ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/24may250

Investigation of Aluminium 7075 Reinforced with Graphene

Naveen Kumar J[1]; Naveen Kumar S[2]; Kavin S[3]; Nishanth R[4]; Prabhakaran S[5]

[5]Assistant Professor
[1,2,3,4,5]Mechanical Engineering Paavai Engineering College, (Autonomous), Namakkal, India

Publication Date: 2025/06/28

Abstract: In the modern world, the metals are used in various industries for the variety of applications. The pure metals having high strength and higher in the weight.so it consumes more energy and their applications. Due to the more weight the power consumption is more. So, to reduce the power consumption and to increase the efficiency of the system, we used the composite metals for the machinery. Combination of two or more metals is called as the composite material. Here we used the Aluminium matrix composite (AMC) for the research process. The aluminium is the soft material and cost wise it is low, when compared to other materials. We are reinforced Graphene with aluminium for the higher strength in composition. Also, we took Chemical composition and X-ray diffraction (XRD) testing for the prepared specimen. the chemical composition is for identify the materials range in the prepared specimen and the XRD test is to define the crystallographic structure of the materials bonding.

Keywords: *Crystallographic Structure, Metal Matrix Composite, Chemical Composition, X-Ray Diffraction.*

How to Cite: Naveen Kumar J; Naveen Kumar S; Kavin S; Nishanth R; Prabhakaran S (2025). Investigation of Aluminium 7075 Reinforced with Graphene. *International Journal of Innovative Science and Research Technology*, 9(5), 3828-3831. https://doi.org/10.38124/ijisrt/24may250

I. INTRODUCTION

In this modern era, there are many evolutions the world. Likewise, the metal usage is also evolved into next category. The next step from the alloy are composite materials. It is also called as the Metal Matrix Composite (MMC). this MMC is one of the classifications of the composite material. the composite material is mainly classified into three categories. They are particle reinforcement, fibre reinforcement, structural. The Aluminium Metal Matrix Composite is the one of the sub category of the particle reinforcement. The aluminum is cost wise lesser then the other materials as well as it is lighter than the other materials. so comparatively the aluminium is better for the moderate load applications. The copper is also used for the composite material but it is heavier the aluminium. That is the reason to use the aluminium for the composite material applications. This AMC's are used majorly in automobile industris and in the aerospace industries. Her we reinforced graphene with the aluminium. The graphene has the higher bonding strength and the bonding with the each atom are high . so the factor agglomeration occurs in combining this two materials . To avoid the such factors we are using the less amount of graphene with the aluminium. We are renforcing 0.3 % of graphene with the alunium 7075.

II. ALUMINIUM 7075 MATRIX MATERIALS

Aluminium is the softer material when compared to other metals and also it is cost wise efficient. here we used aluminium 7075, where it is contained zinc, copper, manganese, silicon, iron, magnesium, chromium, titanium, and other elements. this aluminium 7075 is heat treatable one. there are many other grades in the aluminium alloy. here we used the 7075 grade. So we discussed about 7075 grade. this aluminium 7075 is twice stronger than the other grade of aluminium alloy. This aluminum 7075 is often get from the hardware stores for the home applications. this type of aluminium grade steels are often used in manufacturing devices of automobile system or industries.

- *Chemical Composition:*

Table 1 Chemical Composition

Cu	Mg	Ti	Sn	Fe	Mn	Sb	v
4.089	0.425	0.039	0.013	0.123	0.425	0.015	0.010

- *Physical Properties:*

Table 2 Physical Properties

Physical Properties	Metrices	Imperial
Density	2.78 g/cm^3	0.284 lbmin
Melting point	660	932

