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Study of Mechanical and Tribological Properties of Aluminum-Alumina Metal Matrix Composites

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Abstract - *Metal matrix composites are mostly used in automobile and aerospace industries due to its light weight and strength. Among the metal matrix composites, aluminum matrix composites are preferred over conventional materials because of their high strength to weight ratio, high wear resistance and low cost. Aluminum based metal matrix composites containing different volume fractions of alumina reinforcing particles were produced by powder metallurgy and the effect of the volume fraction of reinforcement on the structural and mechanical properties of the composites has been studied in an attempt to improve its mechanical and tribological properties. The specimens were investigated for microstructural changes using scanning electron microscope imaging technique and changes in mechanical properties were studied by performing compression, micro hardness and wear tests. The best result has been obtained at 2% weight fraction of alumina with pure aluminum showing improvement in resistance to compression, wear and improvement in hardness.*

Key Words: Aluminum metal matrix composite, powder metallurgy, Reinforcement, Alumina, Powder metallurgy.

1. INTRODUCTION

This document is template. In an advanced society like ours we all depend on composite materials in some aspect of our lives. Composite materials have a long history of usage.Aluminium alloy used where weight saving is required because of its light weight application. But, Softness in aluminium alloy can restrict its use for the engineering applications. Hence, aluminium matrix composites are widely used in various automobile and aerospace industries because of their high strength to weight ratio and modulus. The light weight parts are manufactured by using the aluminium matrix composites have led to their use in the automobile and aerospace industries. Aluminium matrix composites have increasing potential due various applications like aircraft pump parts, automotive transmission cases, aircraft fittings and control parts, water-cooled cylinder blocks, brake rotors, cylinder liner, engine parts, pistons, cylinder heads, etc. The production of aluminium composite material by Better quality and less expensive materials like industrial waste are the need of technology.

1. Production of Metal Matrix Composites

Aluminum and alumina were taken in powder form and according to the different proportions of alumina (2%, 6%, 15%) 3 samples were made by mixing them in a planetary ball mill which was run at 200rpm for 120 minutes. Then compaction was done using a die and a punch which was placed in a high compression press to obtain pellets. The sintering process was done by keeping these pellets in a tubular furnace with a soaking temperature of 550 degrees celcius for 1 hour. The furnace was supplied with argon gas during the process.

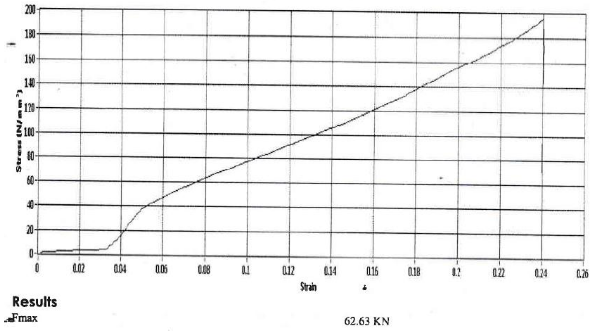
2 .Tests

The samples prepared for microstructure studies, hardness test, compression test and wear tests to know the about the changes in mechanical and tribological properties of composite materials.

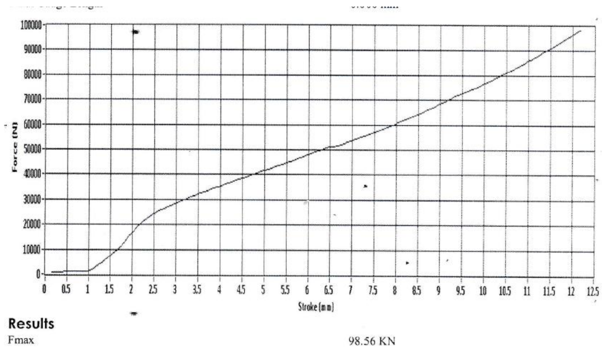
2.1 COMPRESSION TEST

Table -1: Compression test

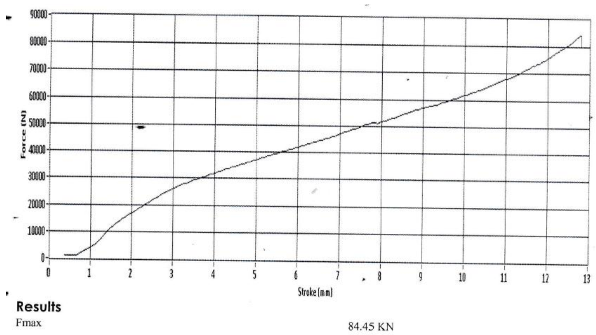
Material specimen	**Max. Compression load in KN UTN:40**
1.Pure Al	62.63
2. $Al\text{-}Al_20_3$(2%)	98.56
3. $Al\text{-}Al_20_3$(6%)	84.45
4. $Al\text{-}Al_20_3$(15%)	50.52



