hybrid processing methods. We explore how these advancements address longstanding challenges, such as cost barriers and material limitations, while unlocking new opportunities for customization and scalability. This study encourages readers to learn how MMCs are not only satisfying current demands but also opening the door for a future of stronger, smarter, and more sustainable technologies by showcasing recent innovations and their revolutionary effects on engineering and advanced manufacturing.

Keywords: research progress; metal matrix composites; casting; powder processing; mechanical behaviour; corrosion properties; applications

1. Introduction

Metal Matrix Composites (MMCs) have emerged as a critical class of advanced materials, offering a unique combination of high strength, low weight, and excellent wear resistance, making them highly valuable in the aerospace and automotive industries. Additionally, MMCs are employed in engine components, including turbine blades and compressor parts, due to their high-temperature stability and wear resistance [1,2]. Their high thermal conductivity also makes them ideal for thermal management systems in spacecraft, where they can withstand extreme temperature fluctuations [3]. Furthermore, the lightweight nature of MMCs contributes to reduced fuel consumption and increased payload capacity in aircraft, with aluminum-based MMCs playing a key role in these advancements [4,5].

Because of these properties, MMCs are considered a better alternative to conventional materials, especially as industries demand lightweight and high-strength materials for engineering applications [6–9]. The structural and functional characteristics of MMCs can be modified to satisfy the demands of sophisticated engineering and structural applications by selecting the optimal combinations of matrix, reinforcement, and manufacturing processes as depicted in Figure 1 [10].

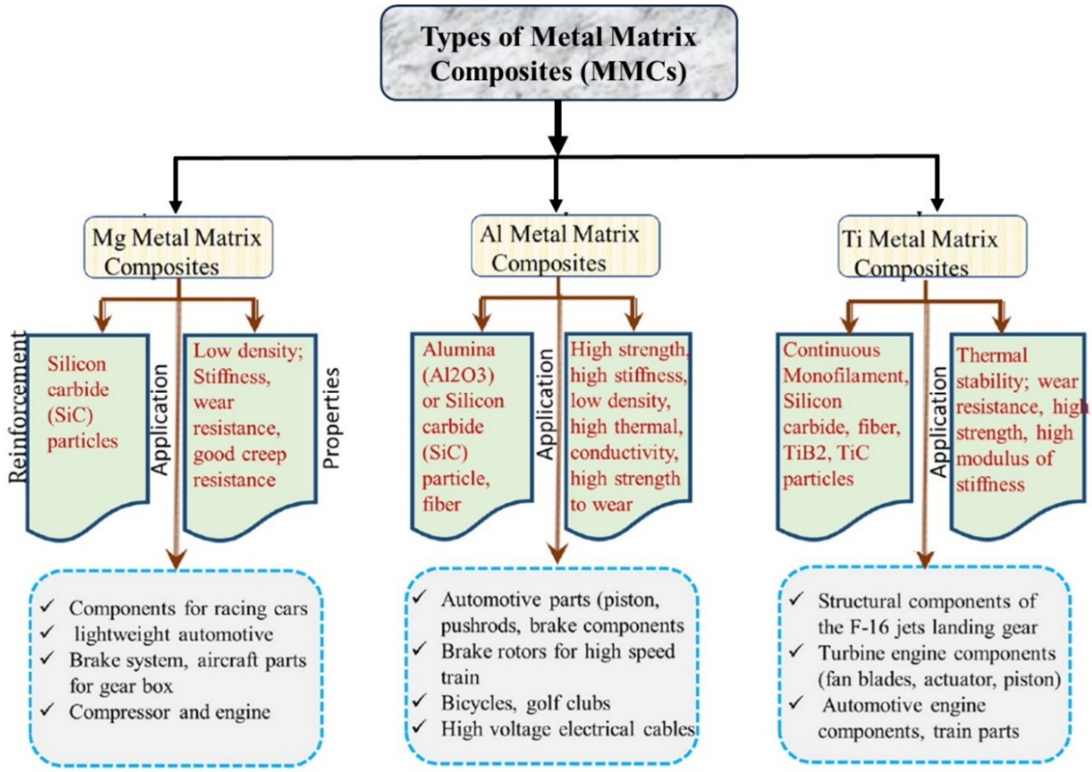

Figure 1. Application and type of MMCs with physical, thermal and mechanical properties [10].

The choice of matrix material in MMCs is crucial, with aluminum being the most widely used due to its low density, high strength-to-weight ratio, and corrosion resistance, making it suitable for both aerospace and automotive applications [11–13]. Magnesium-based MMCs are gaining traction in the automotive industry for lightweight applications such as chassis and body panels [14], while copper-based MMCs are used in niche applications requiring high thermal and electrical conductivity, such as thermal management systems and electrical components [15,16].

Despite their superior mechanical and thermal properties, one of the significant challenges in the application of MMCs lies in their machinability. Due to the presence of hard ceramic reinforcements such as SiC, TiB_2, Al_2O_3, and ZrO_2, MMCs fall under the category of hard-to-machine materials [17–21]. These reinforcements contribute to tool wear, poor surface finish, and increased cutting forces during conventional machining processes like turning, milling, and drilling [22]. The abrasive nature of ceramic particles causes rapid degradation of cutting tools, necessitating the use of advanced tool materials such as polycrystalline diamond (PCD) or cubic boron nitride (CBN) and optimized machining parameters to maintain machining efficiency and product quality [23].

To address these challenges, researchers have explored various advanced machining techniques. One such method is Laser-Assisted Machining (LAM), which involves preheating the workpiece locally using a laser source before material removal [24]. This localized heating reduces the cutting forces and tool wear, thereby improving the machinability of MMCs while maintaining their structural integrity [25]. LAM has shown promise particularly in machining aluminum and titanium-based MMCs with high-volume fractions of ceramic reinforcements [26]. Additionally, hybrid approaches combining mechanical and thermal energy (e.g., laser–ultrasonic machining) are being developed to enhance process efficiency and precision for complex geometries. Including machinability considerations is crucial when evaluating the industrial viability of MMC components, especially for high-precision applications in aerospace and automotive sectors. Understanding the interplay between microstructural characteristics, reinforcement type, and machining response is essential for optimizing component fabrication and extending tool life [27].

