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Effect of Mechanical Properties of AL7075/Mica Powder Hybrid Metal Matrix Composite

K. Arunprasath [1] ✉, P. Amuthakkannan [2], M. Vijayakumar [1], R. Sundarakannan [3], M. Selwin [4], S. Kavitha [5], Lavish Kumar Singh [6]

[1]Department of Mechanical Engineering, PSN College of Engineering and Technology, Tirunelveli, 627152, Tamilnadu, India

[2]Department of Mechanical Engineering, PSR College of Engineering, Sivakasi, 626140, Tamilnadu, India

[3]Institute of Agricultural Engineering, Saveetha school of Engineering, SIMATS, Chennai- 602105, Tamilnadu, India

[4]Department of Mechanical Engineering, SSM Institute of Engineering and Technology, Dindigul - 624002, Tamilnadu, India

[5] School of Mechanical, Aero, Auto and Civil Engineering, Kalasalingam Academy of Research and Education, Krishnankoil, 626126, Tamilnadu, India

[6] Department of Mechanical Engineering, Sharda University, Greater Noida, 201310, India

✉ aruncmr12@gmail.com

Abstract. The applications of aluminum-based Metal Matrix Composite (MMC) are very huge and it possesses good output when combined with Mica Powder. Because Mica is one of the naturally available crafted stones of minerals. It can bind with the materials easily in ambient conditions. This research work is to study the mechanical performance of the AL7075/Mica Powder hybrid MMC's. The varying grams of Mica powder (5 g to 25 g) are added with 500 grams of aluminum 7075. From the results obtained for the mechanical properties of AL7075/Mica Powder composite. Specimen 5 (500 g of AL 7075/25 g of Mica Powder) has excellent mechanical properties such as tensile strength of about 285 MPa, impact strength of about 18 J. The Vicker Hardness indentation is about 80 VHN, all these results define that after the addition of Mica Powder in the composite. The bonding nature of Mica with AL7075 always acts as a supporting agent in the defining of excellent mechanical properties of metal matrix composite.

Keywords: AL7075, Mica Powder, Tensile strength, Impact strength, Vicker's Hardness test, SEM morphology

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Introduction

The progression of composite materials with evaluated properties known as practically reviewed materials has reformed mechanical parts fabricating, particularly in the auto, flight, guard, and biomedical businesses. The mix of composite materials is in light of the fact that each layer is unique in relation to different layers. The strength and tribology properties of

