Studies on mechanical and wear behavior of Al7039 and mos2

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***Abstract* - Aluminium metal matrix composites (AMMC) have emerged as a material for advanced automobile aerospace and consumer-related industries have been hindered by high costs of producing components of even minimally complex shape applications. Today many experiment are going to improve and study the further mechanical property of Aluminum alloy by fabricate with the other metal or another material, such as a ceramic or organic compound etc. An attempt is made in the present work to study the mechanical and tribological properties of Al 7039 alloy, by fabricating it with various percentage of Molybdenum disulphide particle reinforcement using stir casting method. This work involves studying and observing change in mechanical and tribological behavior of metal matrix composite through performing tensile, compression, hardness and wear tests according to ASTM standard.**

***Keywords* - Aluminum alloy-7039, ASTM. Molybdenum disulphide, Hardness. Tensile, Compression, Wear test.**

I INTRODUCTION

A composite is a material made by joining two or more disparate materials in such a path, to the point that the resultant material is enriched with properties better than any of its parental ones which are generally connected in diverse fields like guard, aviation, designing applications, sports products, and so forth. A regular composite material is an arrangement of materials making out of two or more materials (blended and fortified) on a perceptible scale. Generally, a composite material is made out of bolster (strands, particles, drops, and/ or fillers) installed in a framework (polymers, metals, or earthenware era). The structure holds the sponsorship to shape the sought shape while the fortification redesigns the general mechanical properties of the system. The main objective of the project is to fabricate the Al 7039 alloy with various percentage of Molybdenum disulphide using the stir casting method and to investigate the effect of particle reinforcement material in the base metal on the mechanical properties of the composite like tension compression and hardness. To evaluate tribological properties through conducting dry sliding wear test based on its three parameter like applied load, sliding speed and sliding distance. To carry out scanning electron microscope (SEM) analysis of worn surface of the tested specimen.

II METHODOLOGY

1**.** Stir casting technique used to fabricate Al 7039 alloy with 3, 6 and 9 percentage Molybdenum disulphide particle. Stir casting involves the following steps

- Heating base alloy to molten metal.
- Mixing calculate amount of particle reinforcement.
- Stirring molten mixture and
- Pouring molten mixture into precise mould.

2. Casted material is removed from the mould is to be machined as per ASTM standard followed by ASTME 8M – 00b for tension and ASTME E 9 – 89a For compression, to perform tension and compression test respectively, to determine tensile and compressive strength of reinforced and unreinforced matrix material. And also Vickers harness test will be conducted to find out hardness of the casted material.
3.For directing the wear test, the example will be arranged according to the ASTM G 99 standard. This is accomplished by turning the material to the standard width and slicing it to the obliged tallness of 27mm and distance across of 10mm. Machined examples will be tried for dry sliding wear test to distinguish the wear conduct of different rate of Molybdenum disulphide in the base metal of Al 7039 composite.
SEM examination of the well-used surface of the tried example will be completed to study change in.

III MATERIALSAND EXPERIMENTATION

1. Materials:

The metal framework material sure for the here study was based on the Al–Zn– Mg network composite, chose by the American Aluminum Association as Al 7039. This grid compound be select since it give a splendid blend of quality and mischief resistance just as at high and cryogenic temperature The Molybdenum disulphide molecule which be utilized to manufacture the compound had a normal iota mass of 40 μm and normal thickness of 0.001509 g/mm3. The measure of Molybdenum disulphide molecule support fluctuated from 0 to 9 wt. % in three stages. The assumed concoction creation of the grid composite is known in Table3.1.