While both Metal Matrix Composites (MMCs) and Polymer Matrix Composites (PMCs) offer significant advantages in aerospace and automotive applications, MMCs possess several key benefits that make them superior in high-performance, high-temperature, and wear-resistant applications. MMCs exhibit higher tensile strength, stiffness, and load-bearing capacity compared to PMCs [28]. One of the most significant advantages of MMCs over PMCs is their ability to withstand extreme temperatures. Aluminium-based MMCs retain their mechanical properties at elevated temperatures, making them ideal for jet engine components, brake systems, and exhaust structures [29]. In contrast, PMCs suffer from thermal degradation, softening, and loss of mechanical properties at high temperatures, limiting their use in critical high-heat environments [30]. When it comes to engineering applications, Aluminium based metal matrix composites (Al-MMCs) are renowned for providing precise, customized materials with the required property [31]. Because advanced metal composites are widely used in the manufacturing, automotive, aerospace, and biomedical sectors, they are rapidly providing an alternative to ordinary metal alloys among variety of applications.

This comprehensive review provides a critical examination of metal matrix composites (MMCs), with a systematic focus on their mechanical properties, corrosion behavior, industrial applications, prevailing challenges, and prospects. Unlike previous works that often treat these aspects in isolation, our analysis establishes meaningful connections between microstructural characteristics, performance metrics, and real-world functionality across aerospace, automotive, and energy sectors.

The review begins by elucidating how reinforcement selection (ceramic particles, carbon nanotubes, graphene) and processing techniques (stir casting, additive manufacturing) govern key mechanical properties—including exceptional strength-to-weight ratios, enhanced wear resistance, and superior fatigue life. We then analyse the corrosion mechanisms in MMCs, highlighting how matrix-reinforcement interfaces and novel coatings can mitigate degradation in harsh environments. By integrating fundamental science, engineering applications, and sustainability considerations, this review provides both a state-of-the-art assessment and a roadmap for advancing MMC technology—making it invaluable for researchers and industry practitioners alike.

2. Manufacturing Processes of MMCs

There are several ways to manufacture metal matrix composites (MMCs), including solid-state processing, liquid-state processing, gas and vapor phase techniques, and in situ synthesis. Figure 2 provides a clear and structured diagram of these different methods [32]. Solid-state processing, on the other hand, forms MMCs by allowing the matrix metal and the solid reinforcement phase to diffuse into each other under high temperatures and pressure. In liquid-state processing, the MMC is created by mixing the dispersed reinforcement phase into the molten metal before it solidifies. In situ synthesis is another method where the reinforcement phase forms within the matrix itself as the molten material cools and solidifies.

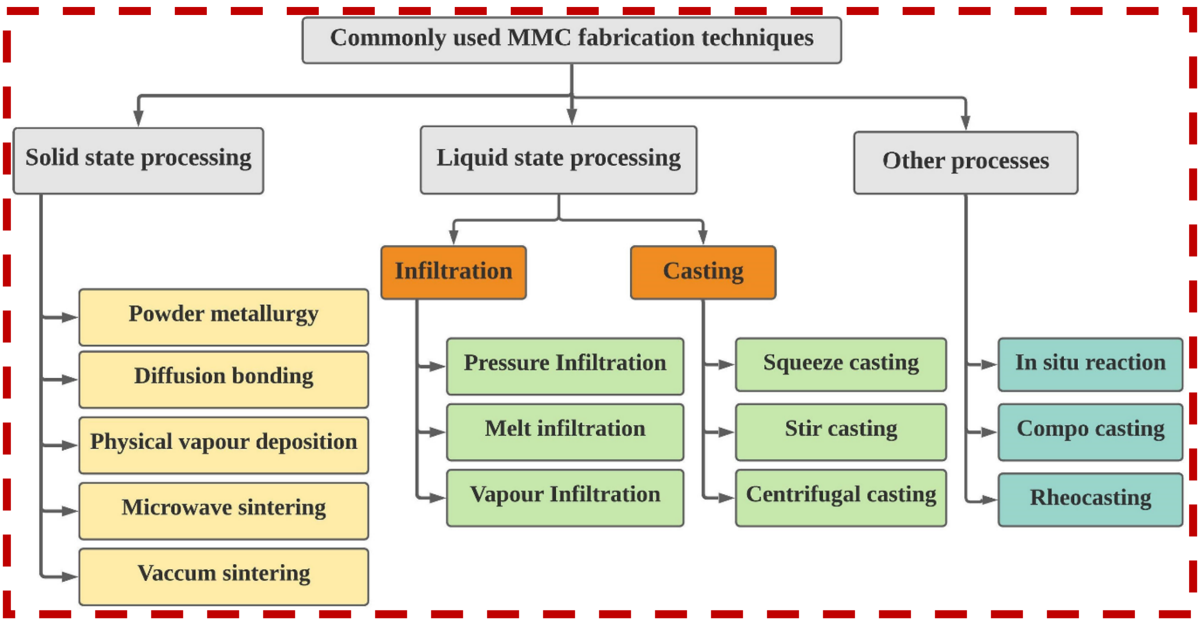

Figure 2. Overview of fabrication of metal matrix composites [32].

Many researchers have developed multiple methods to produce MMCs, but the most commonly used ones are solid-state and liquid-state processing. Each of these methods has its own advantages, depending on cost and the required material properties [33]. In general, the production of MMCs is classified into three categories: solid-state processing, liquid-state processing, and in situ processing.

2.1. Solid-State Processing

Solid state processing method is formed by mixing or combining the matrix and the reinforcing material in their respective solid states. During the process of powder blending method, powdered materials come into contact with a binder substance in a common solvent. The finished powder sheet is alternately piled with reinforcing fibre after drying and rolling. The layers of cloth are heated by vacuum and hot-pressed. Diffusion bonding, mechanical alloying, deformation processing, and powder mixing these are some of the popular solid-state processing techniques [34–36].

2.2. Liquid-State Processing

In this Liquid-state processing the reinforcing material is mixed with the liquid before cooling and condensing therefore it is named after liquid process. There are still some ways to do this like stirring, squeeze casting, infiltration, or spray decomposition [37–39]. For the latter, a reinforcing material is sprayed with liquid metal particles or short fibers. This procedure typically involves dispersing reinforcement elements into a molten matrix to create a composite slurry, which is subsequently solidified into the desired shape.

2.3. In-Situ Processing

Considering this process, we observed that both methods are done by involving solid and liquid and now in this in-situ process [40] is carried out by the chemical reaction within the matrix. As a result of this reaction, a mixture of pure metals with significant matrix dispersion bonding forces is produced. Liquid-gas, liquid-solid, liquid-liquid, and mixed salt reactions are examples of in-situ techniques where reinforcement is formed as a result of chemical reactions between the reactants.