each layer rely upon the constituents present in it. On account of appearance, there is a critical improvement in the presentation and lifetime of mechanical parts like pinion wheels, heading, shafts, and cams [1]. The main impetus for AMCs production is fitting the helpful properties of the material by joining the lightweight, intense and flexible aluminum (Al) composite with reasonable earthenware particles. Especially, AMCs supported with SiC have caught much consideration from auto for example brake drums, chamber liners, cylinders and cylinder rings, and so forth, and aviation ventures like rotor vanes, and drive shafts in view of their amazing mechanical properties alongside monetary and natural manageability execution of AMCs relies upon the synthesis of the grid composite, sort of support, and producing strategies [2]. Serious plastic distortion is a productive methodology for making a high thickness of line deserts in metals. The blend of enormous shear strain with high hydrostatic tension, which is brought about, diminishes the grain size of the amalgam, opportunity agglomerates, and nano precipitation. Attributable to these benefits, Serious plastic distortion is frequently applied in the improvement of a wide scope of ultrafine-grained mass metallic composites with ultrahigh strength [3]. Changing reinforcements like Boron Carbide, Silicon Carbide, Aluminum Oxide, and Titanium Diboride are utilized to bear strength in the subsequent parts. Combinations of aluminum are generally utilized in high-temperature application regions where their mechanical properties assume a significant part in the working of the framework. Later investigationsare on different scopes of network materials in combinations of Aluminum like A356, Al6061, Al7075, and comparative others are utilized for the creation of composites utilizing different techniques like diffusive projecting, mix projecting, crush projecting, and comparable different procedures [4]. 7075 aluminum composites have superb exhaustive properties and high strength at room temperature. It is one of the greatest strengths of aluminum composites as of now utilized. It has better framing properties however broad erosion opposition and helpless hotness opposition. It is moderately low in extinguishing affectability, appropriate for arrangement treatment at different temperatures, and equipped for fast normal maturing. This high-strength and lightweight combination can be utilized to fabricate climbing hardware and bike parts, and be applied to an auto body board, brake lodging, brake cylinder, guide sheet parts, and other field seat rails in flying [5]. Among different Al combinations grew up until now, the commitment of Al7075 combination to underlying applications in auto and aviation businesses is striking in light of its incredibly high strength, low thickness, high warm steadiness, and great weariness strength. Al7075 is a hotness-treatable combination, in which the development of $MgZn_2$ hastens and improves its solidarity by scattering fortifying. Mechanical properties of these combinations can be additionally improved by huge refinement of grains by serious plastic disfigurement, which basically fuses cell separation, what's more, disfigurement [6]. Agglomeration is an extremely urgent issue in the utilization of added substances in metal framework materials. This is particularly the situation when metal framework composites are delivered by fluid projecting techniques on the grounds that these fortifications can isolate at grain limits. Furthermore, these techniques require dissolving the metals, which prompts high creation costs [7]. The use of different hard-clay particles like aluminium oxide, boron carbide, titanium carbide, silicon carbide, and rice husk as support has come about in improved mechanical and tribological attributes of composites. Numerous scientists are chipping away at SiC-based metal network composites in light of the fact that of their appealing components. Contrasted with mix projecting, metal penetration, splash deterioration, and mechanical alloying, one of the broadly utilized strategies to foster composites is the Powder metallurgy process [8]. Al7075 MMC was observed to be expanded when contrasted and Al7075 by 20% and 33%, which is because of the great strength and solidness given by the Al_2O_3 which is mixed with Al7075the particles have a holding ability that bonds with the base material. In mix projecting interaction, the support material is

presented in a persistently mixed liquid grid and afterward cast by sand, long-lasting mold, or strain pass-on projects on the off chance that the blending is done consistently, the B_4C particles are similarly circulated, which invigorates a uniform all through the material [9]. Al7075 with alumina metal network composite by Stir projecting method. It is tracked down that 8% of Alumina with Al7075 has the most noteworthy mechanical properties. This proportion has the most noteworthy worth in the Brinell hardness test, Impact test, and Extreme load test. A portion of the inventive and effective assembling strategies are effectively carried out in numerous fabricating ventures to create composite materials [10]. With consistently scattered TiB_2 and Gr particles, the high hardness and other great properties of these fortifications can be viably utilized for the improvement of the solidarity of composites. The augmentation in a definitive rigidity of Al7075 combination and it is half and half composites are Hall-Petch reinforcing, load move strength, warm crisscross reinforcing, and precipitation fortifying. Here each fortifying is talked about one by one to see how they impact the strength of Al7075 combination furthermore, its half and half composites. Composites show a decrement in grain size likened to that of unreinforced Al7075 amalgam because of half and half fortifications. Because of the expansion in grain limit thickness, the composites [11, 12]. Al7075 compound by means of contact mix welding and finished up that 20 % volume part of nano particles of SiC with Al7075 expanded the mechanical properties of the welded joint. They announced that the mechanical properties of the welded joint are dependent on grain size, support scattering, and the holding quality among network and fortifications materials. The hardness of the contact mix prepared Cu with the B4C was expanded 42 % higher than the without these particulates [13]. Notwithstanding a slight diminishing in the primary hours of the maturing system, the electrical conductivity of the sintered examples for the most part expanded with the expansion in the maturing time [21]. The impact of ball processing time and sintering temperature on the microstructural developments, wear conduct, and mechanical and warm properties of the created composites were researched. X-beam diffractometer and examining electron magnifying lens examination showed that as the ball processing time expanded, the molecule size diminished, the homogeneity expanded the overall thickness of the Al2024 framework diminished with an increment of the nano-ZrO2 particles while the clear porosity expanded [22]. Besides, critical improvement in mechanical properties, for instance, microhardness, extreme strength, reinforcing productivity, and Young's modulus. The wear rate diminished as the support content expanded while it expanded with the increment of the sliding distance and applied load [23,24]. The objective of the research work is to study the mechanical and morphological properties of chosenAl7075/Mica Powder Metal Matrix Composite for automobile, and aerospace applications.