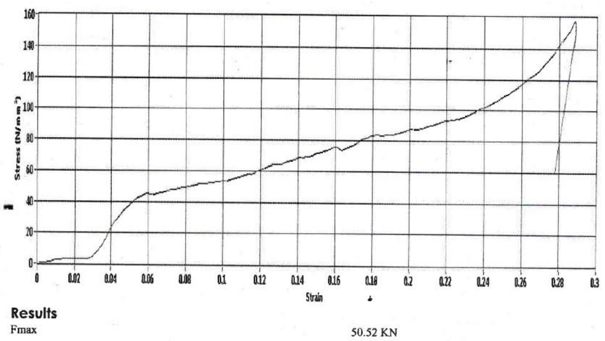
Graph -1: Pure Aluminum



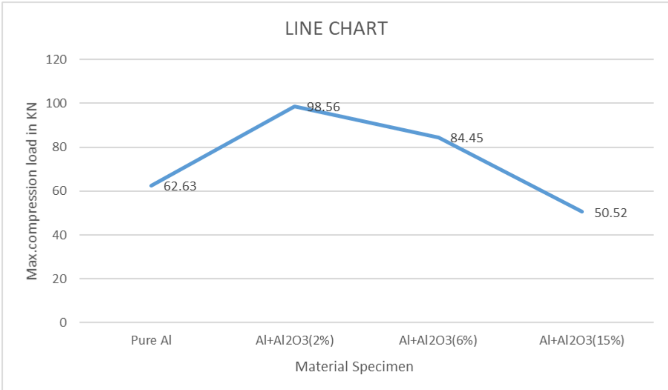
Graph -2: Pure Al+2%Al_2O_3



Graph -3: Pure Al+6%Al_2O_3



Graph -4: Pure Al+15%Al_2O_3



From the graphs above we are able to conclude that the metal matrix composite with 2% Al_2O_3 in it's value has the highest compression strength amongst all the samples which were tested.

2.2 SEM IMAGING

The micro-structure of specimens (different weight percentage of reinforcement) was examined by using Scanning electron microscope (SEM).SEM images with different weight percentage of Aluminium oxide particles of mesh 400 under the magnification factor of 100X. It was observed that reinforcement particles are uniformly distributed on the metal matrix with 2% Al_2O_3.