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/24may250

Amount of graphene nanoplatelets, often through mechanical blending or ball milling. This step is crucial for achieving a uniform dispersion of the graphene within the aluminum matrix, ensuring optimal reinforcement throughout the composite structure.Once the powder mixture is homogenized, it undergoes compaction into the desired shape using techniques such as hot pressing, cold pressing, or spark plasma sintering. During compaction, pressure is applied to consolidate the powder particles and promote inter- particle bonding, while the presence of graphene nanoplatelets facilitates the formation of a strong interface between the reinforcement and the aluminum matrix. Following compaction, the green compact is subjected to a sintering process, where it is heated to temperatures just below the melting point of aluminum in a controlled atmosphere. This allows for the diffusion of atoms across particle boundaries, resulting in densification and the formation of metallurgical bonds between adjacent particles. The sintering processalso facilitates the consolidation of the graphene nanoplatelets within the aluminum matrix, further enhancing the mechanical and functional properties of the composite.The addition of graphene nanoplatelets to the aluminummatrix offers numerous benefits, including improved mechanical strength, stiffness, and wear resistance. The high aspect ratio and excellent mechanical properties of graphene contribute to reinforcing the aluminum matrix and inhibiting crack propagation, leading to enhanced structural integrity and fatigue resistance. Furthermore, the presence of graphene nanoplatelets can enhance the thermal and electrical conductivity of the composite, making it suitable for applications requiring efficient heat dissipation and electrical.

➢ *Powder Metallurgy:*

Powder metallurgy techniques offer a versatile approach for producing aluminum matrix composites (AMCs) reinforced with graphene nanoplatelets (GNPs). This process typically begins with the production of aluminum powder through atomization or mechanical alloying, ensuring a fine and homogeneous powder. Concurrently, graphenenanoplatelets are synthesized through methods like chemical vapor deposition or exfoliation from graphite. The aluminum powder is then mixed with the desired conduction. Overall, aluminum matrix composites reinforced with graphene nanoplatelets produced via powder metallurgy exhibit promising potential for a wide range of applications, including lightweight structural components in aerospace, automotive, and marine industries, as well as heat sinks, electronic packaging, and thermal management systems in electronics and energy storage devices.

III. REINFORCEMENT MATERIAL GRAPHENE

Here for the reinforcement, we used graphene. The graphene is made up of the carbon atoms. the atoms of the graphene have 6 protons and 6 neutrons and also have 6 electrons. The atoms of the graphene are arranged in the hexagonal structure. Here by reinforcing the graphene with the aluminium 7075, the factor called agglomeration occurs in the composition of this to materials. the agglomeration is nothing but the combining of the two materials are in the improper status. The next factor is porosity porosity is nothing but the hole occurs after the combination of these two materials. This porosity occurs due to the factor agglomeration. composed of tetrahedral ofgraphene atoms with strong bonds in the crystal lattice. This produces a very hard and strongmaterial. To reduce and control the agglomeration we are reinforcing the less amount of graphene with the aluminium 7075. Here we reinforced 0.3 % of graphene as then less amount with the aluminium.

➢ *Graphene:*

Graphene is a remarkable material that has captured the imagination of scientists and engineers since its discovery in 2004. It consists of a single layer of carbon atoms arranged in a two- dimensional honeycomb lattice. Despite being only one atom thick, graphene exhibits extraordinary properties. It is incredibly strong, lightweight, flexible, and transparent, while also being an excellent conductor of electricity and heat.The discovery of graphene opened up a world of possibilities for numerous applications across various industries. In electronics, graphene holds promise for the development of faster and more efficient transistors, potentially leading to smaller and more powerful devices. Its exceptional conductivity makes it an ideal candidate for applications in energy storage, such as batteries and supercapacitors, where it could enhance performance and efficiency. Graphene's properties also make it suitable for use in sensors, biomedical devices, and even water filtration systems. Its thin layers can effectively filter out contaminants while allowing water molecules to pass through, offering a potential solution to water scarcity issues. Despite its immense potential, there are still challenges to overcome, particularly in terms of large-scale production and integration into commercial products. Researchers continue to explore ways to overcome these obstacles and unlock the full potential of graphene for various technological innovations.