Materials and methods

Aluminium7075 powder of about 10-60 μm is purchased from Chandan Steel World, Bhuvaneshwar, Mumbai, Maharashtra. Industrial White Mica powder with a particle size of 10-60 μm purchased from the pearl enterprise, Chennai, Tamil Nadu. The stir casting method is used to prepare the composite with the graphite crucible at 680ºC for 25 minutes. The preheated reinforcement is added atregular intervals to avoid unnecessary agglomeration. The reinforcement Al7075 and Mica powder were mixed with 580rpm for 15 minutes. After the mixing of the composite by maintaining 680ºC, the molten mixture is pertained in the die and allows for natural cooling at ambient temperature. The same procedure is repeated for the preparation of 5 specimens with varying ratios of Al7075 and Mica powder. Figure 1 represents the experimental setup of stir casting for the preparation of the composite specimens. Table 1 represents the specimen description of the prepared composite.

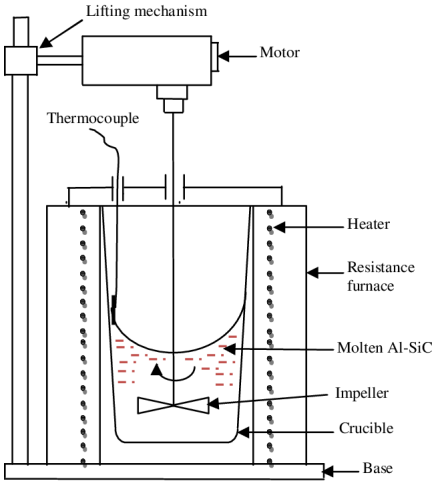

Fig.1. Stir Casting Setup

Table. 1. Composite Specimen Description

S.no	Weight of Aluminium AL7075(g)	Weight of Mica Powder(g)	Prepared Specimen Designation
1	500	0	Specimen 1
2	500	5	Specimen 2
3	500	10	Specimen 3
4	500	20	Specimen 4
5	500	25	Specimen 5

Result and discussion

Tensile test. The tensile strength analysis is carried out using the universal tensile testing machine. The specimen was prepared as per the ASTM E8 standard and values are recorded with an average of five specimens. The tensile strength of the filler Mica Powder increases the tensile strength of the MMC composite also increase [14, 15]. This type of phenomenon represents the bonding and solid strengthening of the metal and the matrix. The maximum tensile peak is noted for specimen 5 about 285 MPa for the combination which has 25 grams of Mica powder with 500 grams of aluminium. Increasing the homogeneity of the particle size produces a tough bonding at the time of fabrication. This type of pocketing of mica powder may improve the tensile strength of the composite. In addition to this, the different-sized atomic combinations are readily exhibiting this type of intervention on the aluminum-based metal matrix composite [16]. Figure 2 shows the tensile strength analysis of varying grams of Al7075/Mica Powder MMC.

Impact test. Impact strength specifies the energy-absorbing capabilities of the material at the time of application of sudden load. At the time of the impact, event happened the workpiece material may withstand the load or break into two halves. The impact test was carried out using the Charpy impact tester with the standard of ASTM A370. For the final value calculation, the average of five specimens is taken. Figure 3 represents the impact strength analysis of Al7075/Mica Powder Metal Matrix Composite. The results of the impact study also, represent the same observation the increase in the content of Mica Powder improves the energy observing capability of the composite about 18 J. While increasing the Mica Powder content increasesthe bonding strength of the aluminium-reinforced composite [17]. Owing to the quality dispersion of Mica in the aluminum shows this kind of observation, during the happening of the impact event.

