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Research Article

Mechanical Behavior of Aluminum and Graphene Nanopowder-Based Composites

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Producing items that are of both high quality and long lasting is a difficult task for companies right now. There is a huge need for a wide range of engineering materials in today's technologically advanced globe. The strength and qualities of the material determine the amount of material that may be used. Due to its excellent mechanical qualities and low density, aluminum-7075 alloy is mostly employed in transportation applications such as aerospace, marine, and vehicle production. This study addresses the fabrication and characterization of Al7075 semisolid metal matrix composite (MMC) reinforced with graphene nanoparticles. Samples are made with and without stirring graphene in aluminum-7075 at various temperatures of 800°, 830°, 860°, 890°, and 920°C. At these temperatures, the material is semisolid, so graphene is introduced and stirred into the molten liquid. The specimens meet the requirements of the *American Society for Testing and Material* (ASTM). The hardness, tensile strength, impact strength, and compression strength of various materials are evaluated and compared. Temperature lowers tensile strength, hardness, and compression. A scanning electron microscope (SEM) is used to examine the microstructure. The specimen is evaluated using ANSYS. Specimens with stirring have better mechanical characteristics. Graphene has high hardness and strength.

1. Introduction

As illustrated by several researchers [1–3] in their studies, composites are created by combining two materials that have different physical or chemical qualities yet are combined to form a new material with attributes distinct from those of either the matrix or reinforcement used alone.

1.1. Types of Composites. The main constituents of structural composites are the reinforcements and the matrix. The reinforcements, which are stronger and stiffer, are dispersed in a comparatively less strong and stiff matrix material. Based on the constituent of the matrix of the materials, they are of these types.

1.1.1. Organic Matrix Composites. An organic polymer matrix binds short and continuous fibers to form a composite material. Matrix fibers are connected by PMCs, which transfer loads between them. PMCs are lightweight, rigid, and strong along the direction of their reinforcements. PMCs contain roughly 60% reinforcing fiber. Fiberglass and graphite are the most frequent [4, 5]. The matrix qualities influence the PMC's resistance to processes including impact, water absorption, chemical assault, and high-temperature creep. Polymer and resin composites are made of glass, carbon, or Kevlar [6, 7]. Plastic or thermoset matrices may be used. They have a high strength-to-weight ratio. These are used in aerospace and marine.

1.1.2. Metal Matrix Composites. One of the constituent materials of a metal matrix composite is metal, whereas the other component element may be another metal or an entirely different substance. Aluminum, magnesium, and titanium are common metals used as the matrix in these devices. Reinforcement of metals is mostly used to alter their characteristics to meet the demands of design. A reinforcing component is dispersed across a metal matrix to produce MMCs [8–10]. To prevent the matrix from reacting with the reinforcing surface, a coating may be applied. Composites with low density and high strength may be made by incorporating carbon fibers into the aluminum matrix. Carbon, on the other hand, interacts with aluminum to form a surface combination that is brittle and water soluble. The matrix is the substance in which the reinforcement is inserted and is totally continuous. Metals like aluminum, magnesium, and titanium are often used as the matrix in structural applications because of their low weight and ability to sustain the reinforcement [11–13]. A matrix is used to hold the reinforcing material in place. A material's physical qualities may be altered by adding reinforcement.

1.1.3. Ceramic Matrix Composites. As a subset of composites and ceramics, ceramic matrix composites are a popular choice for many different applications. Fibers and a ceramic matrix are used instead. Any ceramic material, including carbon and carbon fibers, may be used to make the matrix and fibers. Figure 1 shows metal matrix composite, and Figure 2 shows ceramic matrix composite.

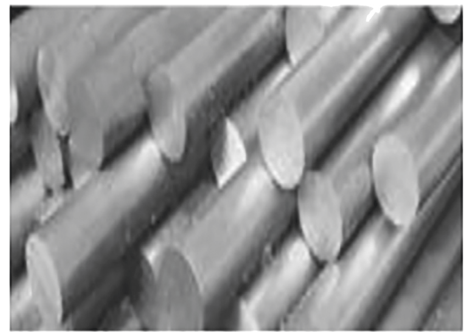


Figure 1: Metal matrix composite.

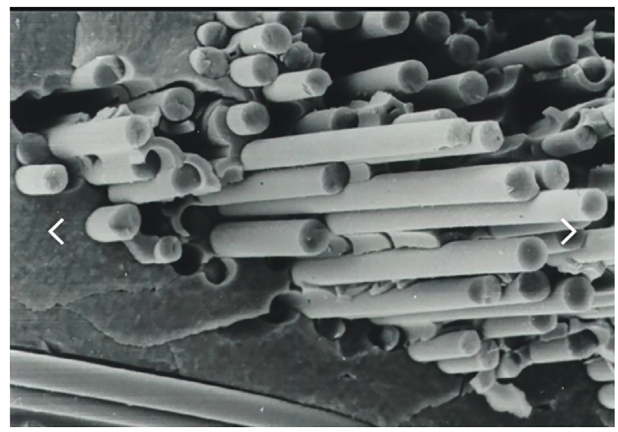


Figure 2: Ceramic matrix composite.

1.2. Semisolid Aluminum Metal Matrix Composites. In aluminum metal matrix composites, aluminum is used as matrix material and the other material, which is embedded in matrix material, is reinforcement [14]. The qualities of the base alloy are enhanced by the addition of each separate reinforcing element. These are manmade. These are different from alloys achieved by control of naturally occurring phase transformation during solidification or thermomechanical processing. This should create properties, which could not be individually obtained. This study deals with the addition of graphene to aluminum-7075. Because of its high strength, low density, and wear resistance, it has been used in many industrial applications like aerospace, marine, and transportation [15–17].