➢ *Ball Milling:*

Ball milling is typically used in the preparation stage of powder metallurgy processes, including the production of aluminum 7075 reinforced with graphene nanoplatelets (GNPs). Here's how ball milling can be utilized for the powder compaction of aluminum 7075 reinforced with graphene. Powder Mixing: Initially, aluminum 7075 powder and graphene nanoplatelets are mixed together to achieve a homogenous distribution of the reinforcement within the aluminum matrix. The mixing process aims to ensure that the graphene nanoplatelets are uniformly dispersed throughout the aluminum powder to facilitate effective reinforcement.

Fig 1 Before Ball Milling

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/24may250


Fig 2 After Ball Milling

➢ *Powder Compaction (Hot Pressing):*

Hot pressing compaction is a widely used technique in powder metallurgy for fabricating metal matrix composites (MMCs) like aluminum7075 with graphene. Powder Preparation: The aluminum7075 powder and graphene powder need to be thoroughly mixed. This can be achieved through various methods such as mechanical mixing, ball milling, or chemical vapor deposition (CVD). Die Preparation: A die or mold is prepared according to the desired shape and dimensions of the final product. The die is often made from materials that can withstand high temperatures and pressures. Loading the Powder: The mixed powder of aluminum7075 and graphene iscarefully loaded into the die cavity. The amount of powder loaded should be sufficient to fill the die and form the desired shape of the final product. Hot Pressing: The loaded die is then placed into a hot press machine. The hot pressing process involves applying both heat andpressure simultaneously to the powder within the die. Typically, temperatures range from several hundred to over a thousand degrees Celsius, while pressures range from several MPato several GPa. Sintering and Consolidation: As the temperature and pressure increase, the powder particles start to bond together, leading to densification and consolidation of the material. The graphene, being a nano- sized material, can disperse evenly within thealuminum matrix during this process. Cooling and Ejection: After the desired level of compaction is achieved, the hot press is turned off, and the die is allowed to cool down. Once cooled, the compacted part is ejected from the die. Post-Processing: Depending on the specific requirements of the application, additional post- processing steps such as machining, surface finishing, or heat treatment may be carried out to further refine the properties of the aluminum7075-graphene composite. Hotpressing offers several advantages for fabricating aluminum7075-graphene composites, including high density, uniform microstructure, and improved mechanical properties. However, it's essential to optimize process parameters suchas temperature, pressure, and heating rate to achieve the desired material properties and minimize defects. Additionally, careful handlingand safety precautions are necessary due to the high temperatures and pressures involved in the hot-pressing process.

IV. TESTING AND REPORT

➢ *XRD Testing:*

X- Ray Diffraction testing is used to identify the Crystallograhic structure as well as the Chemical composition on the prepared specimen.

10.000000 343.000000
20.011308 395.000000
30.002185 341.000000
40.013492 538.000000
50.004369 327.000000
60.015677 389.000000
70.006554 313.000000
80.017861 311.000000

The above mentioned are the Co-ordinates identified from the XRD testing.

