# Aluminium 7075 metal matrix composites with different reinforcement material review paper

**[1]Sagar Kumar Mahato, [2]Yogesh Shivarkar, [3]Sagar Vishvakarma, [4]Roshan paliwal, [5]Aniket sonawane**

[1]Asst. Proffessor, [2]Asst. Proffessor, [3]Lecturer [4]Asst. professor, [5]Asst. proffessor

[1]Department Of Mechanical Engineering, [2]Department Of Mechanical Engineering, [3]Department Of Mechanical Engineering, [4]Department Of Mechanical Engineering, [5]Department Of Electronics Engineering
A.R.M.I.E.T., Thane, India

**Abstract— Metal matrix composites (MMC) are attracting more attention for use in the automotive, aerospace, and defence industries. The materials utilised for these applications typically need to be lighter and more resistant to wear than materials used in conventional applications. A new category of metal matrix composites called aluminium hybrid composites meets the demands of modern advanced technical applications. These requirements are met because to improved mechanical qualities like light weight and high wear resistance, suitability for traditional processing methods, and the potential to lower production costs. Since several of the processing parameters are linked to the reinforcing particles, the performance of these materials is largely contingent on choosing the appropriate combination of reinforcing materials. Aluminium hybrid composites contain just a few envisioned combinations of reinforcing particles. The mechanical and tribological behaviour of aluminium composites affected by various combinations of reinforcing elements is summarised in this work. Numerous studies have shown that adding ceramic reinforcements greatly enhance the mechanical and tribological properties of composites made of aluminium.**

**Index Terms— MMC, aluminium, hybrid. (key words)**

## I. INTRODUCTION

The particle growth required to preserve the final product's nanostructures substantially limits the use of conventional treatment procedures. Therefore, developing consolidation and consolidation technologies appropriate for nano and hybrid composites takes an hour. The construction of nano-reinforcing materials is a challenging undertaking due to the huge surface area and high surface activity of ultrafine particles, which makes them prone to contamination and decreases the physical, chemical, and mechanical properties of AMC. To fully benefit from the nano size effect, treating nano enhancement carefully is necessary [1].

The hardness, yield strength, and tear strength of composite materials are all greatly increased by the addition of nanoparticles. The accomplishment of various strengthening processes, such as reinforcement, particle downsizing, CTE mismatch correction adjustment between matrix and particles, load acceptance effect, etc., contributes to the improvement of strength. The fracture surface of the tensile test piece had several pits of varying diameters, which supported the nano composite's excellent ductility. [2]. The base metal's qualities are improved by the addition of compounds like graphite and mica, leading to MMCs with improved mechanical properties like higher tensile strength, increased hardness, increased heat deflection temperature, and decreased warpage. [3].

The hardness, toughness, strength, corrosion resistance, and wear resistance of composites are all further enhanced by using hybrid reinforcements as opposed to single reinforcements [4]. One such characteristic that tends to diminish with the addition of reinforcements is ductility. Due to the addition of silicon carbide, it reduces steadily; however, when fly ash is added, it only starts to decline after up to 10% [5]. The TiB2 fortification rate, which contributed 38.86 percent to the surface roughness, was found to be the most significant factor by machining analysis. The surface roughness value will rise with the addition of TiB2 reinforcement [6].

In comparison to earlier studies, the Ni rich sample attained the right balance of strength and ductility (380 MPa at UTS, 16.4 percent elongation at break) thanks to the enhanced ultrastructure. [7]. Al2O3 (2 percent constant), SiC (3 percent, 6 percent, 9 percent), and heat treatment temperatures (140° C, 160° C, and 180° C) were shown to be crucial for experimental planning. Selected [8].

By increasing it by 1% by weight, alloy Al7075's hardness rises from 102HV to 120HV. matrix of Micro Sic and A7075 with 1.5wt percent C particles. Hardness has increased by 15.24% compared to the base alloy [9]. A variety of material zones underwent metallurgical testing, and samples with improved tensile strength and hardness characteristics underwent metallurgical analysis [10].

## II. LITERATURE REVIEW

[1] R.Kartigeyan et al. [2012] Through the use of liquid metallurgy successfully created Al 7075 alloy and Short Basalt Fibre composite. The ultimate tensile strength, yield strength, and hardness are all maximised by the addition of short basalt fibres. In comparison to the base matrix's hardness of 92 Mpa, the composite comprising 6 percent by weight of short basalt fibre indicates a greater hardness value of 97.1 Mpa. The maximum tensile strength is increased by 65.51 percent when reinforced with Al-7075/short basalt fibre at a 6 volume percent ratio. In the metal matrix, the distribution of reinforcements is actually uniform.