1.3. Stir Casting. When a dispersed phase and a molten matrix metal are mechanically combined, a composite material known as a "stir cast" is formed in the liquid state. Among the several liquid state manufacturing techniques, stir casting is the most straightforward and least expensive. Conventional casting procedures and metal forming technologies may then be used to mold the liquid composite material. The stir casting method was employed in the aforementioned procedures. Composite materials may be made using the stir casting process. Stirring is used to incorporate the reinforced material into the matrix material [18, 19]. Weighing the matrix and reinforcing materials according to our specifications and heating them to the appropriate temperature are the next step. These are being mixed by using a stirrer. The liquid composite is then poured into a die of the required shape. Figure 3 shows the stir casting setup.

2. Literature Survey

According to Krishnamoorthi, Balasubramanian, et al. [1], theoretical and experimental findings are reviewed in their study. Various casting procedures are explored. AMC's physical and mechanical qualities (density, tensile strength, and hardness) are addressed. It says that reinforcing reduces Al7075 density and enhances Al7075 hardness. The wear rate rises with load. This has a higher tensile strength than the basic material.

Ravi et al. [2] in their work prepared specimens using titanium carbide and silica carbide. The hardness of Al7075-5 TiC+5 SiC MMCs was found to be 39% higher than that of Al7075 base alloy. AMCs made of Al7075 base alloy and TiC+SiC MMCs have ultimate tensile strengths of 129 and 155 MPa, respectively. This is a 32% improvement over the cast Al7075 base alloy. Tensile, yield, and compressive

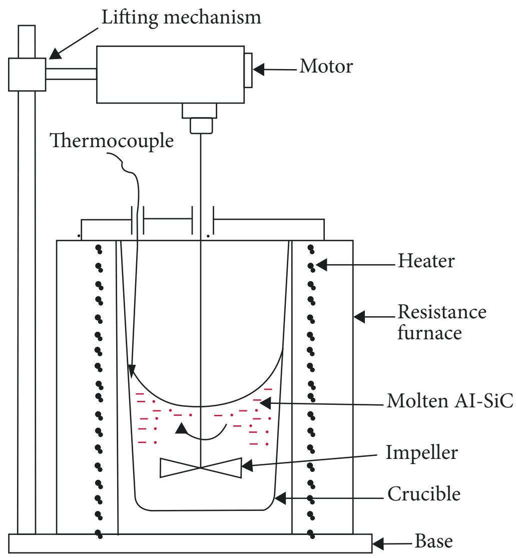


Figure 3: Stir casting setup.

strength improve with TiC reinforcement up to 5% and decrease with SiC reinforcement up to 5%.

In Lokesh, Chetan, et al.'s [3] article, graphene was added to Al7075 at 0.5, 1, 1.5, and 2 % wt%. Graphene with 0.5 weight percentage exhibits good mechanical properties, superior 0.60025 compression strain, and 222 KN maximum breaking load compared to others.

In Balaji, Sateesh, Manzoor Hussain, et al. [4], the density of the matrix has been observed to increase with the use of SiC as a reinforcing material in this study. It was discovered that the hardness of the composite rose by 10% when the filler content was increased. Additionally, the tensile strength of Al7075–SiC is greater than that of the basic material.

In Mohammed Imran, Anwar Khan et al. [5], Al7075's mechanical properties and corrosion resistance are highlighted in this study on aluminum metal matrix manufacturing. Materials like SiC, alumina, and BaC can all be used to make samples that are stronger and harder, while graphite may be used to make samples that are both stronger and softer.

In Torralba, da costa, et al. [6], P/M aluminum matrix composites (AMCs) are the subject of this research, which examines the current state of knowledge. Aluminum may be the most extensively utilized metal matrix composite (MMC) because of its low density and high rigidity. This composite material may be made using a variety of processes. As a result of these findings, P/M may be described as a highly efficient and cost-effective strategy. Composite materials made from aluminum alloys have excellent mechanical, tribological, and density qualities, making them ideal for usage across a wide range of industries.

In Lokesh, Chetan, et al. [7], graphene affects the hardness of an aluminum metal matrix composite in this study. Various samples were generated with variable amounts of matrix material (0.5, 1, and 2% by weight). All produced samples are tested for rock well hardness. It is because of the homogenous dispersion of graphene in the aluminum matrix that this sample exhibits the best resistance to indentation. Particles of graphene boost the hardness of the soft matrix and record 78RHN. The sample containing 2% graphene has the lowest hardness number relative to the parental composition owing to the graphene particles having trouble replacing the parental atoms when cooled.

3. Materials

3.1. Aluminum-7075. The aluminium-7075 which is used in this investigation is the strongest alluminium alloy known to man Zinc serves primarily as an alloying ingredient in aluminum alloys. In this aluminum alloy, zinc serves as the principal alloying element and contributes to the alloy's superior mechanical qualities [8–10]. It is more prone to embrittlement than many other aluminum alloys. Alloys of aluminum, despite their strength and low weight, have found applications across a wide range of industries. The tempering of 7075 has a significant impact on the material's mechanical characteristics. Useful in construction, it is typically used to extrude aluminum bars, pipes, and rods. The 7075 zinc, magnesium, and copper make up the majority of an aluminum alloy's makeup, with the other metals including silicon, iron, manganese, titanium, and chromium making up less than 0.5 percent. In the aircraft industry, it is most often utilized. Reinforcing it with more material may make it even better. Figure 4 shows aluminum 7075 material.

3.1.1. Graphene. Graphene is a carbon allotrope consisting of a two-dimensional hexagonal lattice with a single layer of atoms. Graphite is formed by stacking layers of graphene on top of each other with a separation of 0.335 nanometers. Graphene is the thinnest and lightest compound known to science. In comparison to steel, it is a hundred times stronger, conducts heat and electricity well, and is almost completely transparent. It is mainly used in anticorrosion coatings. Figure 5 shows graphene powder, and Figure 6 shows the structure of graphene.