Figure 3 illustrates widely used methods for producing metal matrix composites [41]. Among powder metallurgy methods, the utilization of microwave sintering, spark plasma sintering, molecular level mixing, friction stir processing, and flake powder metallurgy these are all relatively novel technologies with significant potential. Liquid metallurgy techniques were likely the most fascinating from a metallurgical perspective. However, their usefulness in commercial processing is limited. Disintegrated melt deposition is the most recent approach in this category, with the promise for scaling with minimal equipment and infrastructure costs.

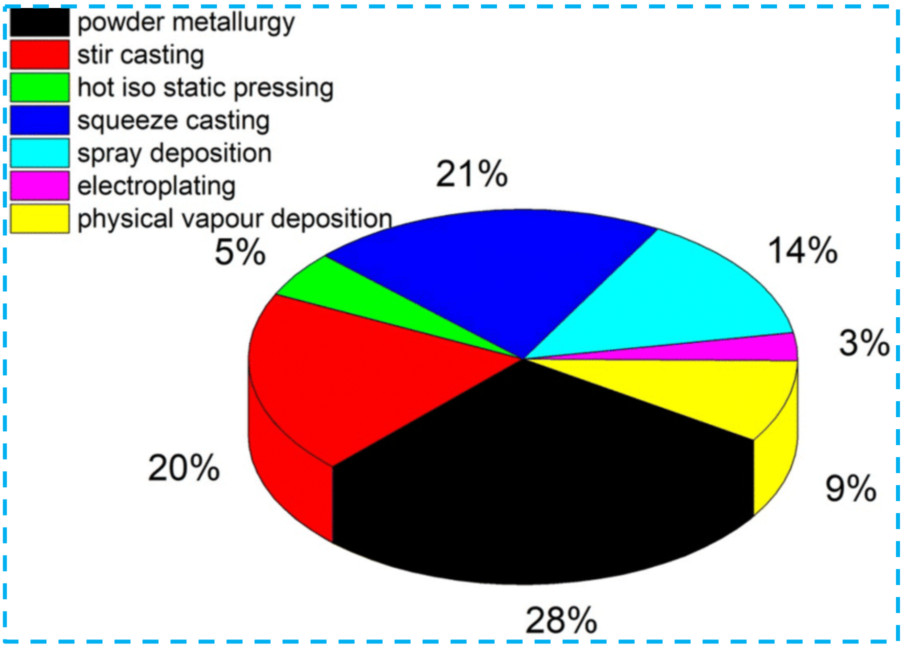

Figure 3. MMCs fabrication route share by percentage [41].

3. Microstructure Analysis of MMCs

Understanding the essential properties of MMCs is essential for optimizing their fabrication process and tailoring their properties for specific applications.

Wan et al. [42] used powder metallurgy to prepare Al matrix composites reinforced by nanocrystalline high-entropy alloy particles and SiC particles. The SEM/TEM and EBSD analysis were carried out for the developed

Al-SiC composite samples. The findings showed that the effect of reinforcement had a substantial impact on the grain size, interfacial condition, and shape of composite powders. Additionally, it shows that the reinforcements are uniformly distributed in both composites.

Matli et al. [43] used the powder metallurgy approach, which involves microwave sintering followed by hot extrusion, to fabricate Al-Si_3N_4 (0, 5, 1 and 1.5 vol.%) nanocomposites. The authors observed that a homogenous distribution of Si_3N_4 nanoparticles in the Al. The presence of Si and N phases was validated by EDS analysis in which also showed good agreement with the distribution of Si_3N_4 in the Al matrix.

Ma et al. [44] studied the AlNp/Al composite to understand its microstructure, focusing on the distribution, morphology, and size of the AlN nanoparticles (AlNp) within the aluminum (Al) matrix. Using a liquid-solid reaction technique, nanoscale AlNp has been effectively designed in-situ in the composites. The detection of AlN and AlB_2 was confirmed by energy dispersive spectroscopy (EDS) analysis based on the X-ray diffraction (XRD) pattern (Figure 4a–c). The HRTEM image (Figure 4e) further demonstrates that the in-situ synthesized AlNp contained in the matrix has a clean and close AlNp/Al interface with atom bonding.