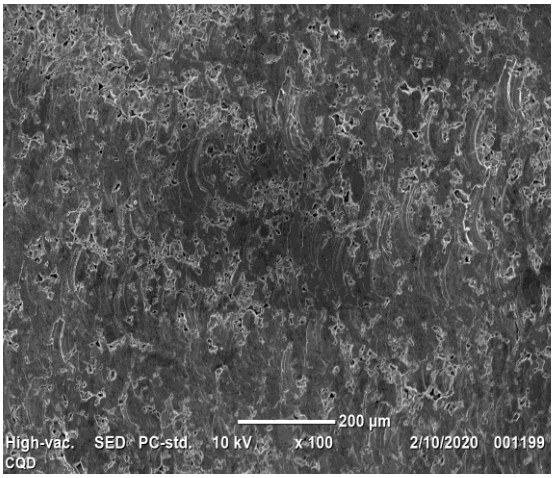


Fig -1: Pure Aluminum

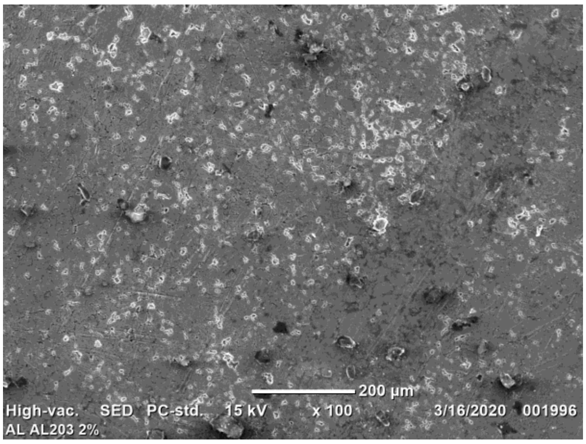


Fig -2: Pure Al+2%Al_2O_3

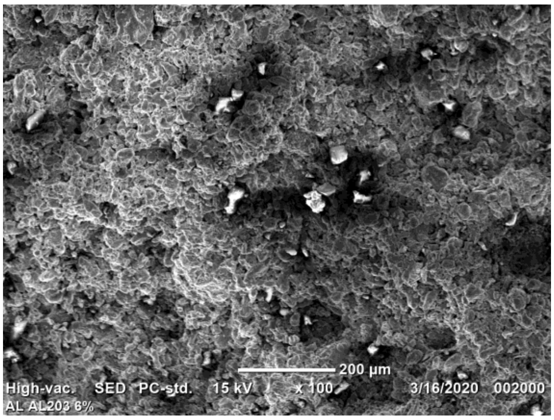


Fig -3: Pure Al+6%Al_2O_3

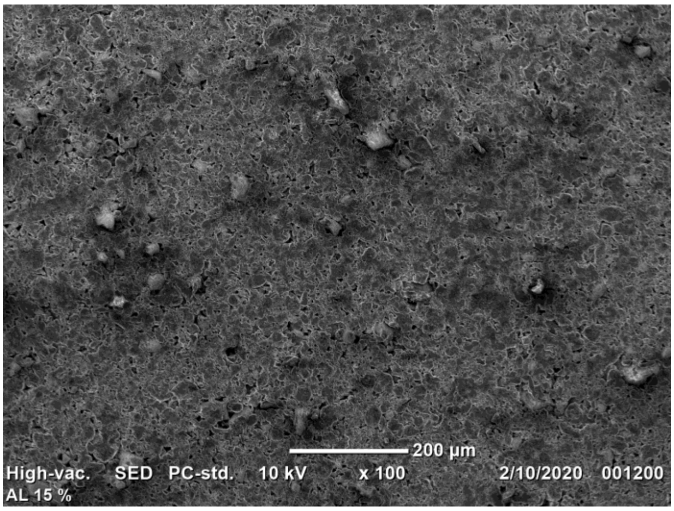
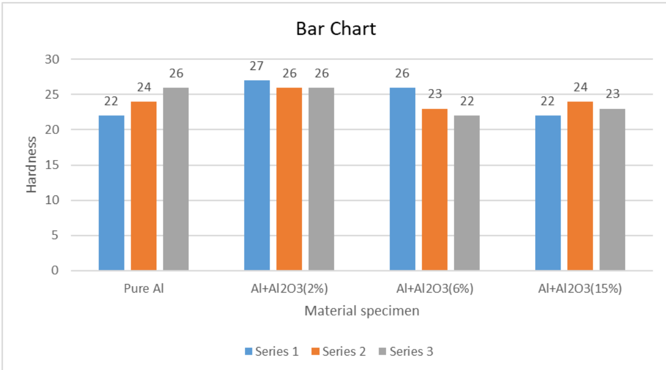


Fig -4: Pure Al+15%Al_2O_3

2.3 MICROHARDNESS TEST

Generally, several factors would affect the micro hardness of the composites, such as particle shape, size, amount, distribution, density of reinforcement, and method of preparation. The Vickers hardness test is used as an alternative to the Brinell method to measure the hardness of materials. The Vickers test is often easier to use than other hardness tests since the required calculations are independent of the size of the indenter, and the indenter can be used for all materials irrespective of hardness. The basic principle, as with all common measures of hardness, is to observe a material's ability to resist plastic deformation from a standard source. The Vickers test can be used for all metals and has one of the widest scales among hardness tests. The unit of hardness given by the test is known as the Vickers Pyramid Number (HV) or Diamond Pyramid Hardness (DPH).