3.2. Components Used

3.2.1. Die. A die is a specialized instrument used to form materials. Die of required dimensions is to be manufactured. The die has to be shaped to our required specimen dimensions. Our required shape is to create a hollow in the middle of the die. In this hollow shape, the molten melt is to be placed and is left to cool till it gets solidified. A hollow cylinder-shaped die is being utilized in this instance. Two hollow cylinders are used in this process, and the casting material is poured into both of them. A 23 cm long specimen with a 2.5 cm diameter may be made using this method. The design and production of dies are simple, as is their cheap cost. Figure 7 shows the die used in casting.

3.2.2. Crucible. Ceramic or metal crucibles may be used to melt or heat metals or other material to very high temperatures. Though traditionally made of clay, crucibles can

Figure 4: Aluminum 7075 material.

Figure 5: Graphene powder

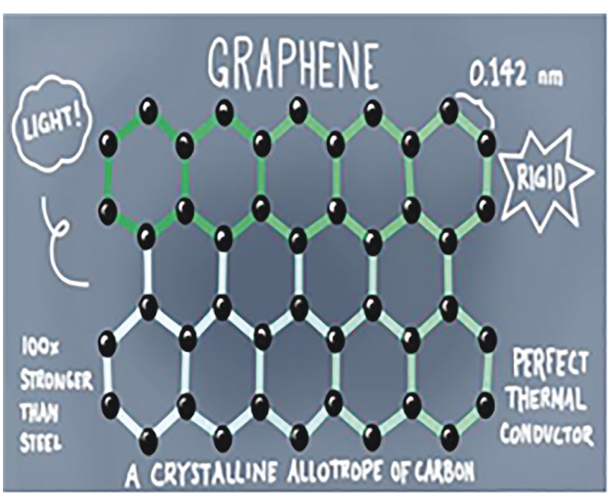


Figure 6: Graphene structure.

Figure 7: Die used in casting

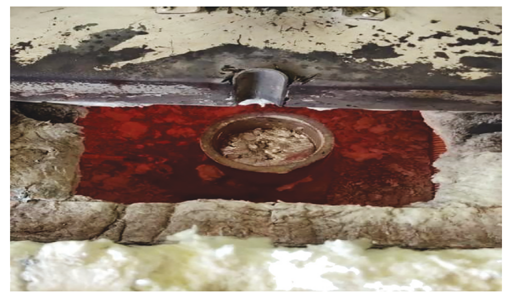


Figure 8: Crucible placed in furnace.

Table 1: Specifications of components.

S. no	Specifications	Value
1	Capacity of furnace	100 kg
2	Input voltage	250kw
3	Diameter of crucible	68 mm
4	Length of crucible	108 mm

Figure 9: Furnace.

now be constructed from virtually any material that is capable of withstanding high enough temperatures to melt or otherwise alter their contents. A 15 mm thick clay and graphite crucible were used in this experiment. Once the crucible has been heated to its desired temperature, the material is poured into the crucible and placed inside the furnace. Due to the transfer of heat through the crucible walls, the charge is heated. Crucible can withstand a temperature of 1050 K. Figure 8 shows the crucible placed in the furnace. Table 1 shows the specifications of the components.

3.2.3. Furnace. To melt the material Al7075 and graphene, the furnace is heated to the desired temperature. The furnace is equipped with a temperature gauge that allows us to heat to the desired temperature. The furnace can have a capacity of 100 kg. It can bear a maximum temperature of 1200°c. An input voltage of 250 kw is to be supplied to the furnace. A motor-driven stirrer is attached to this furnace. The stirrer's rotational speed must be altered. Figure 9 shows the furnace.

(a) (b) (c)

Figure 10: (a) Crucible in furnace. (b) Manual stirring. (c) Stirring of molten melt.

(a) (b) (c)

Figure 11: (a) Molten melt poured in die. (b) Molten melt cooled in die. (c) Removal of specimen from die.

Table 2: Time taken for cooling at different temperatures.

Temperature (°C)	Time taken for cooling (min)
680	5
710	7
740	8
770	9
800	10
830	10
860	11
890	13
920	15

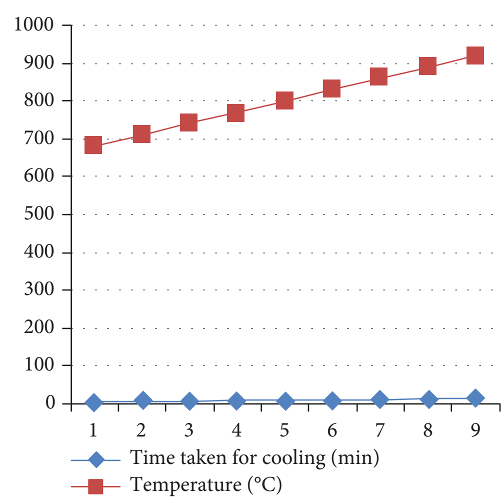
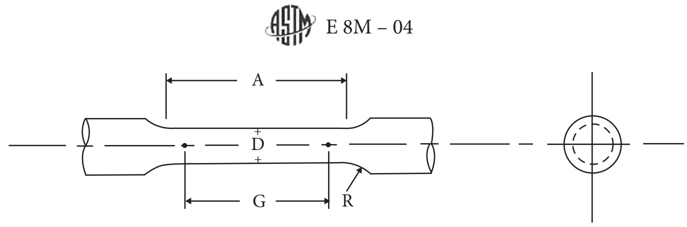


Figure 12: Graph between temperature and cooling time.