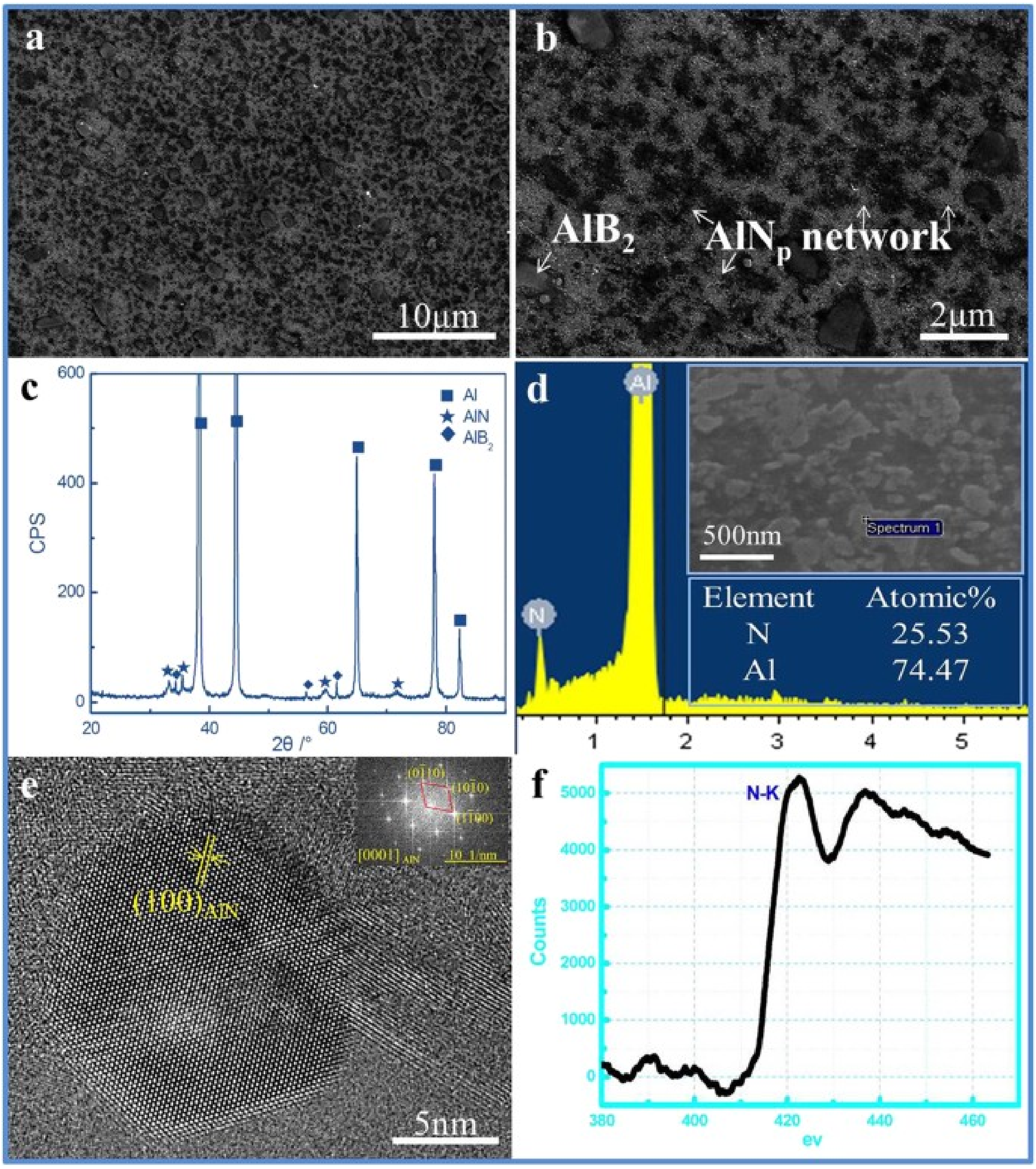

Figure 4. (a–f). Phases identification and microstructures of the 16.4% AlNp/Al composites [44].

Li and colleagues [45] examined the mechanical properties of nanocomposites containing 10% SiC/Al. Hot extrusion and hot pressure sintering methods were used to prepare the nanocomposites. Due to the enhanced wettability between the matrix and the reinforcement, the nano-sized SiC particle reinforcement were distributed well throughout the matrix. When SiC was added, the composites' tensile strength increased because of the improved strengthening of the grain boundaries. Thus, they claimed that their procedure to be one of the most cost-effective and efficient methods of producing Al-SiC nanocomposites.

Balcı et al. [46] investigated 40 vol.% of $Fe_{50.1}Co_{35.1}Nb_{7.7}B_{4.3}Si_{2.8}$ glassy particle reinforced Al composites manufactured by powder metallurgy and consolidation process. The mechanical characteristics and microstructure were thoroughly examined. SEM micrographs of extruded Al composites at various milling periods. Authors reported that the composite sample's improved density and lack of pores in SEM micrographs were caused by the hot extrusion. The composite achieved remarkable flexibility (21%), as well as high strength (390 MPa).

Yuan et al. [47] employed the hot pressing method to prepare high volume percentage (40 and 60%) of Al-based ($Al_{60}Cu_{20}Ti_{15}Zr_{5}$) glassy alloy particles reinforced Al matrix. After 120 h of ball milling, Al-based ($Al_{60}Cu_{20}Ti_{15}Zr_{5}$) glassy alloy particles were successfully obtained in this attempt.

The microstructure of SiC-reinforced Al-MMCs made by manual stir casting was studied by Kundu et al. [48]. The uneven distribution of SiC revealed by microstructural investigation was ascribed to variations in the density of the molten metal.

GNS-reinforced Al-SiC nanocomposites were produced by Zhang et al. [49] using a two- step ball milling process combined with SPS and hot extrusion. The high-energy ball-mill process demonstrated a uniform distribution of aluminum, SiC, and graphene nanoparticles throughout nanocomposites. A microstructure investigation demonstrated that the addition of SiCnp improved the uniform GNS dispersion, resulting in fine crystal structure with intracrystalline nano-phase distribution (Figure 5a–i).

