Experimental Investigation of Aluminum Graphite and MOS2 Composite Materials

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Abstract. Metal Matrix Composites (MMCs) have light weight, high quality, firmness and display more prominent protection from consumption, oxidation, and wear. In this investigation half and half Aluminum network composite was created through blend throwing course. Molybdenum disulfide (MoS2) and graphite (Gr) particles were utilized as fortification stages for the present investigation. Three grinding material examples were created dependent on a trial detailing, and vol. % graphite + vol. % MoS2, individually.

1. INTRODUCTION
This content deals with the composition of three materials to change its behavior by increasing wear, stiffness and ability against corrosion. In this aluminum is used as major material because of its low weight, high strength, excellent corrosion resistance, good thermal and electrical conductivity to increase the property of aluminum graphite and molybdenum disulfide as shown Fig. 1 is used.

1.1. Structure
After iron, aluminum is presently the second most generally utilized metal on the planet. The properties of aluminum include: low thickness and along these lines low weight, high quality, unrivaled flexibility, simple machining, superb erosion opposition and great warm and electrical conductivity are among aluminum's most significant properties. Aluminum is additionally extremely simple to reuse [6] Graphite's Non-metallic properties incorporate idleness, high warm opposition and lubricity. A portion of the real end employments of graphite are in high-temperature ointments. Graphite is a layer grid lamella precious stone structure where the bonds between the carbon iotas in the gem structure of the layer are more grounded than the carbon bonds between layers. Graphite is contained carbon and water vapor. Every carbon iota is clung to three other encompassing carbon particles. The level rings of carbon molecules are reinforced into hexagonal structures. The hexagonal carbon structure is alluded to as a benzene ring.
MoS2 has a hexagonal crystalline structure. The natural property of simple shear happens at the interface between the sulfur particles. The connection between layers gives an impact like what an individual may involvement if endeavoring to move over a story totally secured with fresh out of the plastic new playing a game of cards. Each playing card slides effectively concerning every individual layer. The molecule size and film thickness are significant parameters that ought to be coordinated to the surface harshness of the greased up part.

1.2. Composite Materials:

For composite material selection of Matrix and reinforcement are of prime importance. Aluminum is a synthetic component in the boron bunch with image Al and nuclear number 13. It is a shimmering white, delicate, flexible metal. Aluminum is the third most inexhaustible component and the most plenteous metal in the Earth's outside layer. It makes up about 8% by weight of the Earth's strong surface. Aluminum metal is so artificially responsive that local examples are uncommon and constrained to outrageous lessening conditions. Rather, it is discovered joined in more than 270 distinct minerals. The main mineral of aluminum is bauxite. Aluminum is wonderful for the metal's low thickness and for its capacity to oppose erosion because of the marvel of passivation. Basic segments produced using aluminum and its composites are essential to the aeronautic trade and are significant in different regions of transportation and auxiliary materials. The most helpful mixes of aluminum, at any rate on a weight prize, are the oxides and sulfates. In spite of its pervasiveness in the earth, no known type of life utilizes aluminum salts metabolically. With regards to its inescapability, aluminum is all around endured by plants and creatures. Inferable from their predominance, potential useful (or something else) organic jobs of aluminum mixes are of proceeding with intrigue.

1.2.1. Chemical composition of pure aluminum:

|   | Si   | Fe  | Ti   | V    | Cu   | Mn   | Al   | others |
|---|------|-----|------|------|------|------|------|--------|
|   | 0.07%| 0.34%| 0.001%| 0.008%| 0.001%| 0.004%| 99.55%| 0.002% |

Particles of MoS2 and graphite are used as reinforcement. Addition of graphite particle results in low friction of composite as it is good dry lubricant hence reduces wear and abrasion. Molybdenum disulfide is similar to graphite. It is widely used as a solid lubricant because of its low friction properties and robustness.

2. FABRICATION PROCESS

In this project, we make the Aluminum Rod in different materials composite. The materials are Aluminum, Graphite, and MoS2. In this Rod the major Material was Aluminum and some percentage of Graphite and MoS2. Three different composition is done to have a better matrix material.