4. Experimentation

Using either stirring or not, aluminum MMC may be produced in two ways. In this experiment, the metal matrix is aluminum-7075 and the reinforcing ingredient is graphene. Different graphene concentrations and temperatures must be used to get similar samples. The samples are prepared without stirring and using stir casting procedures. The mechanical characteristic like tensile, compression, impact, and hardness tests are performed. The microstructure of these samples is also being analyzed.

4.1. Casting Process-Without Stirring. First aluminum-7075 and graphene are weighed. First, Al7075 and graphene are weighed based on our requirements. Nearly 1000 g of Al7075 is weighed and taken in a crucible and is heated in furnace up to 660°c until it gets melted. Graphene is preheated to temperature of 150°c to prevent moisture content, and die is also preheated. Now graphene is added to melted Al7075 at constant feed rate. After attaining required temperature, the molten melt is poured into die and is cooled for 1 hour. The same procedure is repeated for the preparation of



Dimensions, mm					
	Standard Specimen	Small-Size Specimens Proportional To Standard			
	12.5	9	6	4	2.5
G–Gage length	62.5 ± 0.1	45.0 ± 0.1	30.0 ± 0.1	20.0 + 0.1	12.5 ± 0.1
D–Diameter (Note 1)	12.5 ± 0.2	9.0 ± 0.1	6.0 ± 0.1	4.0 ± 0.1	2.5 ± 0.1
R–Radius of fillet, min	10	8	6	4	2
A–Length of reduced section, min (Note 2)	75	54	36	24	20

Figure 13: Tensile test specimen dimensions according to the standards.

other samples. The same procedure is repeated for other temperatures

4.2. Casting Process-With Stirring. This process is similar to the above process, and Al7075 and graphene are weighed based on our requirements. Nearly 1000 g of Al7075 is weighed and taken in a crucible and is heated in a furnace up to 660^0c until it gets melted. Graphene is preheated to a temperature of 150^0c to prevent moisture content, and the die is also preheated. Now graphene is added to melted Al7075 at a constant feed rate. The molten melt is manually stirred by using a stirrer, and the stirring process is to be carried out for 5–10 minutes. After attaining the required temperature, the molten melt is to be poured into the die. After it gets cooled, it is separated from the die. The sample has to be machined according to the ASTM standards. The same procedure is repeated for other temperatures, and tests are conducted. Figures 10 and 11 explain the process of making of specimen.

From Table 2 at different temperatures, the time of cooling for different samples has been noted. Aluminum metal matrix was in a semisolid state mostly at temperatures like 680˚C, 710˚C, and 740˚C; as the molten melt is already in a semisolid state, it gets quickly solidified as it is taken out.

At higher temperature, the time taken would be more to solidify than at lower temperature. While plotting a graph between the temperature and the time of cooling, it was observed that as the temperature increases the time taken to solidify also increases. As the time taken for cooling is low, fine grains are formed as it would be quickly cooled and at high temperature large grain size are formed if it takes time to cool. Figure 12 shows the graph between temperature and cooling time.

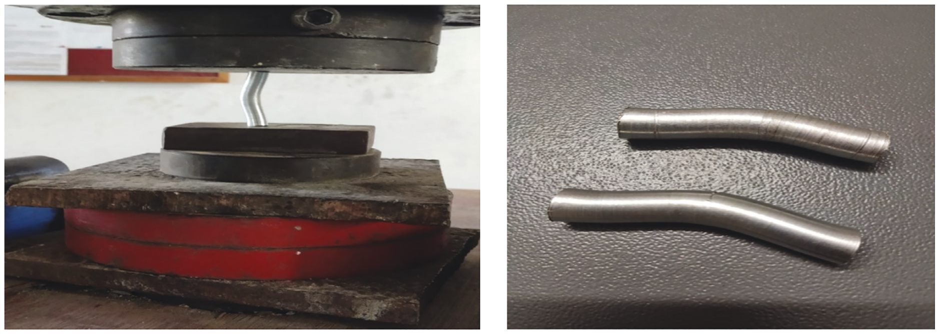
4.3. Mechanical Properties. The specimens that are prepared from casting processes are tested for their mechanical properties. The tests including tensile, compressive, impact, and hardness testing are performed. The findings are tabulated, the specimens are produced both with stirring and without stirring, and their experimental values are compared. The specimens that are manufactured with the stirring technique have excellent mechanical characteristics than without a stirring process.

Figure 14: Tensile test specimen.

Figure 15: Specimens after tensile test.

4.3.1. Tensile Test. When doing a tensile test, a force is exerted on a material. Materials are tested for their strength and how far they can stretch using this method. A universal testing machine (UTM), sometimes known as a universal tester, is used to measure a material's tensile strength. A tensile test is performed in accordance with the ASTM E8 criteria. An extensometer, if required, may be used to automatically record the change in gauge length as the test progresses. This may be done if the machine does not have an extensometer, by recording the distance between its cross head and the specimen. The specimen's length is likewise recorded here. Immediately after activating the machine, the specimen is subjected to increasing tension. When conducting tests, the specimen's load and extension or compression are recorded by the control system and its related software. At some point during loading, the specimen fractures. The results of tensile tests on different materials will be compared. Figure 13 shows tensile test specimen dimensions according to the standards.