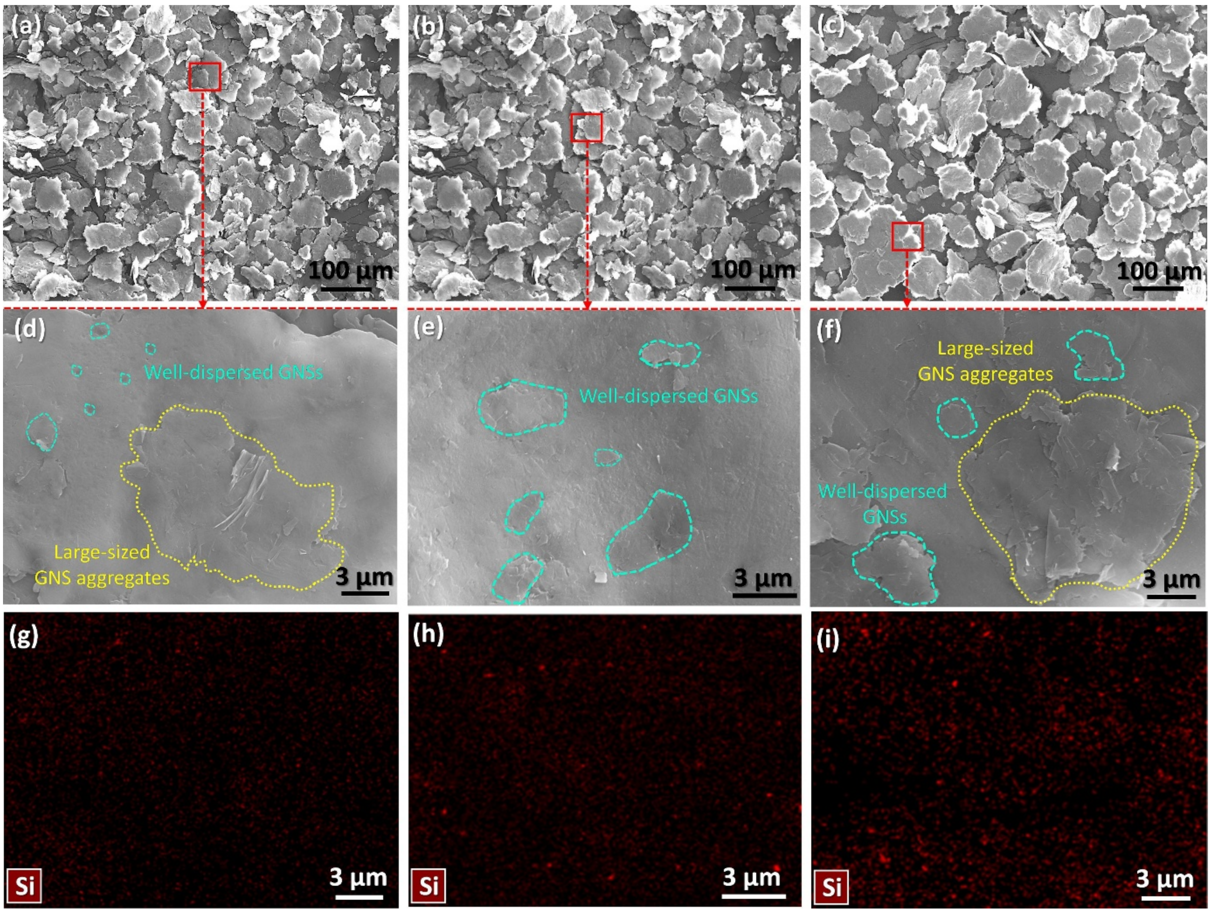

Figure 5. (**a**–**c**) SEM micrographs of Al-SiCnp-GNS composites, (**d**–**f**) and (**g**–**i**) show the GNS and Si distribution on the surface of Al flakes in (**a**–**c**) [49].

Shahin et al. [50] produced $Ni_{50}Ti_{50}$ amorphous particles (0, 0.5, 1.0, and 1.5 vol%) reinforced aluminum composites by microwave-assisted rapid sintering and hot extrusion. The mechanical and microstructural properties of hot extruded composites were investigated. By using this method, we can achieve uniform dispersion of $Ni_{50}Ti_{50}$ amorphous particles in the Al matrix. It reveals that there are strong interfacial connections and a very uniform distribution of amorphous particles in the matrix.

4. Mechanical Properties of MMCs

Aluminum matrix composites (AMCs) are innovative materials known for their improved mechanical qualities when compared to traditional aluminum alloys. The features of AMCs are significantly influenced by the various processing factors used during composite manufacturing. A wide range of important processing parameters must be considered while improving the mechanical properties of AMCs.

The room temperature mechanical characteristics of SiC reinforced aluminum matrix nanocomposites were investigated by Matli et al. [51]. The study employed silicon carbide particles with an average size of about 15 nm. Al-1.5 vol% SiC had the strongest yield and tensile strengths, which are about 51% and 49% higher than those of pure Al, respectively. The hardness and tensile strength of the microwave-hot extruded Al-SiC nanocomposites were significantly better than those of the stir-cast materials.

Akbari et al. [52] developed a novel approach to fabricate A356-based nanocomposites containing Al_2O_3 nanoparticles. The Al_2O_3 nanoparticles were ball milled for 1, 4, 8, 16, and 24 h. The distribution of Al_2O_3 nanoparticles in the composites was quite consistent. However, the hardness and tensile strength of the nanocomposites decreased as the Al_2O_3 nanoparticles' ball milling time increased.

Zheng et al. [49] used hot extrusion and high-energy ball milling to investigate the mechanical performance of Al-5vol% graphene nanosheet (GNS) composites. The ultimate tensile strength (UTS) of the composites reached 479 MPa, which was 60% greater than that of the extruded pure Al matrix.

Xu et al. [53] studied the room temperature tensile stress-strain curves for the Al-CNT nanocomposites. The authors reported that the yield strength (YS) and ultimate tensile strength (UTS) are shown to be considerably enhanced by the addition of CNT. This is because the matrix and reinforcement have a strong interfacial connection and good dispersion.

Bisht et al. [54] investigated the effect of the addition of graphene nanoparticles on microstructural and mechanical properties of Al-GNP nanocomposites prepared by Spark plasma sintering. Both Scanning/transmission electron microscopy and XRD studies confirmed that graphene particles were present in the aluminum matrix. With the addition of 1 wt.% of GNP's to the Al matrix, hardness, yield strength and ultimate tensile strength, and hardness were enhanced by 21.4%, 84.5% and 54.8%, and respectively.

Jeevan et al. [55] used powder metallurgy method to prepare unreinforced aluminum and Al-SiC composites. The composites were subjected to artificial aging and solution heat treatment. The powder shape and composite structure were examined using microscopy. A trend toward increased micro-hardness and compressive strength was observed as the weight percentage of SiC increased.

Garbiec et al. [56] employed the spark plasma method to produce Al reinforced with Al_2O_3 (5%, 10%, 15%, and 20%) composites. The composites were sintered at 600 °C at 100 °C/min in pressure of and held at the sintering temperature for 150 s. Hardness, compression, and tensile strength increased as the amount of Al_2O_3 increased. Maximum hardness, tensile strength and toughness were obtained at 15 weight percent of Al_2O_3, however the highest compressive strength was observed at 20 weight percent Al_2O_3.

The typical stress-strain diagram of the produced composites with various reinforcement types and Al matrix is displayed in Figure 6 [57–59]. The yield strength (YS) and ultimate tensile strength (UTS) are shown to be considerably enhanced by the addition of GNP/Al_2O_3. This is because the matrix and reinforcement have a strong interfacial connection and good dispersion.

Spark plasma sintering (SPS) was used by Alok et al. [57] to examine the effect of microstructural and mechanical behaviour of Al-GNP nanocomposites with both microcrystalline and nanocrystalline matrices. The strengthening effects of nanocrystalline Al matrix and GNP reinforcement have been systematically studied. In contrast to the microcrystalline Al compact, the authors found that the nanocrystalline Al compact (without GNPs) showed improvements in yield strength and ultimate tensile strength of 57% and 53%, respectively. The incorporation of GNPs reinforcement and layered structure were responsible for a notable increase in strength and elongation.

The effect of the addition of 2, 5 and 10 vol% of Al_2O_3 NPs to pure aluminium on its tensile characteristics was investigated by Ma et al. [58]. When compared to monolithic magnesium, the Al-5vol% Al_2O_3 nanocomposite exhibited good improvement in yield strength, ultimate strength and elongation about ~23%, 26%, and 30%, respectively.

Yang et al. [59] prepared graphene reinforced aluminum matrix composites (Gr/Al) using powder metallurgy and examined the effects of the Gr content on corrosion resistance and mechanical performance. The UTS increases gradually as Gr content increases (0–0.3 wt%), reaching its maximum (110 MPa) at 0.3 wt%, which is 23.6% higher than that of pure Al. However, the UTS drops when the Gr content reaches 0.5 wt%.

Ma et al. [44] studied the impact of nano-AlN network nanoparticles on the microstructural and mechanical properties of aluminum matrix composites.