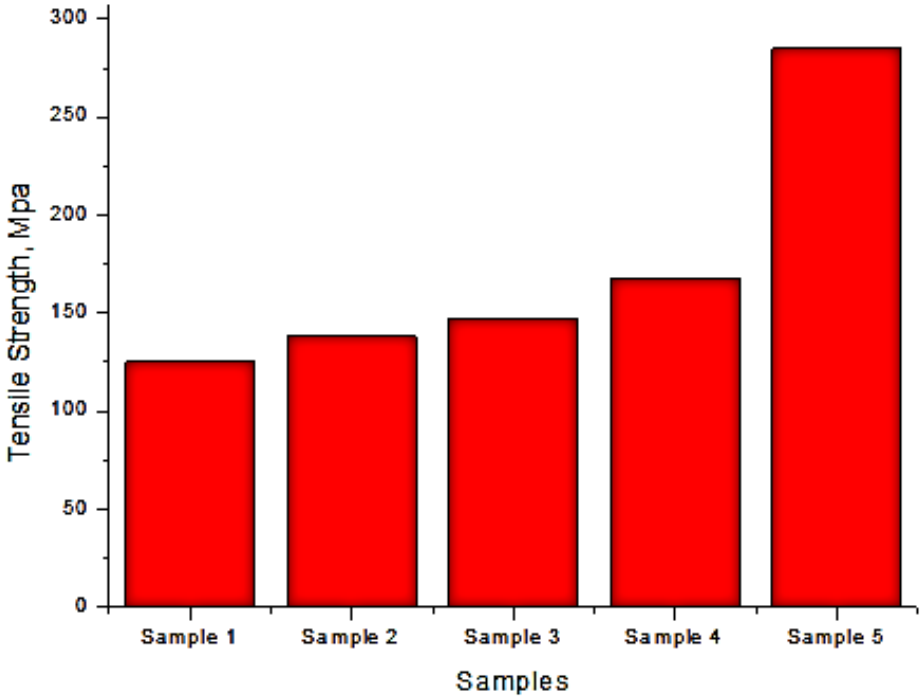

Fig. 2. Tensile strength analysis of Al7075/Mica Powder

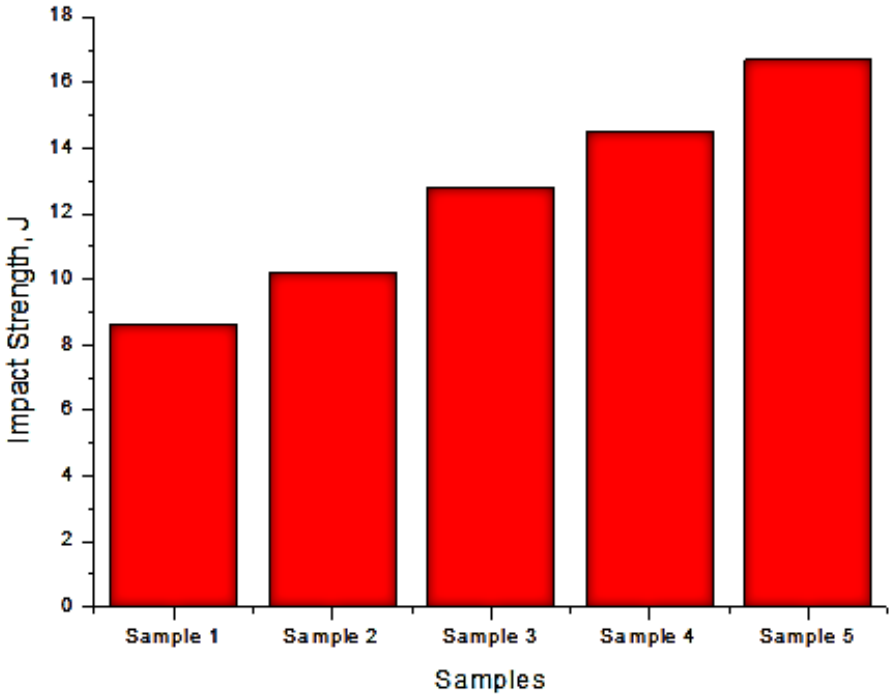

Fig. 3. Impact strength analysis of Al7075/Mica Powder

Hardness test. Hardness is one of the tests which helps to determine the deformation of the materials by means of indentation. Vicker hardness tester is used to evaluate the hardness of the prepared specimens. A load of 100 kg is applied to the composite for 20 seconds. An average of five specimens are taken for the hardness study. The increase of the filler Mica Powder is an inorganic material thatproduces an improved hardening condition for the composite [18]. Because the hardness value is only depending on the incorporation of powdered particles in the layers of aluminum which shows about 80 VHN for specimen 5. Figure 4 represents the Vicker Hardness Number of the prepared specimen.