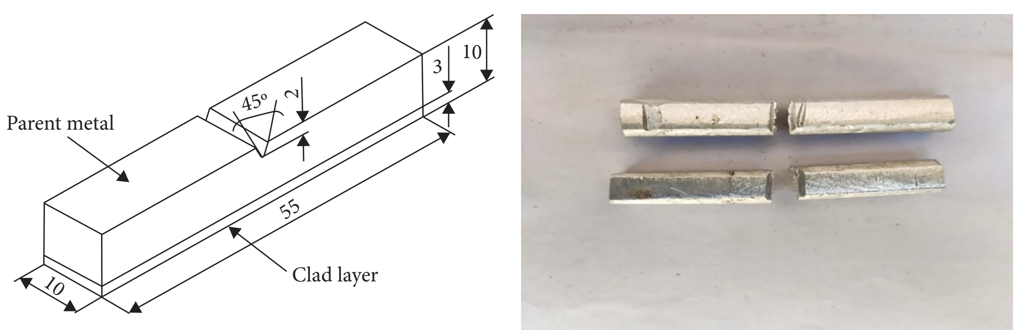
Figure 14 shows the tensile test specimen, and Figure 15 shows the specimens after tensile test.



(a) (b)

Figure 16: (a) Specimen during testing. (b) Tested specimen.

Figure 17: Impact testing machine.



(a) (b)

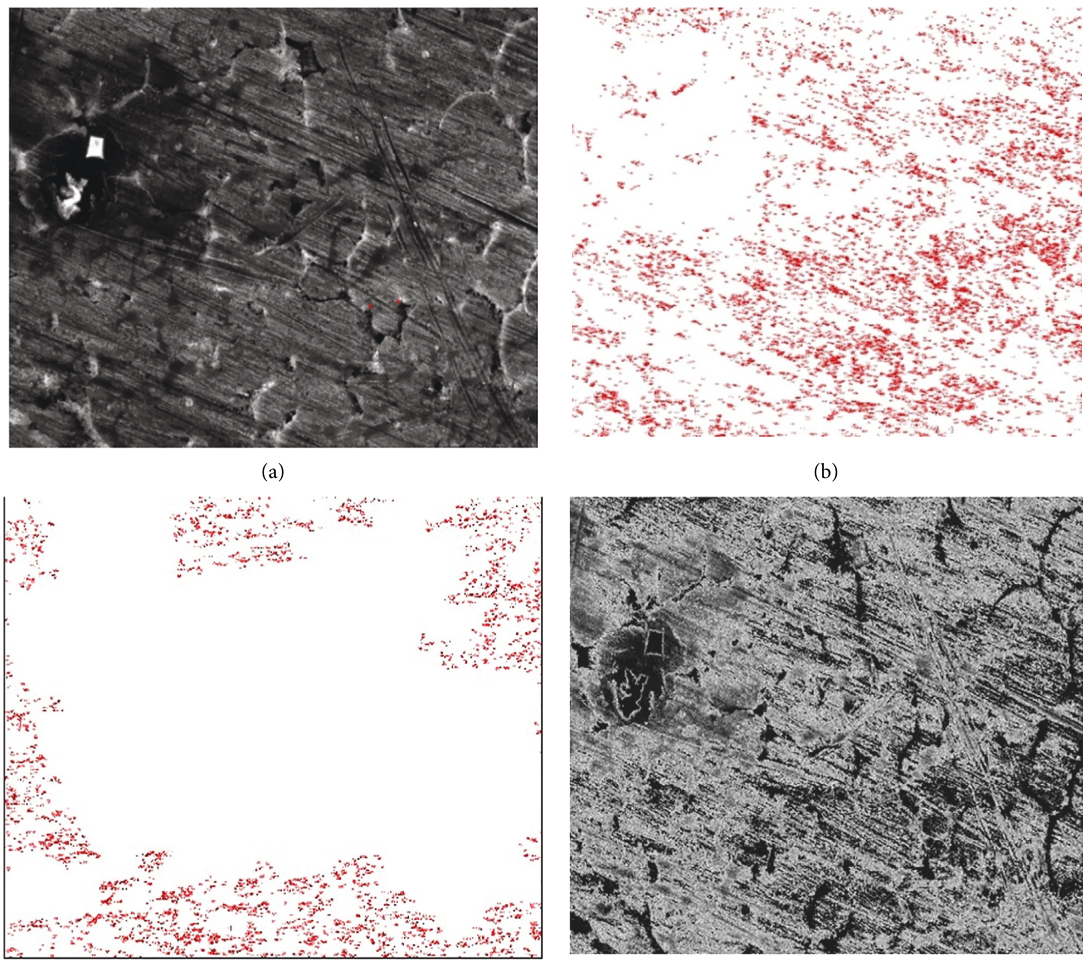
Figure 18: (a) Specimen according to the ASTM standard. (b) Tested specimen.

4.3.2. Compression Test. Product or material behavior under compressive stress is evaluated by conducting compression testing. Specimen behavior under compressive stress is also evaluated. According to the ASTM guidelines, the specimen should be prepared. The UTM machine is used to do compression testing. Once the specimen is in place, the weight is applied and the test is complete. This also keeps track of the specimen's growth.

Figure 19: Rockwell hardness testing machine.

(a) (b)

Figure 20: (a) Specimen before hardness testing. (b) Specimen after hardness testing.



(a) (b) (c) (d)

Figure 21: Microstructure analysis for 680°c (a) Microstructure at 680°c, (b) Nodularity, (c) Porosity, (d) inclusions.

Immediately after activating the machine, the specimen is subjected to increasing tension. During testing, the control system and its supporting software record the load, extension, and compression of the specimen. At some point during loading, the specimen fractures. The specimen is crushed by the weight of the container. Measured and compared to other specimens, the compression strength is recorded. Figure 16 shows the compression test specimen before and after the compression test.

4.3.3. Impact Test. The Charpy impact test also known as Charpy V-notch test determines the amount of energy absorbed by the material. The test specimen is prepared according to the ASTM A370 standard, and the test specimen is being machined to a square shape with a notch. The hamer is raised and kept in position. The pointer is adjusted to coincide with the initial reading. The hamer is let go when the specimen has been horizontally clamped on the anvil. The specimen is ruptured when the striking edge comes into

Table 3: Analyzed values at 680°c.