Table 3.1 Composition of Al 7039 alloy (wt. %)

Element	Content
Mg	2.3 to 3.3
Zn	3.5 to 4.5
Mn	0.1 to 0.4
Cr	0.15 to 0.25
Si	0.3
Cu	0.1
Fe	0.4
Ti	0.1
Al	Balance

2. PREPARATION OF COMPOSITE:

Fluid state creation of Metal Matrix composite include amalgamation of spread stage into liquid lattice metal, take after by its Solidification. In immediate to offer tall phase of mechanical property of the compound, fine interfacial holding between the diffuse stage and the liquid lattice must be acquire. Wetting advancement may be accomplished by covering the scattered stage particles (strands). Schematic representation of stir casting set up is as shown in Fig3.1. It consist of rotor(rabble)(as shown Fig 5.7) which is used to stir molten mixture composite, high temperature resisting ceramic device called crucible, container to cover whole apparatus and heating coil which is used to heat mixture for higher temperature

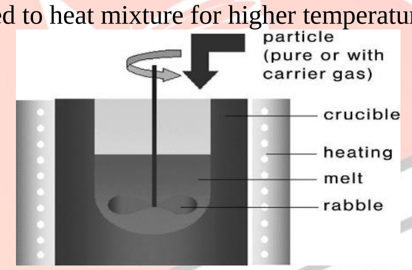

Fig 3.1 Schematic operational sequence during melt stirring.

In next step, 3% of Molybdenum disulphide powder (as shown Fig 5.4) has been taken with respect to weight of Al 7039 alloy, Al 7039 alloy heated to melting temperature then pour 3% of Molybdenum disulphide into molten Al 7039 alloy then it stir the both the mixture of Al 7039 alloy and Molybdenum disulphide for about 5 minutes till we observe that black color of Molybdenum disulphide is disappear.

3. Preparation of tensile and compressive specimen for test

Specimens obtained after cooling the mould is of irregular shape which are surrounded by some unwanted scales which have highly curved cross section, higher diameter then required specimen, higher length and lightly irregular surface .the specimen for the tensile test turned to required size as per ASTM standard[4] shown in Fig 3.2

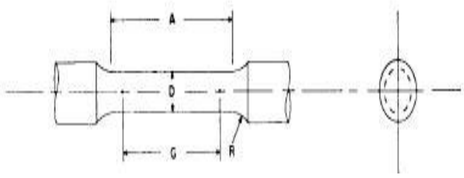

Fig 3.2 Standard specimen for tensile test.

4. Wear test

The dry sliding stick on circle wear testing machine used for the experimentation is shown in figure 5.11.The dry sliding wear characteristics of the aluminum amalgam and Al- Molybdenum disulphide composites as per ASTM G99-95 standards. Wear tests be guide with weights territory from 10 to 60 N and down surge of 1.53 m/s, 3 m/s, 4.6 m/s, and 6.1m/s for a sliding frigid of 400 m ,800m,1200m ,1600m and 2000m. All tests were conduct at locale temperature. The essential mass of the illustrations was definite using a private skillet electronic measure machine with a precision of 0.0001g. In the midst of the trial the pin be pressed close by the supplement turning by an steel plate by applying the stack.

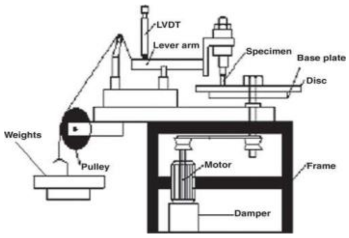

Fig 3.3 Schematic chart of the dry sliding wear testing device

5. Hardness test

Fig 5.12 shows the Vickers hardness apparatus. Major load weight is hanged at the pendulum pan for different material. the specimen placed on the worktable, base plate rotated in clockwise direction up to pointer just touches the surface of the specimen after that minor load of 10 kg is applied this reading is shown by small pointer co-incident with mark provided, this is done by rotating table in clock wise direction until pointer coincide the mark during all the operation. Ten seconds it is allowed and the diameter of indentation recorded with help of the micrometer.

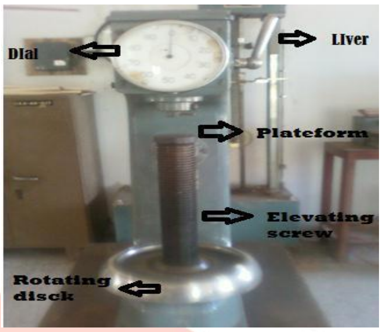

Fig 3.4 Vickers hardness testing machine.