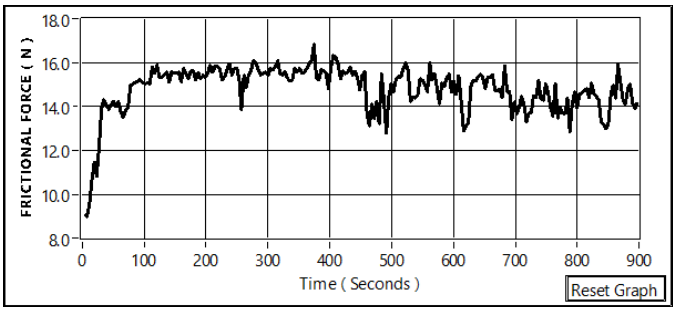
Material specimen	**Hardness in HV** 0.1kg load
1.Pure Al	22,24,26
2. Al-Al_2O_3(2%)	27,26,26
3. Al-Al_2O_3(6%)	26,23,22
4. Al-Al_2O_3(15%)	22,24,23



The sample with 2% Al_2O_3 showed an improvement in hardness.

2.4 WEAR TEST

In this experiment the applied load is 25 N, Rotating Speed is 250 rpm, Time elapsed 15 minutes, Disc distance 20 mm and test conducted at room temperature.



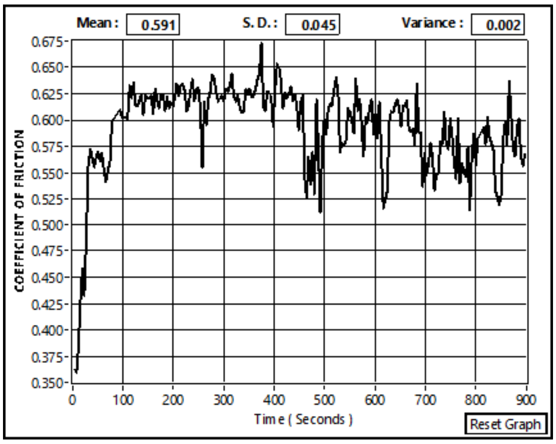
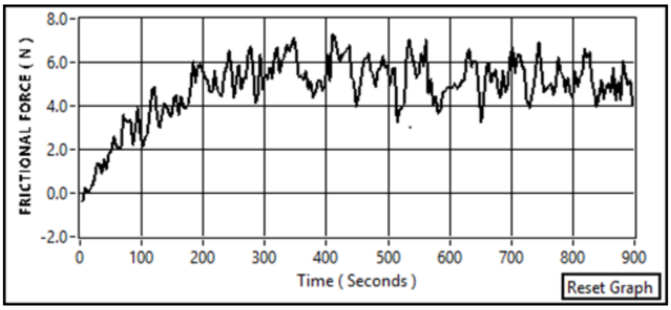


Fig -1: Pure Aluminum



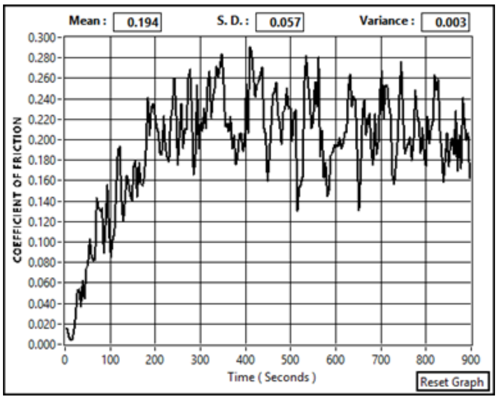
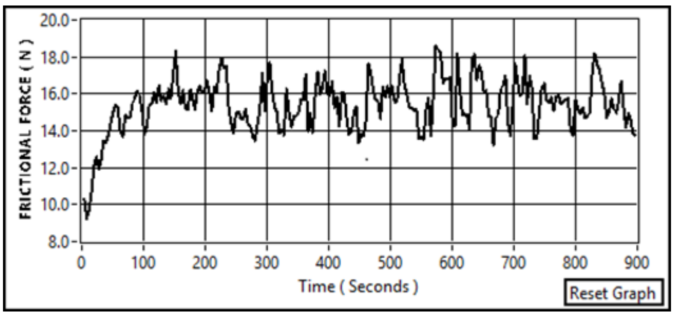