Slice	Count	Total area	Average size	% Area	Circ.	Solidity	Feret
IMG-20200226-WA0020.jpg	1252	28422	2.701	2.313	0.679	0.743	6.83

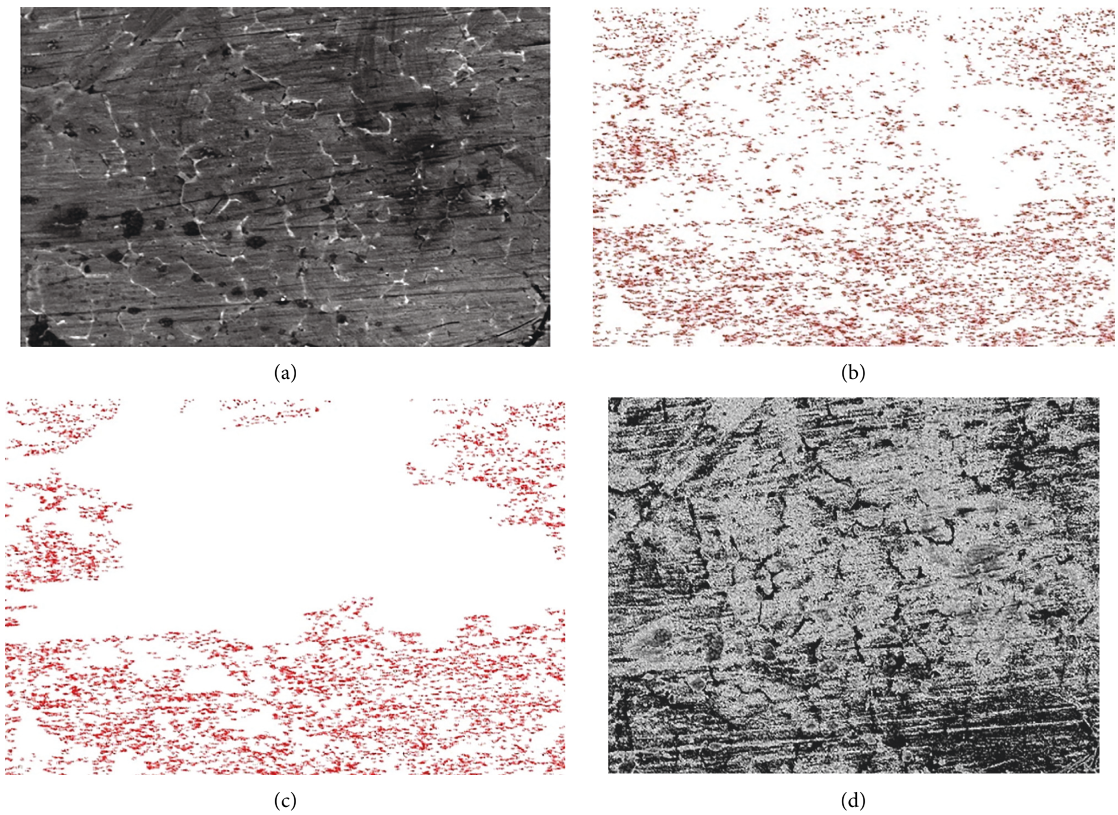


Figure 22: Microstructure analysis for 740°c (a) Microstructure at 740°c, (b) Nodularity, (c) Porosity, (d) inclusions.

contact with it. Indicated by a scale, the amount of energy needed to break the specimen is shown. It is necessary to compute the force of impact. The same steps must be followed a second time in order to arrive at a final figure. Figure 17 shows the impact testing machine.

Figure 18 shows the specimen according to the ASTM standard and tested specimen.

4.3.4. Hardness Test

Description. The machine body is the shell of the tester, and the other body components are directly or indirectly put onto the machine body. The overall test force is formed of the primary test force, which is created by the weight of body components comprising a bigger level and main shaft. The complete test force is applied to the top end face of the penetrator, and the sharp point enters the surface of the item being tested. The load is to be applied. The unloading handle is to be pushed back to remove the load. Test value may be read straight from the indicator dial gauge *Testing Procedur.* Figure 19 shows the Rockwell hardness testing machine. The Rockwell hardness tester is used to measure the hardness. The specimen is inserted into the indentor using a 1/16-inch red ball indentor. The specimen will be subjected to a force of 100 N, and the associated hardness number will be recorded and measured at various points on the specimen. Other samples' hardness values are determined in the same way and then compared. Figure 20 shows the specimen before and after hardness testing.

Table 4: Analyzed values at 740°c.

Slice	Count	Total area	Average size	% Area	Circ.	Solidity	Feret
4.bmp	8703	17610	4.521	0.8	0.784	0.77	3.856

4.4. Microstructure Analysis. The SEM is used to analyze microstructure (SEM). Numerous signals are generated by electron interactions that convey information about the sample's surface. The location of the electron beam and the intensity of the received signal are used to create an image. Generally, an electron microscope generates pictures of a magnified surface. Electrons interact with atoms in picture samples. These generate signals that reveal surface topography and sample makeup. The electron beam is scanned, and the signal intensity is detected to