2.1. 1ST PROCESS (Al 85%, Graphite 10%, MoS2 5%): In this process, we are used aluminum pieces for aluminum melting. The melting process was done by using the furnace. The weight machine is used for measuring aluminum pieces. Before measure the aluminum piece we set the weight machine at 0 reading. The aluminum pieces are filled in the cup and measure percentage in weight machine. Before filling into the cup, we place the cup on the weight machine and we should set the reading as 0. Then we filled the aluminum pieces in the cup in the measurement of ½ kg of aluminum 85%. Then we measure graphite at 10% and MoS2 at 5%. Then we move to furnace and we set the furnace temperature at 950°C. Then we filled the measured aluminum pieces in the furnace in Crushable cup. The aluminum filled in 2 times of furnace. On First time we filled 50% aluminum in the Crushable cup then close the furnace door after 20 min the
aluminum pieces are melted. Then we filled the balance aluminum pieces that is 35% in the Crushable cup of furnace then close the door, in this time we open the furnace door after 15 min. The total aluminum pieces are melted then we add the graphite 10% in the crushable cup in that time we mixed the graphite powder and melted aluminum by using mixing blade in furnace in this process going to 10 min. this process is called by STIR CASTING.After 10 min we open the furnace then add the MoS2 powder 5% in the crushable cup. Then we mix the aluminum, graphite, MoS2 by using mixing blade. The STIR CASTING process is done within 10 Min. Then furnace indicate alarm in 950°C the process was done. Then the crushable cup hold by using the metal grip holder. Then we pour the hot metal in die. Then the die was cooled 1 hour in outside. To take the aluminum rod the die should be braked. Then turning process done by lathe. The aluminum rod is fabricated. In this result the rod is full of black powder because the materials are not mixing properly[5].

Fig.1. Fabrication of Aluminum Graphite and MOS2 Composite Materials

2.2. 2nd PROCESS (Al 93%, Graphite 5%, MoS2 2%): we filled the aluminum pieces in the glass in the estimation of aluminum 93%. At that point we measure graphite at 5% and MoS2 at 2%. At that point we move to heater and we set the heater temperature at 950°C. At that point we filled the deliberate aluminum pieces in the heater in Crushable glass [1]. The aluminum filled in multiple times of heater. On First time we filled 63% aluminum in the Crushable container at that point close the heater entryway after 20 min the aluminum pieces are dissolved. At that point we filled the equalization aluminum pieces that is 30% in the Crushable measure of heater at that point close the entryway, in this time we open the heater entryway after 15 min. The all out aluminum pieces are liquefied then we include the graphite 5% in the crushable container in that time we blended the graphite powder and softened aluminum by utilizing blending sharp edge in heater in this procedure going to 10 min. this procedure is called by STIR CASTING. After 10 min we open the heater at that point include the MoS2 powder 2% in the crushable glass. At that point we blend the aluminum, graphite, MoS2 by utilizing blending cutting edge. The STIR CASTING process is done inside 10 Min. At that point heater show alert in 950°C the procedure was finished. At that point the crushable glass hold by utilizing the metal grasp holder. At that point we pour the hot metal in die. At that point the kick the bucket was cooled 1 hour in outside. To take the aluminum pole the kick the bucket ought to be braked. At that point turning process done by machine. The aluminum bar is manufactured. In this outcome the pole is loaded with gaps that is porosity.

2.3. 3rd PROCESS (Al 96%, Graphite 2%, MoS2 2%): we filled the aluminum pieces in the container in the estimation of aluminum 96%. At that point we measure graphite at 2% and MoS2 at 2%. At that point we move to heater and we set the heater temperature at 950°C. At that point we filled the deliberate aluminum pieces in the heater in Crushable glass. The aluminum filled in
multiple times of heater [2]. On First time we filled 66% aluminum in the Crushable container at that point close the heater entryway after 20 min the aluminum pieces are softened. At that point we filled the parity aluminum pieces that is 30% in the Crushable measure of heater at that point close the entryway. in this time we open the heater entryway after 15 min. The all out aluminum pieces are softened then we include the graphite 2% in the crushable container in that time we blended the graphite powder and dissolved aluminum by utilizing blending edge in heater in this procedure going to 10 min. this procedure is called by STIR CASTING. After 10 min we open the heater at that point include the MoS2 powder 2% in the crushable glass. At that point we blend the aluminum, graphite, MoS2 by utilizing blending cutting edge. The STIR CASTING process is done inside 10 Min. At that point heater show caution in 950°C the procedure was finished. At that point the crushable glass hold by utilizing the metal grasp holder. At that point we pour the hot metal in pass on. At that point the kick the bucket was cooled 1 hour in outside. To take the aluminum pole the kick the bucket ought to be braked. At that point turning process done by machine. The aluminum bar is created. In this outcome it conquer superior to past two procedure [4].