In this study, a nano-sized 3D network AlNp was effectively synthesized in-situ in composites utilizing a liquid-solid reaction approach. The authors revealed that in-situ generated AlNp significantly increases the UTS of prepared composite samples. At 350 °C, the UTS of all composites exceed 110 MPa. With increasing AlNp quantity, UTS of 16.4% AlNp/Al can potentially reach up to 190 MPa.

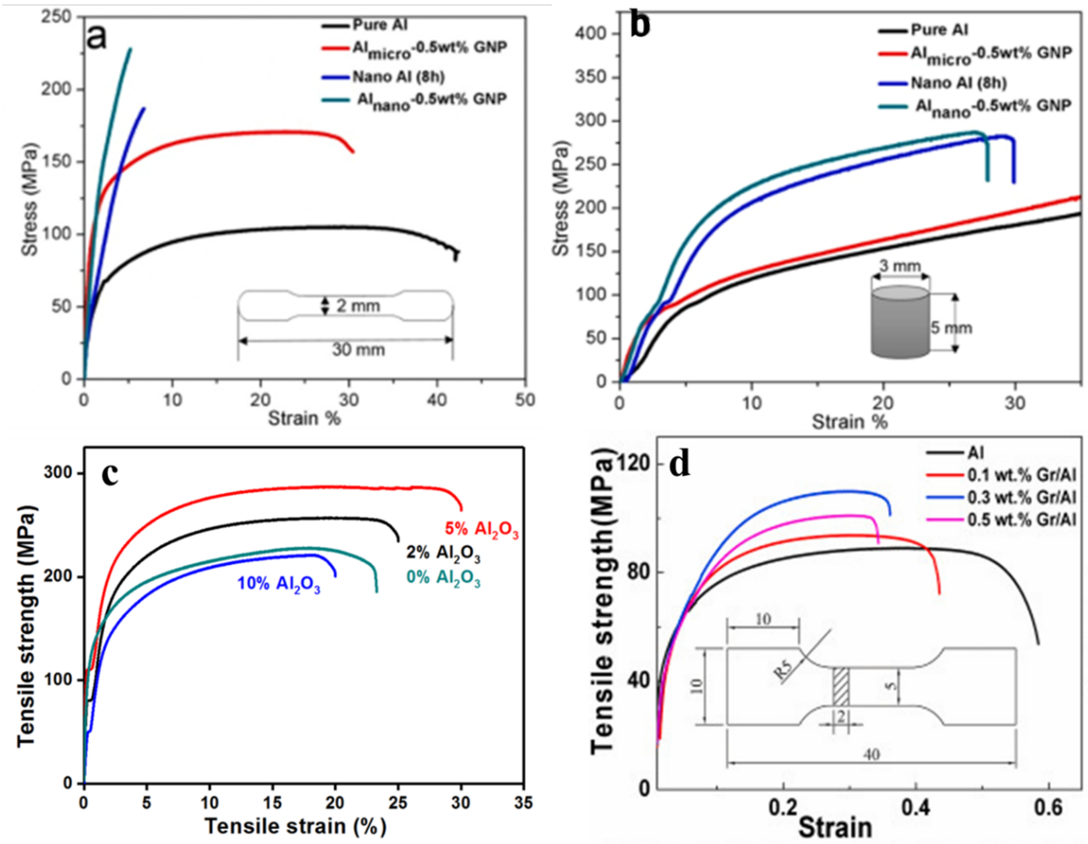

Figure 6. (**a–d**) Stress-strain curves of Pure Al and various Al based composites [57–59].

The microstructure and interface properties of BN, AlB_2, and AlN particles (0, 1, 3, 5, and 7 weight percent) reinforced aluminum matrix nanocomposites were investigated by

Steinman et al. [60]. High-energy ball milling and spark plasma sintering were used in this work to develop Al based nanocomposites. The results of the room and high temperature (500 °C) tensile tests demonstrated that Al-BN composite had the highest strength of 170 MPa. While the Al-AlB_2 sample had a value of 80 MPa, which is still 60% more than that of Al, the Al-AlN samples had a strength of 30 MPa, which was lower than that of pure Al (42 MPa).

Raju et al. [61] examined the effects of nano alumina on the mechanical properties of aluminum matrix composites produced using both powder and liquid metallurgy. Hardness and tensile strength increase with increasing Al_2O_3 content up to 1.5% of Al_2O_3, after which tensile strength declined.

A study on the mechanical and structural characteristics of an aluminum matrix reinforced with SiC and Al_2O_3 particles was carried out by Dixon et al. [62]. According to the authors, as reinforcements increased, ductility declined while yield strength and ultimate tensile strength increased dramatically.

By employing the liquid state mixing approach, Kheder et al. [63] developed MMC's from pure aluminum reinforced with various ceramic additives (Al_2O_3, SiC, and MgO) in varying volume fractions. The yield strength and ultimate tensile strength of the matrix alloy were enhanced while the elongation (ductility) decreased by the addition of Al_2O_3, SiC, and MgO particles.

Przestacki et al. [24] used LAM for machining of A359/20SiCp composite material and compared it with conventional turning process. The authors reported that A359/20SiCp composite has poor machinability during conventional turning with use of sintered carbide insert coated by TiAlN layer. The micrograph showed the distribution of SiC in the Al matrix was uniform. The result shown that a 100% lower tool wear can be achieved compare to conventional turning, during 10 min machining test. This result is explained due to increase in temperature in cutting zone, which increase plastic deformation of matrix of A359/20SiCp. It was also found that the laser assisted machining process shows a considerable improvement in machinability of metal matrix composite by the lower tool wear, and thus increased tool life, along with reduction in the cutting time.

Figure 7 shows the main reinforcing components and the higher tensile strength of the Al-MMCs that were previously reported in the literature [64].