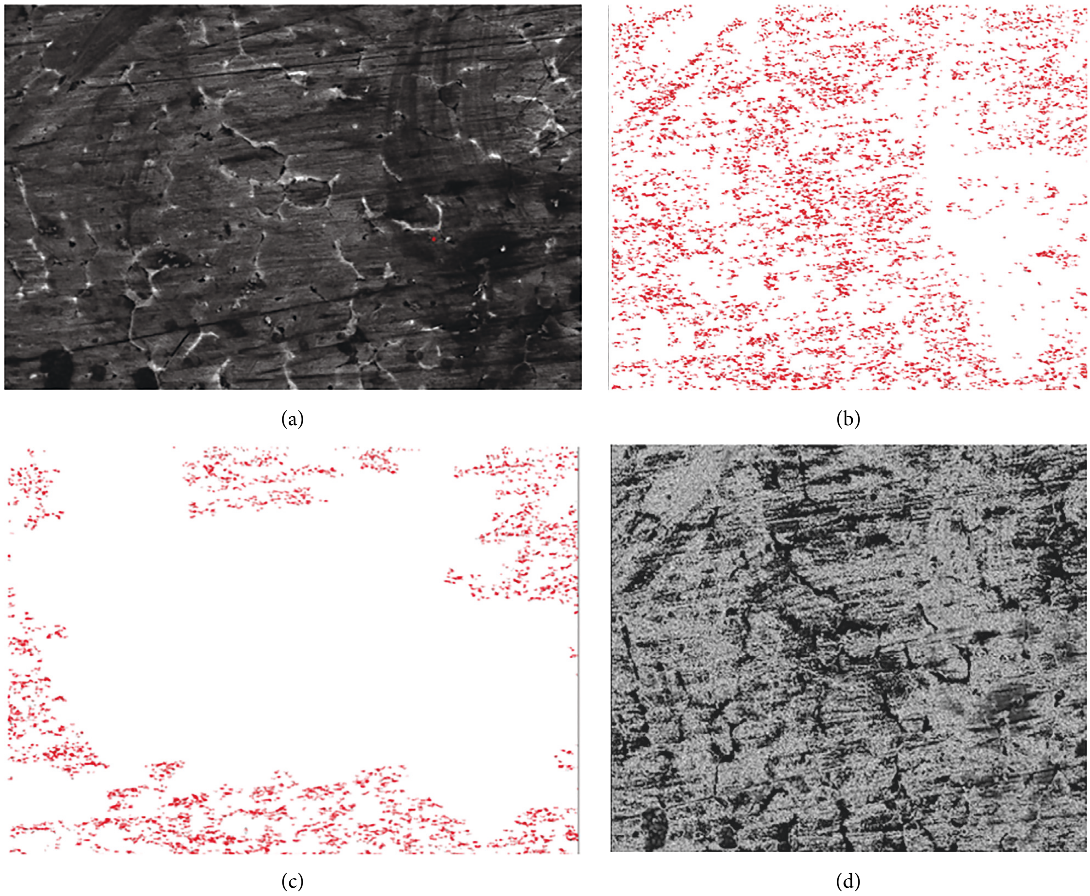


FIGURE 23: Microstructure analysis at 770°c (a) Microstructure at 770°c, (b) Nodularity, (c) Porosity, (d) inclusions.

create a picture. This may help spot pollutants on an image's surface. Besides these approaches, the scanning electron microscope has numerous more uses that may offer contrast depending on image materials.

4.5. Image J Software. We used ImageJ to analyze these SEM photographs. ImageJ is a program that calculates the area and pixel values of selected areas. It can also measure angles. ImageJ has an open architecture that allows for Java plugins. Custom acquisition, analysis, and processing plugins are created using ImageJ's built-in Java compiler. Plugins built by users may practically address any image processing or analysis issue. Density histograms and line profiles are produced. It can do things like sharpening, smoothing, edge detection, and median filtering. It scales, rotates, and flips geometry. It is zoomed up to 32 : 1 and down to 1 : 32. Any analytic or processing function may be magnified. As long as you have enough memory, you can use as many windows (images) as you like. Figure 21 shows the microstructure analysis for 680°c, and Table 3 shows the analyzed values for 680°c.

Figure 22 shows the microstructure analysis for 740°c, and Table 4 shows the analyzed values for 740°c.

Figure 23 shows the microstructure analysis for 770°c, and Table 5 shows the analyzed values for 770°c.

The above microstructure is being analyzed by using ImageJ software. This software is used to find the different properties, which are included in the microstructure. The microstructure is being analyzed for its nodularity, porosity, and inclusion. The samples that are analyzed using SEM analysis are being used in this. The various samples at different temperatures like 680°c 740°c and 770°c are being analyzed. At these temperatures, the microstructure inclusions, nodularity, and porosity are analyzed. The porosity is the region of the weakening zone, and it is the region where fracture begins. It was observed that the grain size is simultaneously increasing; it is due to the effect of time of cooling. As the time taken for low cooling, fine grains are formed as it would be quickly cooled and at high temperature large grain size are formed if it takes time to cool.

TABLE 5: Analyzed values at 770°c.

Slice	Count	Total area	Average size	% Area	Circ.	Solidity	Feret
3.bmp	3967	17610	4.439	0.358	0.786	0.771	3.836

5. Results and Discussion

Table 6 shows the final results of all the tests performed.

From the above table, it is clear that different tests are carried out on various specimens depending on the

Table 6: List of results.