According to the research paper mentioned above, under tension stress without compromising tensile ductility,Tensile strength measurements rise. For Al-MMCs, experimental values of short basalt fibre produce the greatest results.

[2] Pradeep P et al. [2017] The stir casting approach has been used to manufacture Al 7075 and Titanium DI Boride (Tib2). 4 percent, 6 percent, and 8 percent are the quantity fractions of TiB2 that were prompted. They assessed the qualities of hardness, wear, and microstructure. The basic matrix is strengthened when TiB2 at 8 percent weight reaches its maximum hardness of 126 VHN. In view of the work hardening the material surface, explicit wear rate decreases as the sliding rate increases up to rotation speed (1.6 m/s) and weight. The composite reinforced with 8 Wt% TiB2 had a negligibly little impact on the wear rate. With the light weight, the speed and sliding distance are at their extremes. The micro picture shows that the aluminium debris are uniformly distributed throughout the particle matrix with the greatest volume percent of 8%.

I inferred from the aforementioned study that the wear and abrasive area characteristics of MMCs using aluminium as the base material depend mostly on the filler particle used, including its size and weight distribution. If the lattice was reinforced with particles, the wear obstruction would increase as the volume of the support materials was divided.

[3] Arun kumar D T et al. [2018] Using the stir casting technique successfully produced Al-7075 composites with mica and kaolinite reinforcements. They carried out a wear test for various time intervals under constant load using equal volume fractions of mica and kaolinite, which are [(2+2)%, (4+4)%, (6+6)%), and (8+8)%. Wear loss is seen to diminish more slowly in composite materials that contain 8% mica and kaolinite. The composite's SEM microstructure shows that the reinforcement is distributed uniformly throughout the matrix, with no signs of agglomeration.

I deduced from the aforementioned study that the inclusion of mica and kolonite increased wear resistance and reduced wear loss.

[4] Rajesh Kumar Bhushan et.al.[2013], contemplated Al7075 combination interfaced with SiC particles was made. For combinations of Al7075 with SiCp of various work sizes, specimens are prepared for the examination using the fluid vortex cast process (20-40). Investigations using EPMA, XRD, SEM, EMPA, and DTA were conducted on composites containing different volume divisions of filler components (10% and 15%). The interface-based synthesis processes have been restricted by SiC oxidation. Because of the numerous mixed combinations of filler materials, the wetting operation linking the base material and Si particles improved. The homogeneous distribution of filler particles is seen by SEM micrographs. The Al4C3 XRD chart shows no increase. According to the EPMA analysis, copper, zinc, and magnesium were included in the particles as well as aluminium, which was the basic constituent.

I deduced from the aforementioned study that Al alloying with 2.52 weight percent Mg and its detachment at the interfaces has been found to be very effective in limiting the course of the Al4C3at the interfaces during example planning. These composites are appropriate for use in cars, aeroplanes, and protective applications because there are no opposing designed reactions.

[5]Madhuri Deshpande et.al.[2016] using the Powder Metallurgy (PM) process, effectively synthesised pitch-based carbon fibre added to Al matrix composites. Uncoated (UnCf) and coated milled pitch-based carbon fibres (NiCf) make up 5 to 50 percent of the weight of carbon fibre, whereas AA7075 serves as the matrix and has varying carbon fibre volume percentages. Carbon fibres that were both uncoated and nickel-coated were strengthened using AA7075 aluminium alloy powder before being hot-pressed and their density and hardness strength were investigated. When compared to Al7075 as it was cast, a 50Vol percent Cf Composite exhibits a density loss of up to 11%. It stated that when compared to Pure Al7075 hot pressed specimens, composites made with uncoated carbon fibre have the lowest hardness values. While the Ni-coated carbon fibre composites exhibit an up to 20% increase in hardness. For all weight percent compositions, it can be seen from the microstructures that the carbon fibres are uniformly dispersed throughout the aluminium matrix.

I deduced from the aforementioned research paper that the electroless nickel coating on the fibre surface enhances the interfacial bonding, increasing the composite's hardness. Improved density results from double action hot pressing, and the density gradient in the composite is not visible.

[6] Manoj Singla et.al.[2009], successful execution They tested the hardness and impact strength of materials by varying the SiC weight percent (5 percent to 30 percent at intervals of 5 percent). The uniform dispersion of SiC particles in the Al matrix reflects an upward trend in the liquid vortex method used to prepare specimens. The study's findings suggest significant expansions in hardness, impact strength, and standardised strain have been seen with inclusions in SiC particle. For 320 grit size SiC particles at 25% weight fraction, the best results were obtained for hardness 45.5BHN and maximum impact strength 36.6N-m.