Fig -2: Pure Al+2%Al_2O_3



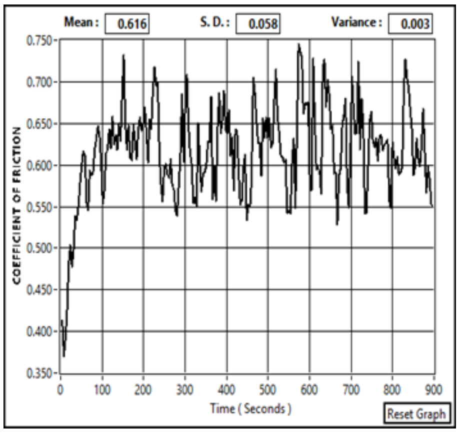
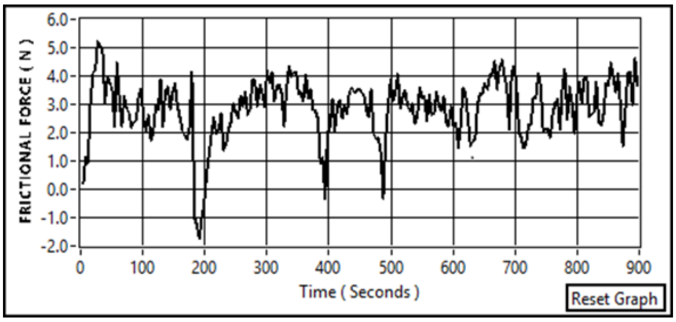


Fig -3: Pure Al+6%Al_2O_3



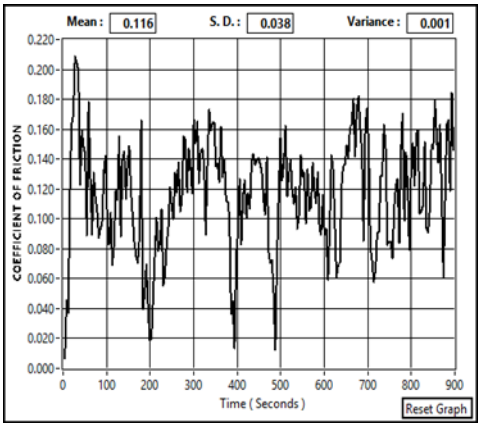


Fig -4 Pure Al+15%Al_2O_3

From the graphs we are able to conclude that the sample containing 2% Al_2O_3 has an uniform as well as lesser wear rate than the other samples.

3. CONCLUSIONS

*It was observed that reinforced particles are uniformly distributed on matrix material by SEM analysis.

*Micro Hardness of composites was increases to the peak value by increasing weight percentage of aluminium oxide particles to 2% and 6% and drops beyond that.

*It was observed that compressive strength increases by increasing weight percentage of aluminium oxide particle.

*It was also observed that the tribological property wear rate decreases as the weight percentage of aluminium oxide increases and coefficient of friction increases as weight load increases.

REFERENCES

[1] Girija Moona, R S Waliab, Vikas Rastogib, Rina Sharma (2018) Aluminum metal matrix composites a retrospective investigation.

[2] Pulkit Garg, Anbesh Jamwal, Devendra Kumar, Kishor Kumar, Sadasivuni Chaudhery, Mustansar Hussain, Pallav Gupta (2019) Advance research progresses in aluminum matrix composites: manufacturing and applications.

[3] Muhammad Hayat Jokhio, Muhammad Ibrahim Panhwar, Mukhtiar Ali Unar (2010) Manufacturing of aluminum composite material using stir casting process.

[4] Kumba,Anand (2014) Exploration of mechanical behavior of alumina reinforced aluminum metal matrix composites.

[5] Dinesh Kumar Koli, Geeta Agnihotri, Rajesh Purohit (2013) Properties and characterization of Aluminum-alumina composites processed by casting and Powder metallurgy.

[6] Anil Kumar, J. Satheesh, Praveen Kittali, T. Madhusudhan (2016) Effect of alumina particles on the tribological and mechanical properties of aluminum metal matrix composites fabricated by powder metallurgy technique.

[7] Lina Xu, Fengqing Zhang, Xuetao Yue, Qingbao Tian (2016) Advance on alumina particulates reinforced aluminum metal matrix composites manufactured by powder metallurgy methods-improved powder metallurgy techniques.