S. no	Pouring temperature (°C)	Without stirring (tensile strength) MPa	With stirring (tensile strength) MPa	Without stirring (compression strength) MPa	With stirring (compression strength) MPa	Without stirring (impact strength) J	With stirring (impact strength) J	Without stirring (hardness number)	With stirring (hardness number)
1	680	142	210	224.17	392.74	1.2	2	55	58
2	710	138	196	220.38	387.45	1.5	3	51	55
3	740	125	185	198.72	374.52	2.7	6	49	54
4	770	109	115	188.53	361.78	6	20	48	53
5	800	104	107.4	162.74	344.82	8	26	48	52
6	830	98	105	159.23	331.21	16	40	47	53
7	860	97	102	156.63	324.73	18	48	46	53
8	890	94	98.9	149.72	321.57	24	50	46	52
9	920	94	97	147.59	319.19	31	54	44	51

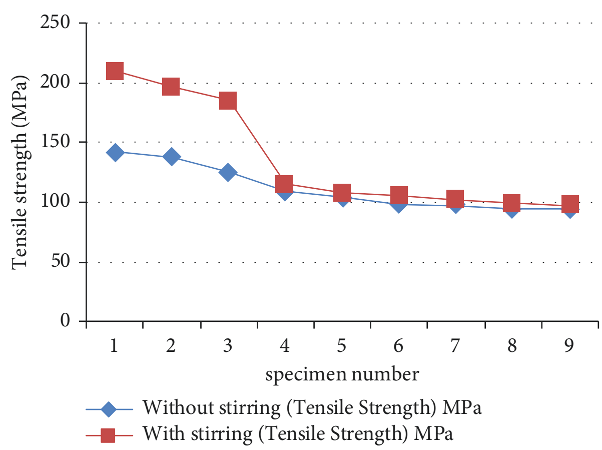


Figure 24: Graph for tensile strength for different specimens.

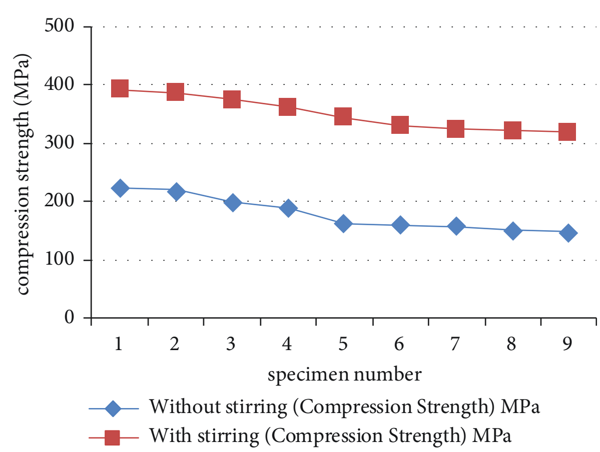


Figure 25: Graph for compression strength for different specimens.

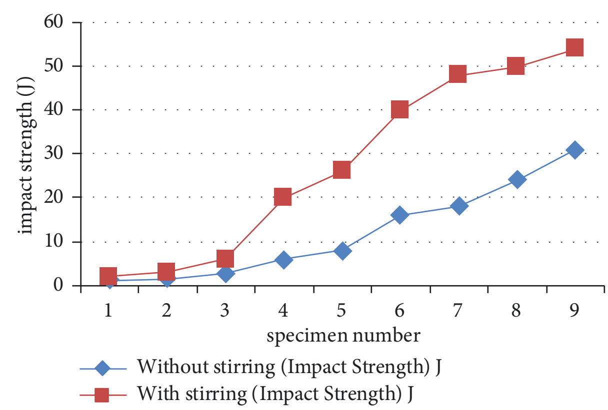


Figure 26: Graph for impact strength for different specimens.

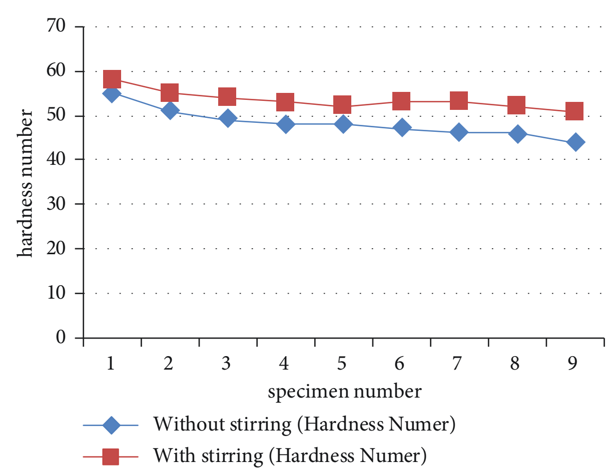


Figure 27: Graph for hardness number compared with stirring and without stirring.

temperature being used. These samples are subjected to hardness, tensile, and compression tests. The hardness, tensile, and compression test values are all decreasing in value as the temperature rises. Increased ash formation during casting results in lower hardness and tensile strength, which is why these values decrease. At low temperatures, the values are at their highest. It was found that an increase in temperature affects the mechanical properties, and higher temperature reduces strength, while lower temperature increases material strength.

From Figure 24, the tensile strength of different samples is shown. The tensile strength of with stirring process is more compared with a tensile strength of without stirring process; this is due to that graphene has been mixed well with the matrix material. The tensile strength has been decreasing with temperature; as the temperature is high, it affects the tensile properties. From Figure 25, compression strength for different samples is shown; compression strength for with stirring process is more than without stirring process as like tensile strength. From Figure 26, impact strength has been increasing with an increase in temperature, and it is more for with stirring process than for without stirring process. From Figure 27, the hardness number has been decreasing with an increase in temperature, and it is more for with stirring process than for without stirring process.

6. Conclusions

Both the stir casting and nonstirring processes were effective in producing Al7075 reinforced with graphene. Based on the results of the experiments, the following conclusions were drawn:

(a) In both the stirring and nonstirring processes, different samples may be generated with variable temperatures.

(b) These samples are cast, and specimens are prepared in accordance with the ASTM standards.

(c) As temperatures rise, the hardness and tensile strength of the material decrease, as do the compressive and elongation strength of the material.

(d) Reinforcement using graphene led to higher tensile strength, hardness number, and compression strength.

(e) The microstructure analysis was performed using ImageJ software for its nodularity, porosity, inclusion, grain size, and Feret distance.

Data Availability

The data used to support the findings of this study are included in this article.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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