I deduced from the aforementioned study that homogenous mixtures of SiC particles in the alloy Al exhibit an expanding pattern in the examples shown by not using a mixing process, by manually guiding, and by using a two-stage stirring process for liquid vortex method independently.

[7] Jamaluddin Hindi et.al. [2016], Al 7075 was successfully prepared. Stir casting is used to create reinforced grey cast iron with varying weight percentages of 2 percent, 4 percent, and 6 percent, as well as 2 weight percentage of fly ash. Tensile strength was seen to increase as the weight percent of GCI increased. At 6% GCI, the maximum tensile strength of 275Mpa was obtained. With an increase in the weight percentage of GCI in the composite, hardness increases opulently. The wear rate decreases from 410 m with an increase in the weight percentage of GCI.

I deduced it from the research paper mentioned above. Support material increases and intermolecular space decreases as the weight percentage of GCI in the grid increases. The matrix shows no signs of having developed holes.

[8] Mohan Kumar S et.al.[2014], completed examinations on an Al 7075-T6 with a 10–20 m thick electroless nickel coating. In this investigation, the plane strain crack mechanics and confirmation were used. Uncoated Al 7075-T6 composite shows a 560 MPa yield nature, and when EN coating is applied on a mix of 10 and 20 m, the yield nature increases to 569 MPa and 603 MPa, respectively. The critical load for uncoated aluminium is 4.44 KN, and the K1c value is 22.28 mpa $\sqrt{m}$. Additionally, secured aluminium compound has an essential load of 6.67 kN and 7.41 kN for 10 and 20 microns, respectively, which contrasts with KIC estimates of 34.48 MPa $\sqrt{m}$ and 37.67 MPa $\sqrt{m}$, respectively.

I deduced from the aforementioned research paper that the EN covering experiences improving delamination and crack at the highest load because of the ductile material's tendency to plastic deformation. Due to the strong adhesion between the EN coating and the aluminium alloy, the split development is unstable.

[9] Bateshwar Prasad et.al.[2022], metal matrix composites of Al-7075 and SiC mix together by the stir casting process for the uniform distribution throughout the process, after completion of the casting process composites material is undergo to the finishing in the lathe machine, after that prepared composite material is undergo to polishing for microstructure testing of the surface, and also for the hardness testing, result of hardness test on AA 7075 alone without adding reinforcement (nanoparticles) of silicon carbide produced the final calculated result of 901.23 BHN; tests on the same sample with silicon carbide reinforcement of 0.25 percent of its weight produced 936.96 BHN; tests on the same sample with silicon carbide reinforcement of 0.50 percent of its weight produced 951.34 BHN; and finally tests on the same sample with silicon carbide reinforcement.

I deduced from the research paper mention above the hardness analysis, the parent or original AA 7075 obtained a hardness of 901.23 BHN, and with reinforcement materials of 0.25, 0.50, and 0.75 percent, the hardness was 936.96 BHN, 951.34 BHN, and 970.94 BHN, respectively. In light of the aforementioned findings, it is also possible to draw the conclusion that the mechanical and hardness properties of the AA 7075 with nano silicon carbide reinforcement were improved over those of the parent AA 7075.

## III. CONCLUSION

The yield strength, tensile strength, and other mechanical properties of distinct categories of ductile and brittle materials are all determined by the tensile test, which has many uses. Numerous studies have demonstrated that, compared to the base matrix, the tensile strength improves as the amount of reinforcement material is increased. When various reinforcements, such as SiC, B4C, Al2O3, Graphite, Carbon fibre, and Grey Cast Iron, are added to aluminium base alloy, the tensile strength of the alloy increases to 278 MPa, exceeding the base matrix's 167 MPa. From the foundation material of aluminium, the tensile strength rises by 60–70%. When the composites' hardness was evaluated, taking all factors into consideration, it was discovered that as the support material in the framework material grew, so did the composites' hardness. In addition, experiments designed to determine the equivalent showed that (Vickers and Brinell's hardness) expanded hardness with enlarged support substance when compared to the base lattice. It goes without saying that the fortifications' architecture and other characteristics influence how the composite materials behave mechanically.

The primary goal of a wear test is to gather data on parameters that significantly affect tribological properties, such as sliding distance, friction behaviour, heat treatment, lubrication, load, and speed. The wear resistance of the composite aluminium metal metal matrix increases with the addition of the hard ceramic particles. According to the statistics in this survey document, adding reinforcing material causes a reduction in wear rate of up to 50% when compared to base matrix.