IV RESULTS AND DISCUSSION

1. **TENSION TEST**

In order to analyze the tensile properties Al 7039 alloy and of the fabricated composite. A tensile test was conducted on the specimen as per the ASTM standers. The load was applied gradually till the break point and a graph of load vs. displacement were plotted. The details are discussed as below

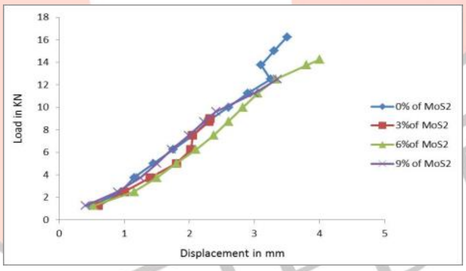

Fig 4.1 load vs. displacement of tension test for different composition of MoS2 in Al7039 alloy.

The figure 4.1 shows the load verses displacement curve for the 0, 3, 6 & 9 percent MoS_2specimen. It observed from the graph as the load increased, displacement also increased indicating the deformation. When tensile load is applied, week portion within the specimen will form small internal void these void will grow gradually as load increased there will be decrease in cross section area will take place [8]. when the internal resistance of specimen exceed the applied load the material cross section area will not withstand for high load, specimen will finally fail by ductile fracture due substantial plastic deformation and creation of micro void the material is fail due to micromechanics such as nucleation and motion of dislocation .In this material crack growth occurs by coalescence of void which form by dislocation [15] at load of 16.25 (KN) the specimen will fail under tensile load.

2. **COMPRESSION TEST**

Aluminum alloy reinforced with MoS_2 particulates specimen is prepared for compression test with length of 26mm and diameter of 13 mm. this prepared specimen is mounted in universal testing machine and a compressive load was applied gradually for 0%, 3%, 6% and 9%, MoS_2 reinforced specimens and bulking and bending loads were noted for the compressive strength analysis of the composite fabricated and are discussed as below.

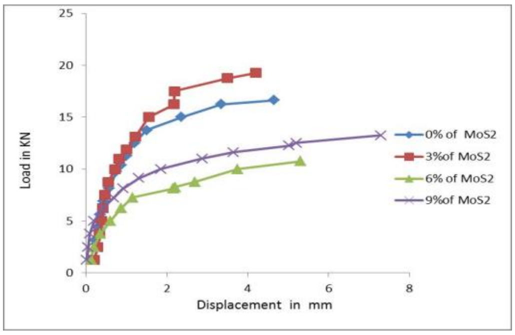

Fig 4.2 load vs. displacement for compression test of different composition of $MoS_2$with Al7039

Figure 4.2 shows the Load verses displacement plots for 0%, 3%, 6% and 9%, MoS_2 reinforced specimens. It is observed from the graph that as the load increased the displacement also increased gradually till 13.75KN and started buckling and finally at 16.64 KN of load failed with displacement of 4.65mm for the unreinforced Al 7039 alloy. Whereas for Al 7039 alloy reinforced with 3% MoS2, the load has increased for the specimen till 15kn and its compressive load has increased suddenly to 16.25kn indicating the buckling point later stared bending and failed at point19.25 KN with 4.2 displacements indicating better compressive strength because of uniform distribution of reinforcements. The compressive strength for 6% MoS_2 and 9% specimen has decreased this is due to reduced hardness because of the non-uniform distribution of the particulate reinforcements.

3. WEAR TEST

In order to study the wear behavior of the composite, wear test was conducted on Duocom make a dry sliding pin on disc wear testing machine with, varying parameters to study their effect of each on the wear loss . Weight loss was considered for the calculation of the wear loss and graph of various parameters considered and weight loss is plotted.