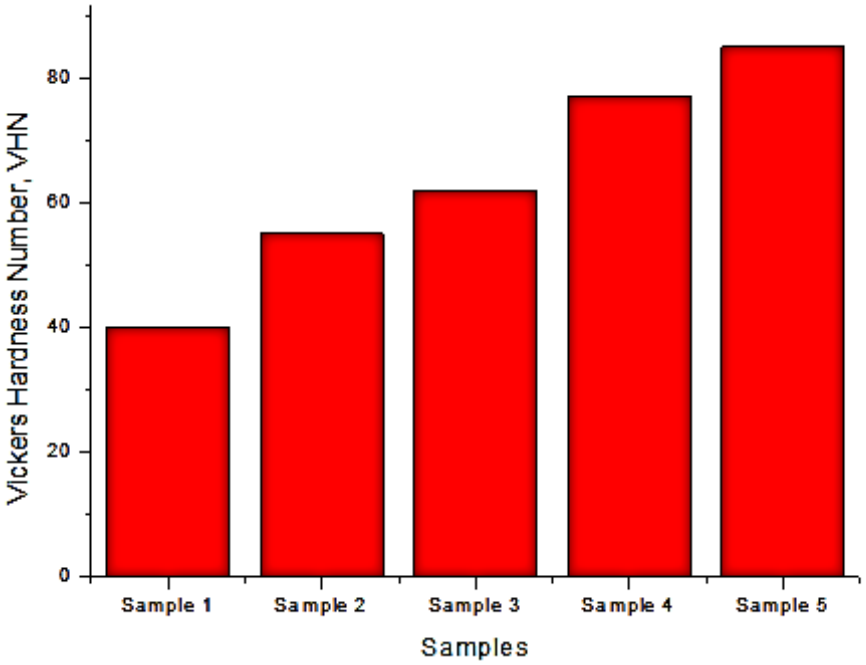

Fig. 4. Hardness test analysis of Al7075/Mica Powder

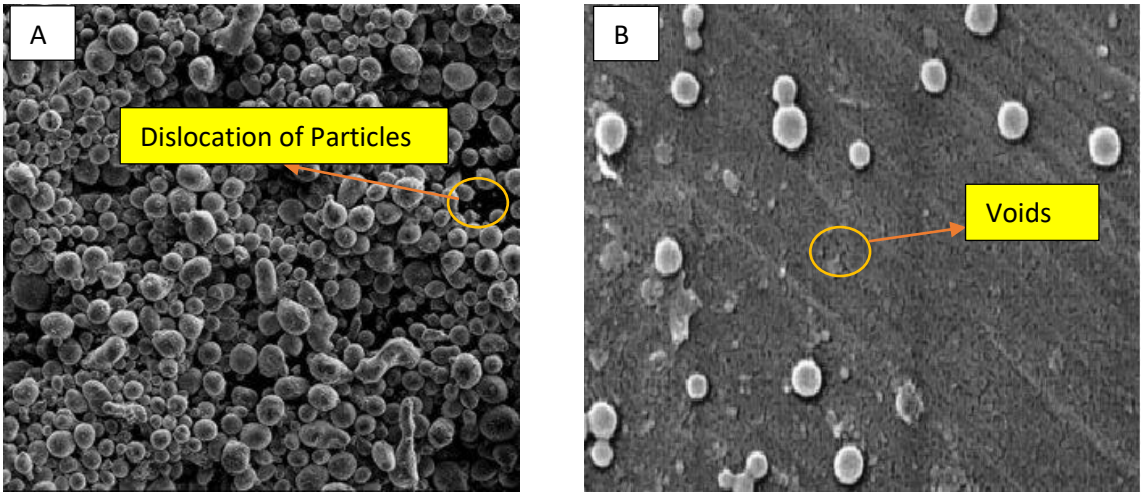

Fig. 5. SEM Morphology of tensile and impact fractured specimen

SEM morphology studies. Scanning electron microscopy is one of the effective microstructure analysis tools which helps to study the failure pattern of the composite. Figure 5 (a) and (b) show the impact and tensile failure pattern of the Al7075 and Mica powder combination of 15 micron. SEM morphology of tensile fractured specimen 5 (a) clearly locates the potential mismatch on the surface of the composite. Formation of conjunction among the composite may create nucleation of the powdered particles and convert the composite into hard particles. These hard particles of Mica Powder deposited on the surface are responsible for the dislocation of reinforcement particles on the composite. Even though they are having good agglomeration between Al7075 and Mica powder, these types of interventions may occur [19]. The high-pressure compaction of between is responsible for the happening of voids in the composite. Also, the higher stirring time leads to voids in the presence of Mica powder on Al7075 in the composite. The formation of poor

grain boundaries is responsible for the uneven breakdown of the composite at the time of impact load with some voids also noted in Fig. 5(b). The voids and hair line fins are called two-line surface disturbance which completely collapses the impact strength of the metal matrix composite [20].

Conclusions

Alumium7075 reinforced with Mica Powder metal matrix composite is successfully fabrication using stir the casting method. To study the mechanical properties of the prepared specimens, from the results discussed in the above chapter. The following conclusions are made,