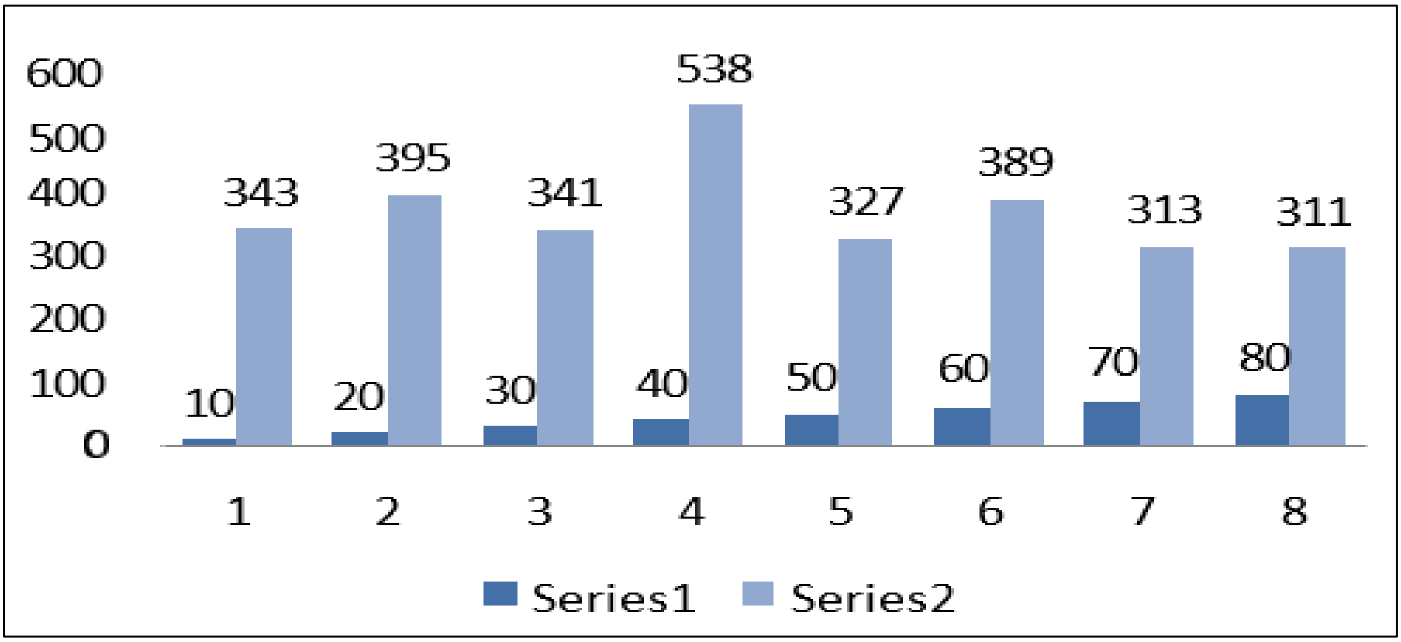

Fig 3 Bar Chart for XRD Testing

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/24may250

➢ *Chemical Composition:*

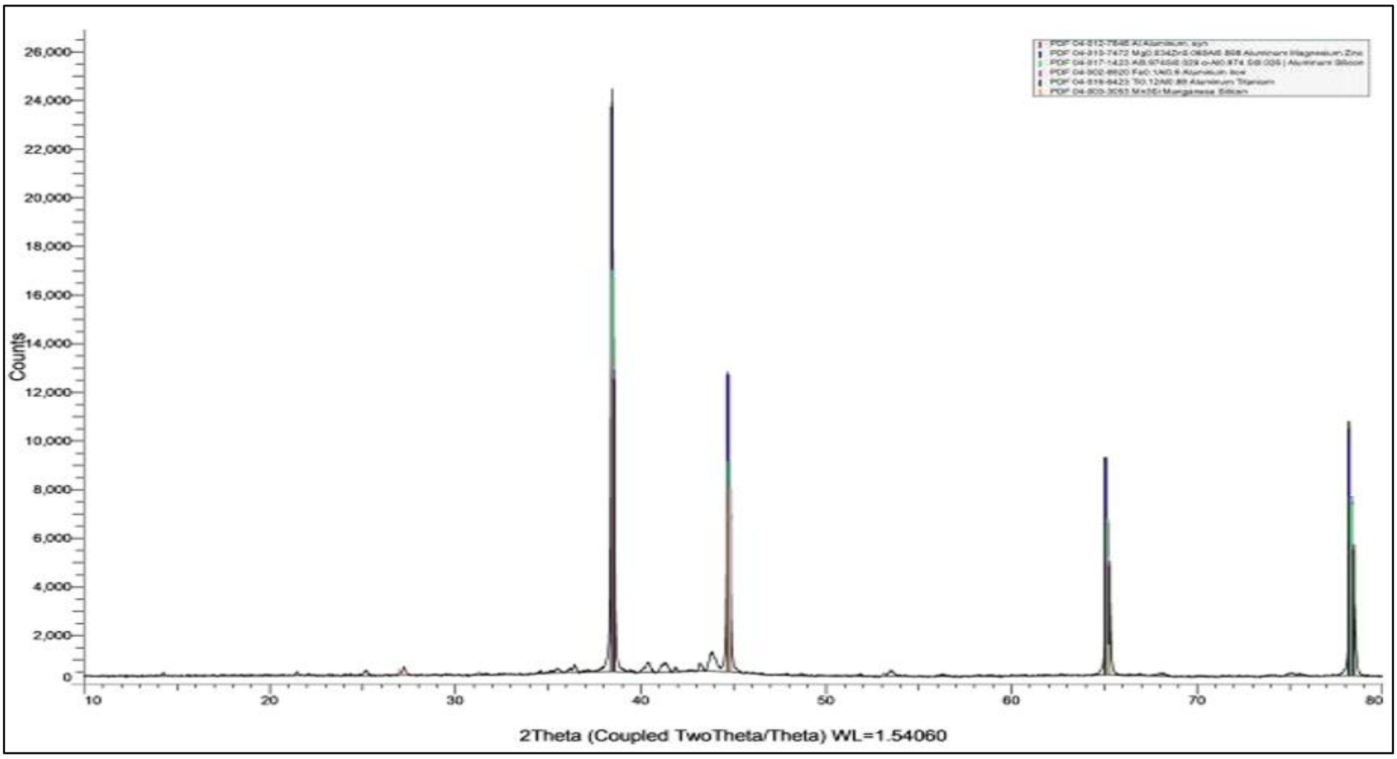

Fig 4 Chemical Composition for the Prepared Specimen

The above-mentioned graph is for the Chemical composition of the Prepared specimen.

V. CONCLUSION

Here as the result we observe that, Agglomeration is the factor that affects the composition of reinforcement of grapheme with the metal phase and which occurs the porosity, chemical bonding, surface energy reduction etc., also we discussed that the chemical compositions of the specimen created with the 0.3 % of graphene reinforced with aluminium 7075. And also here the crystallographic structure was defined by XRDtest and it shows the strong bonding of this composition. The less amount of reinforcing the graphene shows that the material strength. As the result it shows the higher strength of this composition as well as in the lighter weight when compared to copper alloy and also the cost of the of the aluminium is less than the copper**.**

REFERENCES

[1]. Muhammad Yasir Khalid, Rehan Umer, Kamran Ahmed Khan (2023). Department of Aerospace Engineering, Khalifa University, Abu Dhabi, 127788, United Arab Emirates. https://doi.org/10.1016/j.rineng.2023.1 01372.