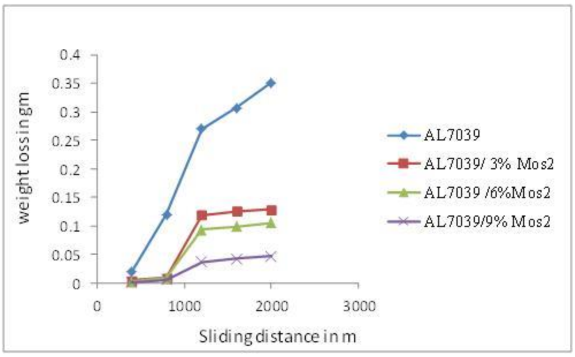

Fig: 4.3 Demonstrates the variety of weight reduction with sliding separation for both unreinforced

Al 7039 composite and Al 7039-Molybdenum disulphide composites with differing rates of Molybdenum disulphide support for fluctuating sliding separation for steady speed and heap of 3.5m/s and 30N separately. It has been seen from the diagram that as sliding separation expand weight reduction of both composite and in addition unreinforced amalgam increments. Further, as the rate of fortress assembles, the

Wear of the composite declines. It can be seen that unreinforced combination show more noteworthy degree of wear weight reduction when contrasted with composite compound. Further From chart it has been watched that as rate of support build wear resistance of composite material builds demonstrating decline in rate of weight reduction because of wear.

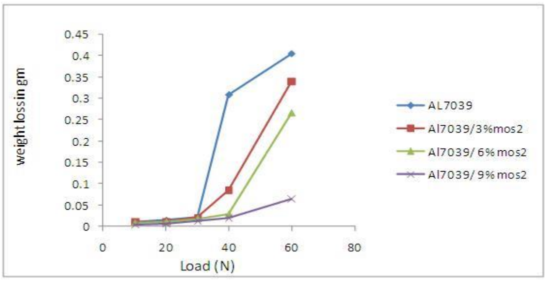

Fig 4.4 Effect of Load on wear weight loss with constant sliding distance and sliding speed.

Figure: 4.4 represents the effect applied load of on wear loss for the constant sliding speed and sliding distance of 3.5 m/s and 1200 m respectively. Load varied from 10 to 60N in steps of 10N. It is seen from the assume that the weight reduction of the both unreinforced and strengthened composite increments with expansion in connected burden. Further a mild wear was observed for a small applied load till 30 N for both reinforced and reinforced composite. Beyond 30N, there is sudden change in wear pattern of the unreinforced alloy is being observed. For 40N much rate of wear observed for unreinforced alloy compare to Molybdenum disulphide reinforced Al 7039 alloy. Further at 60N of applied load, there is less wear was observed for higher composition Molybdenum disulphide reinforced Al 7039 alloy.

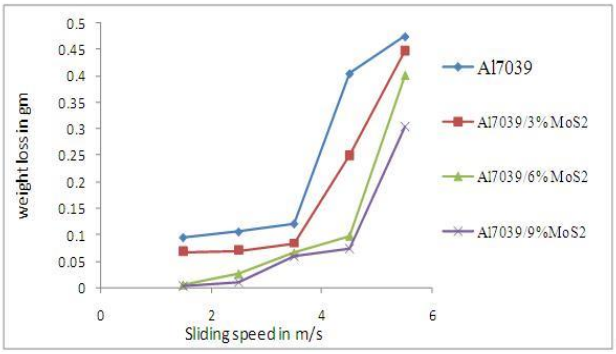

Fig 4.5 Effect of sliding speed on wear weight loss with constant load and sliding distance

The wear loss of both unreinforced composite and the toughened reduction as the sliding rate augmentation up to 3.5 m/s. in any case, at a pace of 4.5 m/s, simply the wear rate of the unreinforced amalgam changes from delicate to compelling, while the made composites continue showing the same example. Further At a speed of 5.5 m/s, the composite wear adversity changed to amazing wear. The unreinforced amalgam seizes at 5.5 m/s, however as the composite does not. Further, the wear loss of the composite decreases as the measure of fortress additions. Overpowering confusion and vibration were seen in the midst of the strategy and trade of the pin material to the plate was moreover viewed.