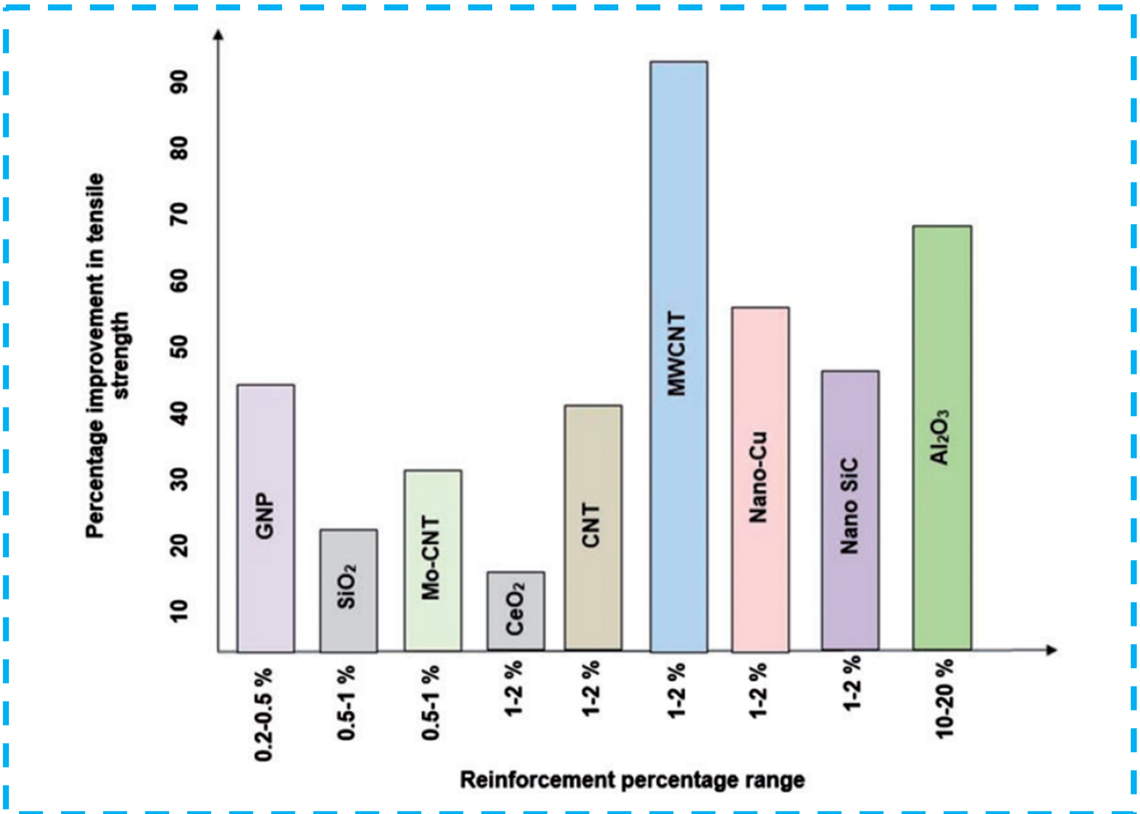

Figure 7. Improvement in the tensile strength of the Al based MMCs with the different types and amounts of reinforcements [64].

5. Corrosion Properties of MMCs

Various researchers have recently examined the corrosion behavior of metal matrix composites. Trzaskoma et al. [65] investigated how SiC-reinforced Al MMCs (AA2024, AA6061, and AA5456) corroded in NaCl solution with and without dissolved oxygen. With the exception of AA2024, the pitting susceptibilities of the wrought alloys and composites did not differ much, and oxygen has a greater impact on overall corrosion behavior than reinforcing material.

The corrosion behavior of an Al6061 matrix composite reinforced with SiC nanoparticles was examined by Shirazi et al. [66] in solutions containing 0.1 M H_2SO_4 and 3% NaCl, respectively. The corrosion potential, corrosion rates, and polarization curves of Al-SiC nanocomposites with varying SiC nanoparticle volume fractions are displayed in Figure 8. The authors reported that the Al-SiC nanocomposite had a greater corrosion resistance than the Al matrix (Al6061). According to the first-principle computation, the electron localization in the interfacial region between the SiC particle and Al matrix is responsible for the increase in corrosion resistance.

The stress corrosion cracking behavior of SiCp reinforced AA6061 composites was investigated by Monticelli et al. [67]. Numerous localized corrosion forms were noted, and the tensile stress identified by electrochemical noise analysis was responsible for the rise in corrosion rate. The corrosion rate of composites based on AA6061 was lower than that of composites based on AA2014,

Ahmad et al. [68] studied the corrosion behavior of SiC-reinforced AA 6013 MMCs and found that the production of a homogenous protective coating boehmite (AlO-OH) contributed to the reduced corrosion rate at 100 °C as opposed to 50 °C.

Albiter et al. [69] used pressureless melt infiltration to create TiC-reinforced Al MMCs and examined how they corroded. TiC was shown to lower the anodic current density, while particles rich in Cu and Ti caused pitting and galvanic corrosion.

Using a plasma-transferred arc (PTA) surface technique, Deuis et al. [70] synthesized Al composite coatings with SiC, TiC, or Al_2O_3 on AA5083 and examined how they corroded in a 3.5 weight percent NaCl solution. The corrosion rate was reduced as a result of the higher volume percentage of coatings containing Al_2O_3. The corrosion rate was increased by the addition of SiC and TiC.