[2]. , V. Vaishnav, Kiran Shahapurkar, Ch andru Manivannan (2023). Department of Mechanical Engineering, PSG College of Technology, Coimbatore 641014, Tamil Nadu, India. Department of Mechanical Engineering, Dhirajlal Gandhi College of Technology, Salem, India. https://doi.org/10.1016/j.triboint.2023. 108486

[3]. Hui-min Xia, Lan Zhang, Yong-chao Zhu, Na Li, Yu-qi Sun, Ji-dong Zhang & Hui-zhong Ma.(2020).Mechanical properties of graphene nanoplatelets reinforced 7075 aluminium alloy composite frabicated by spark plasma sintering.

[4]. Dinaharan, I., Kumar, G. A., Vijay, S. J., &Murugan, N. (2014). Development of Al< sub> 3</sub> Ti and Al< sub> 3</sub>Zr intermetallic particulate reinforced aluminum alloy AA6061 in situ composites using friction stir processing. Materials & Design, 63, 213-222.

[5]. Kumar, S., Panwar, R. S., & Pandey, O. P. (2013a). Effect of dual reinforced ceramic particles on high temperature tribological properties of aluminum composites. Ceramics International, 39(6), 6333-6342.

[6]. Kumar, S., Panwar, R. S., & Pandey, O. P. (2013b). Wear Behavior at High Temperature of Dual- Particle Size Zircon-Sand- Reinforced Aluminum Alloy Composite. Metallurgical and Materials Transactions A, 44(3), 1548-1565.

[7]. Rajan., Ramabalan., Dinaharan., Vijay (2014). Effect of TiB2 content and temperature on sliding wear behaviour of AA7075/TiB2 in situ aluminum cast.