- ✓ The maximum tensile peak is noted for specimen 5 about 285 MPa for the combination which has 25 grams of Mica powder with 500 grams of aluminum. In addition to this, the different-sized atomic combinations are readily exhibiting this type of intervention on the aluminum-based metal matrix composite.
- ✓ The results of the impact study also, represent the same observation the increase in the content of Mica Powder improves the energy-observing capability of the composite by about 18 J. While increasing the Mica Powder content increases the bonding strength of the aluminum-reinforced composite.
- ✓ Owing to the quality dispersion of Mica in the aluminum shows this kind of observation, during the happening of the impact event.
- ✓ The increase of the filler Mica Powder is an inorganic material that produces an improved hardening condition for the composite. Because the hardness value is only depending on the incorporation of powdered particles in the layers of aluminum which shows about 80 VHN for specimen 5.
- ✓ Mica Powder deposited on the surface is responsible for the dislocation of reinforcement particles on the composite. Even though they are having good agglomeration, these types of interventions may occur during tensile loading conditions. The formation of poor grain boundaries is responsible for the uneven breakdown of the composite in the time of impact load with some voids.
- ✓ The better cast ability, high corrosion, low density, and high elasticity of the Al7075/Mica powder composite is one of the potential replacements for the conventional MMC's can utilize transport, automobile, aerospace, and marine applications.

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THE AUTHORS

K. Arunprasath
e-mail: aruncmr12@gmail.com

P. Amuthakkannan
e-mail: amuthakkannanp@gmail.com

M. Vijayakumar
e-mail: vijayam74@gmail.com

R. Sundarakannan
e-mail: sundarakannan.r@gmail.com

M. Selwin
e-mail: selwin123@gmail.com

S. Kavitha
e-mail: skavitha@klu.ac.in

Lavish Kumar Singh
e-mail: lavish.singh2011@gmail.com