In this study, numerous studies on the mechanical and tribological characteristics of various aluminium material series and various filler particles added to the base matrix are covered. This broadens our understanding of composite materials and piques our interest in cutting-edge materials utilised in cars, planes, and other daily necessities.

All of the study papers reach the same conclusion: The mechanical, physical, and tribological properties of different aluminium series materials are significantly influenced by the reinforcement materials. This encourages other researchers to examine various mechanical qualities by fusing novel materials to aluminium in the hopes of obtaining the best mechanical and tribological results.

## REFERENCES


1. R. Karthigeyan, G. Ranganath, S. Sankaranarayanan "Mechanical Properties and Microstructure Studies of Aluminium (7075) Alloy Matrix Composite Reinforcedwith Short Basalt Fibre" European Journal of ScientificResearch, ISSN 1450-216X Vol.68 No.4 (2012), pp. 606- 615.
2. P. Pradeep, P. S. Samuel Ratna Kumar, Daniel Lawrence I,Jayabal S "Characterization of par particulate reinforcedAluminium 7075 / TiB2 Composites" International Journal of Civil Engineering and Technology (IJCIET), Volume 8, Issue 9, September 2017, pp. 178–190.
3. Arunkumar D T , Raghavendra Rao P S, Mohammed Shadab Hussain , Naga Sai Balaji P R "Wear Behaviour and Microstructure Analysis of Al-7075 alloy reinforcedwith Mica and Kaolinite" IOP Conf. Series: Materials Science and Engineering 376 (2018) 012067.
4. Rajesh Kumar Bhushan, Sudhir Kumar and S. Das, "Fabrication and characterization of 7075 Al alloy reinforced with SiC particles", International Journal of Advanced Manufacturing Technology, No. 65, pp. 611- 624, 2013.
5. Madhuri Deshpande, Rahul Waikar, Ramesh Gondil, S.V.SNarayan Murty, T.S.Mahata "Processing of Carbon fiber reinforced Aluminium (7075) metal matrix composite" International Journal of Advanced Chemical Science and Applications (IJACSA), ISSN (Online): 2347-761X, Volume -5, Issue -2, 2017.
6. Manoj Singla, D. Deepak Dwivedi, Lakhvir Singh, Vikas Chawla "Development of Aluminium Based Silicon Carbide Particulate Metal Matrix Composite"Journal ofMinerals & Materials Characterization & Engineering, Vol. 8, No.6, pp 455-467, 2009.
7. Jamaluddin Hindi, Achuta Kini U, S.S Sharma "Mechanical Characterisation of Stir Cast Aluminium 7075 Matrix Reinforced ith Grey Cast Iron & Fly Ash" International Journal of Mechanical And ProductionEngineering, ISSN: 2320-2092. Volume- 4, Issue-6, Jun.-2016.
8. Mohan Kumar S, Pramod R, Shashi Kumar M E, Govindaraju H K "Evaluation of Fracture Toughness andMechanical Properties of Aluminum Alloy 7075, T6 withNickel Coating" ScienceDirect, Procedia Engineering 97(2014 ) 178 – 185.
9. Muley, A.V., Aravindan, S. and Singh, I.P., 2015. Nanoand hybrid aluminum based metal matrix composites: an overview. Manufacturing Review, 2, p.15.
10. Mazahery, A. and Shabani, M.O., 2012. Characterization of cast A356 alloy reinforced with nano SiC composites. Transactions of Nonferrous Metals Society of China, 22(2), pp.275-280.
11. Kalra, C., Tiwari, S., Sapra, A., Mahajan, S. and Gupta, P., 2018. Processing and characterization of hybrid metal matrix

composites. Journal of Materials and Environmental Science, 9(7), pp.1979-1986.

**12.** Rino, J.J., Chandramohan, D., Sucitharan, K.S. andJebin, V.D., 2012. An overview on development of aluminium metal matrix composites with hybridreinforcement. Int. J. Sci. Res, 1(3).

**13.** Sharma, R., Jha, S.P., Kakkar, K., Kamboj, K. and Sharma, P.A., 2017. A review of the aluminium metal matrixcomposite and its properties. International Research Journal of Engineering and Technology, 4(2), pp.832-842.

**14.** James, S.J., Ganesan, M., Santhamoorthy, P. and Kuppan, P., 2018. Development of hybrid aluminium metal matrix composite and study of property. Materials Today: Proceedings, 5(5), pp.13048-13054.