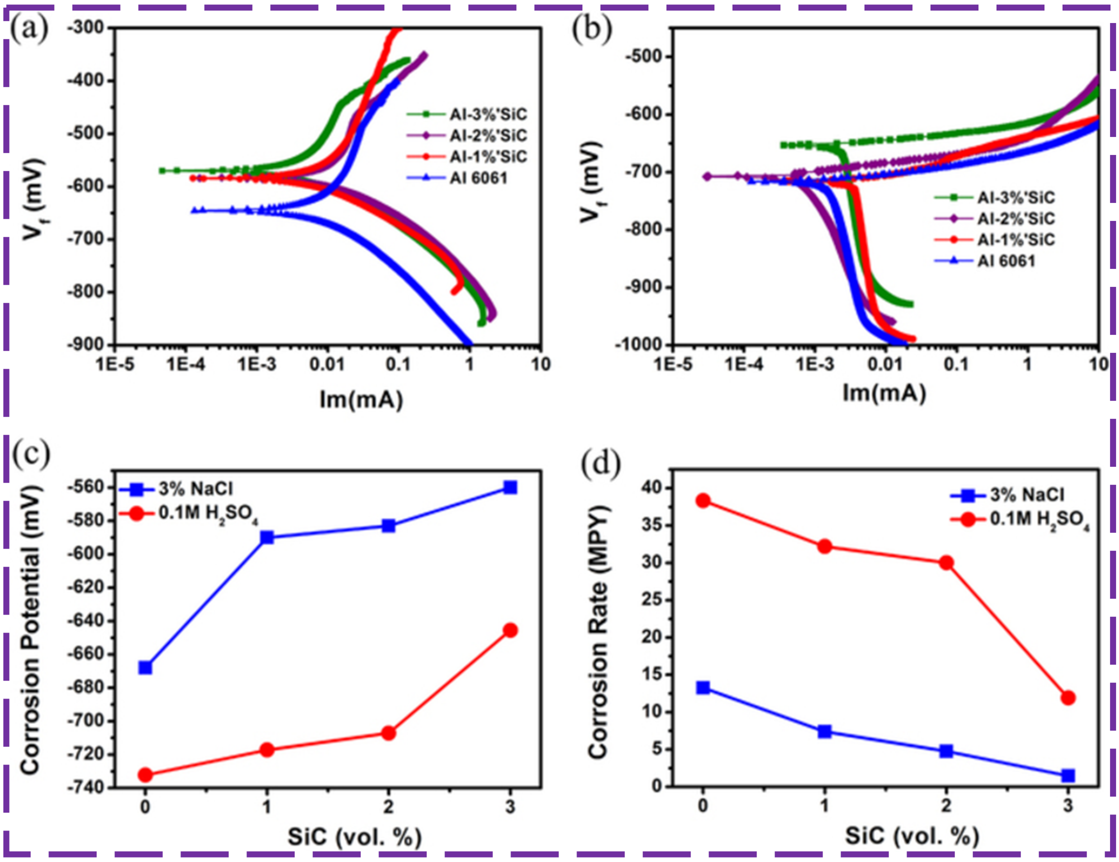

Figure 8. (**a**,**b**) Potentiodynamic polarization curves (**c**) corrosion potential and (**d**) corrosion rate for Al-SiC composites [66].

6. Applications of MMCs

Because of their great strength, affordability, and light weight, Al-MMCs have the potential to be widely used in a range of industrial applications in the automotive industry. Compared to traditional materials, MMCs offer several benefits, including better mechanical properties and a broad range of uses in the mechanical, electrical, automotive, electronics, transportation, and aviation sectors. Figure 9 [71] shows that the metal matrix composites are commonly used in applications.

Some of the main uses in various industries are as follows:

(a) Automotive: MMCs benefit from procedures like laser direct and coatings via laser cladding, which help create lighter, stronger automotive components like engine parts and brake rotors.

(b) Aerospace: MMCs are crucial in the aerospace industry for components required excellent thermal properties and high strength-to-weight ratios. These parts are frequently manufactured using selective laser melting.

(c) Electronics: MMCs superior thermal conductivity makes them perfect for heat sinks and electronic packaging, improving device longevity and performance through the cutting-edge material science advances.

(d) Military and Defence: MMCs improved performance and compressive yield strength are crucial for lightweight yet durable military applications, including as armor and vehicle components.

(e) Sports Equipment: Using matrix alloy technologies and discontinuous reinforcement, MMCs' great strength and low weight enhance sporting equipment like golf clubs and bicycles.

(f) Industrial: In industry, MMCs often contain metallic glass and graphite particles and are used in instruments and equipment that need to be extremely durable and resistant to wear.

(g) Construction: With the help of cutting-edge composite materials and heat treatments, they are used in construction for applications that require both strength and light weight.

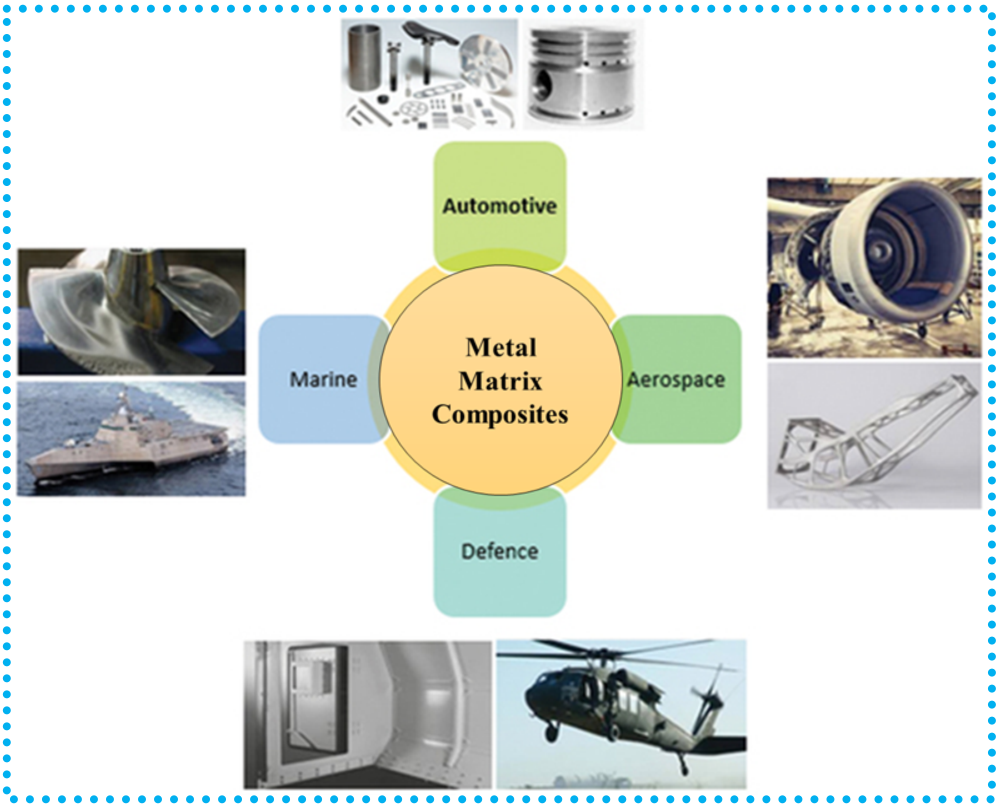

Figure 9. Metal matrix composites for automotive, aerospace, defence and marine applications [71].

7. Conclusions and Discussion

Based on the information provided above, MMCs have a lot of opportunities for use in sophisticated engineering applications in the future. Metal matrix composites have gained popularity in the automotive industry due to their appealing and efficient qualities. This article reviews the recent advancements in the microstructural, mechanical, and corrosion behaviour of the Al based metal matrix composites containing different types of reinforcements processed using various synthesis techniques, resulting in a reliable and high-quality product. The use of Al based MMCs is growing annually, but a larger proportion of applications are seen in ground transportation, electronic/thermal management, and other fields. These materials are anticipated to become increasingly important in the creation of sustainable infrastructure and next-generation technologies as they develop further.

Author Contributions

P.R.M.: conceptualization, methodology and writing-original draft preparation; M.G.: formal analysis, data curation; K.R.G.: writing–review and editing; S.S.R.L.: writing–reviewing and editing; All authors have read and agreed to the published version of the manuscript.

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Data will be made available on request.

Conflicts of Interest

The authors declare no conflict of interest.

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