3. COMPOSITION STUDY

By using stir casting process these material in combined at efficient ratio as shown in the table. This process is done three times using different composition.

| Table 1 (AL85%+C10%+MOS2 5%) |
|--------------------------------|
| **Calculating** | **Values** |
| Density         | 2.7        |
| Young’s modulus | 70         |
| Poisson’s ratio | 0.35       |
| Thermal conductivity | 237   |
| Tensile strength ultimate | 75       |
| Compressive strength ultimate | 210     |
| Bonded          | 5% mixing  |

| Table 2 (AL93%+C5%+MOS2 2%) |
|--------------------------------|
| **Calculating** | **Values** |
| Density         | 2.9        |
| Young’s modulus | 68         |
| Poisson’s ratio | 0.31       |
| Thermal conductivity | 234   |
| Tensile strength ultimate | 67       |
| Compressive strength ultimate | 215     |
| Bonded          | 75% mixing |

| Table 3 (AL96%+C2%+MOS2 2%) |
|--------------------------------|
| **Calculating** | **Values** |
| Density         | 3          |
| Young’s modulus | 65         |
| Poisson’s ratio | 0.32       |
| Thermal conductivity | 211    |
Tensile strength ultimate | 60  
Compressive strength ultimate | 209  
Bonded | 85% mixing

### 4. TESTING CONDITION

- HARDNESS TEST
- BENDING TEST

**HARDNESS TEST** - The assurance of the Rockwell hardness of a material includes the utilization of a minor burden pursued by a noteworthy burden as shown in Fig 2. The minor burden sets up the zero position. The real burden is connected, at that point evacuated while as yet keeping up the minor burden. The profundity of entrance from the zero datum is estimated from a dial, on which a harder material gives a higher number. That is, the infiltration profundity and hardness are contrarily corresponding. The main favourable position of Rockwell hardness is its capacity to show hardness esteems legitimately, consequently deterring dreary estimations engaged with different hardness estimation systems. The condition for Rockwell Hardness is \( HR = N - d/s \), where \( d \) is the profundity (from the zero burden point), and \( N \) and \( s \) are scale factors that rely upon the size of the test being utilized (see following segment). It is normally utilized in designing and metallurgy. Its business prominence emerges from its speed, unwavering quality, vigour, goals and little region of space [3].

**Fig.2 HARDNESS TEST**  
**Fig.3 BENDING TEST**

**BENDING TEST** - In applied mechanics, bending (also known as flexure) characterizes the behaviour of a slender structural element subjected to an external load applied perpendicularly to a longitudinal axis of the element as shown in Fig 3. A beam deforms and stresses develop inside it when a transverse load is applied on it. In the quasi-static case, the amount of bending deflection and the stresses that develop are assumed not to change over time. In a horizontal beam supported at the ends and loaded downwards in the middle, the material at the over-side of the beam is compressed while the material at the underside is stretched. There are two forms of internal stresses caused by lateral loads. They are shear stress and compressive
5. RESULT

5.1. Rockwell Hardness test

Specification: AL+C+MOS2
Test method: ASTM E18:2016
Rockwell Hardness Result = 63(HR15N)

5.2. Bending test

Test method: ASTM A 370:2017
Load at peak: 2.760 KN
Bend strength : 13.988 N/mm²

Fig.4 BENDING TEST RECORD

6. CONCLUSION

In this project we fabricated Aluminum rod in different composites (Aluminum, Graphite, and MoS2). The result of 1st stage is full of black powder on aluminum rod in the 2nd stage is full of holes on the aluminum rod and in the 3rd stage it better than previous two process. We are doing the better process for the good finished aluminum rod.

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