**15.** Mousavian, R.T., Behnamfard, S., Khosroshahi, R.A., Zavašnik, J., Ghosh, P., Krishnamurthy, S., Heidarzadeh, A. and Brabazon, D., 2020. Strength-ductility trade-off via SiC nanoparticle dispersion in A356 aluminium matrix. Materials Science and Engineering: A, 771, p.138639.

**16.** M Ravi Kumar et al., (2017). Mechanical and Wearbehavior of Al7075/Al2O3/SiC Hybrid Composite.

**17.** Sekar, K. and Rao, D.A., 2020. Investigation of Hybrid Composite A7075/SiC/B4C by Stir and Squeeze Casting method. Materials Today: Proceedings, 22, pp.1398-1408.

**18.** Kumar, A.V., Balasrinivasan, M., Kumar, R.V., Balachandar, K. and Sivakumar, C., 2020. Temperature Distribution Study of Friction Stir Welded Aluminum Alloy7075-T6 joints Reinforced with SiC Powders. Materials Today: Proceedings, 22, pp.1333-1340.

**19.** Kumar, V.M. and Venkatesh, C.V., 2019. Acomprehensive review on material selection, processing, characterization and applications of aluminium metal matrixcomposites. Materials Research Express, 6(7), p.072001.

**20.** Sarada, B.N., Murthy, P.S. and Ugrasen, G., 2015. Hardness and wear characteristics of hybrid aluminium metal matrix composites produced by stir casting technique. Materials Today: Proceedings, 2(4-5), pp.2878-2885.

**21.** Casati, R. and Vedani, M., 2014. Metal matrix composites reinforced by nano-particles—a review. Metals, 4(1), pp.65-83.

**22.** Bodunrin, M.O., Alaneme, K.K. and Chown, L.H., 2015. Aluminium matrix hybrid composites: a review of reinforcement philosophies; mechanical, corrosion and tribological characteristics. Journal of materials research and technology, 4(4), pp.434-445.

**23.** Ravindranath, V.M., Shankar, G.S., Basavarajappa, S. and Kumar, N.S., 2017. Dry sliding wear behavior of hybrid aluminum metal matrix composite reinforced with boron carbide and graphite particles. Materials Today: Proceedings, 4(10), pp.11163-11167.

**24.** V.M.Ravindranath et al.,(2017). Dry sliding Wear Behavior of Hybrid aluminum Metal Matrix composite reinforced with Boron carbide and graphite particles

**25.** Behera, R.K., Panigrahi, S.C., Samal, B.P. and Parida,P.K., 2019. Mechanical properties and micro-structural studyof sintered aluminium metal matrix composites by P/M technique. Journal of Modern Manufacturing Systems and Technology, 3, pp.89-97.

**26.** Mousavian, R.T., Behnamfard, S., Khosroshahi, R.A.,Zavašnik, J., Ghosh, P., Krishnamurthy, S., Heidarzadeh, A. and Brabazon, D., 2020. Strength-ductility trade-off via SiC nanoparticle dispersion in A356 aluminium matrix. Materials Science and Engineering: A, 771, p.138639.

**27.** Dwivedi, S.P., 2020. Microstructure and mechanical behaviour of Al/B4C metal matrix composite. Materials Today: Proceedings, 25, pp.751-754.

**28.** Soutrik Bose et al., (2019). Comparative and Experimental study on Hybrid Metal Matrix Compositesusing Additive Ratio Assessment and MultiAttributive Border Approximation Area Comparison methods varying the different Weight Percentage of the Reinforcement.

**29.** Saravanan, C., Saravanan, K., Sevvel, P. and Sudharsan, P., 2021. Investigation and evaluation of mechanical Behaviour of Al-TiC alloy. Materials Today: Proceedings, 37, pp.1203-1207.

**30.** Mungara, S.R., Manohar, H.S. and Trishul, M.A., 2021. Study of mechanical characteristics of stir cast AA7050-B4C metal matrix ceramic composites. Materials Today: Proceedings, 37, pp.1463-1468.

**31.** Chakrapani, P. and Suryakumari, T.S.A., 2021. Mechanical properties of aluminium metal matrix composites-A review. Materials Today: Proceedings, 45, pp.5960-5964.

**32.** Manghnani, S., Shekhawat, D., Goswami, C., Patnaik, T.K. and Singh, T., 2021. Mechanical and tribological characteristics of Si3N4 reinforced aluminium matrix composites: A short review. Materials Today: Proceedings, 44, pp.4059-4064.

**33.** Vasudevan, N., Bhaskar, G.B., Prasad, A.R. and Suresh, S.M., 2019. Corrosion study on AA5083 aluminum alloy-boron carbide composite. Materials Today: Proceedings, 16, pp.1124-1129.