4. HARDNESS AND SEM

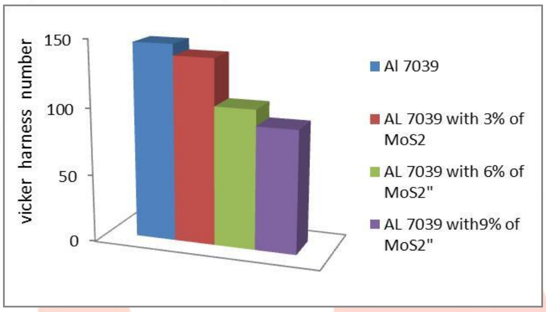

Fig 4.6: 3D bar chart of hardness number of Al 7039 alloy and its composition

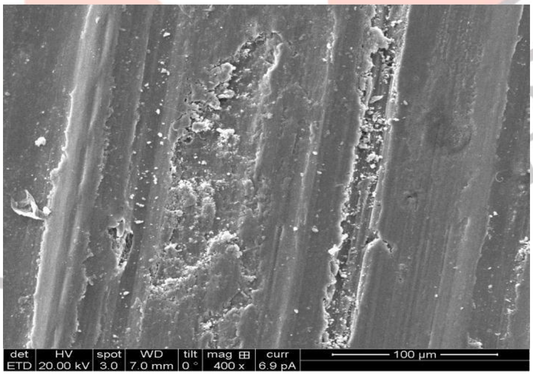

Fig 4.7: SEM micrographs of worn surface of the Al 7039/9% MoS_2composite.At speed 3.5m/s, load 30N for the sliding distance of 2000m

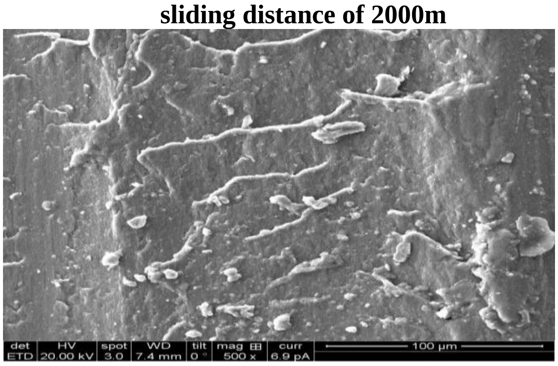

Fig 4.8: SEM micrographs of worn surface of the Al 7039/6% MoS_2composite at speed of 3.5m/s and load of 30N after distance of 1200m.

V CONCLUSION

Tensile strength of reinforced Al 7039 alloy and unreinforced Al 7039 alloy were not decided due to inconvenience result.

Compressive strength of Al7039 alloy increased for 3% mixture of Molybdenum disulphide particle with Al 7039 alloy in comparison with pure Al 7039 alloy. Because Molybdenum disulphide is uniformly distributed within the alloy. There is no coagulation of Molybdenum disulphide particle in case of 3% Molybdenum disulphide fabrication which result in increase in compressive strength of the composite material. As percentage of Molybdenum disulphide increases in the base alloy, hardness of unreinforced Al 7039 alloy increases in comparison with Al 7039 alloy reinforced with various percentage molybdenum disulphide. SEM of Molybdenum disulphide reinforced composite shows the micrograph of delamination of worn surface, formation of macro chips resulting in fine debris due to abrasive wear and also damaged acne in the form of craters were experiential for base metal. It has been observed that poor delamination, light debris was observed on the worn surface of the tested specimen for 9% Molybdenum disulphide reinforced matrix material.

VI SCOPE OF FUTURE WORK

- Further work can be expanded by carrying out impact test and fatigue test to find out impact strength and fatigue strength of reinforced composite material respectively.
- Other tribological properties can be evaluated for different volume fractions for better understanding.
- SEM analysis can be done after the heat treatment to study the change in microstructure of the heat treated specimen.

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