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Evaluation of Mechanical and Tribological Properties of Al 5083 - ZrSiO4 - TiO2 Hybrid Composite

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Abstract

This project compact through the mechanical and tribological properties of Al 5083- TiO_2 -$ZrSiO_4$ with different reinforcement of 3,5,7,9 wt% of $ZrSiO_4$ and constant 5wt% of TiO_2. Here the fabrication of the samples are carried out by stir casting technique. The microstructure of samples are examined by using SEM, EDAX. The mechanical properties like hardness and tensile are investigated. The wear test was carried out in pin-on-disc wear apparatus with different parameter like, sliding velocity, sliding distance, with different load. The wear surface of the samples are examined by using SEM. The hardness of the samples are increased due to the presents of $ZrSiO_4$, the maximum tensile strength of the composite is up tined in Al 5083- 5% TiO_2 – 5% $ZrSiO_4$.

Keywords: Al 5083, TiO_2, $ZrSiO_4$, SEM and EDAX.

INTRODUCTION

The Aluminium matrix composites (AMCs) reinforced with ceramic particles has been widely used in aeronautical and aerospace industries due to their high specific Strength and modulus, readily fabrication and low cost [1, 2]. The Metal matrix composites are being to their enhanced properties such as hardness, tensile strength, elastic modulus and elevated temperatures, wear resistance combined with significant weight savings over unreinforced alloys. The MMCs production is preferred by alloys matrix materials. They are inherent with heat resistant, wear resistant and its properties Gr, Al_2O_3, MMCs and Sic are used as reinforcements [3-5].

The Tribological properties of aluminium (Al) can be significantly improved by the addition of hard ceramic particles into matrix. Moreover the Tribological properties of these composites can be further improved by adding solid lubricant particles, namely graphite and molybdenum disulphide, in order to produce hybrid composite [6, 7]. Wear is common phenomenon of all elements having any relative motion such as reciprocating and rotating motions of pistons, cylinder bores, connecting rods, drive shaft, brake rotors, bearings, etc. Therefore, wear is an important aspect to be duly considered while designing with these elements to ensure better and reliable performance in any tribological applications [8, 9].

The aim of this Study is to investigate the effect find the mechanical and Tribological properties of Aluminium (Al 5083 / TiO_2 / $ZrSiO_4$) such as Hardness, Tensile Strength, SEM and EDAX, Wear loss of Aluminium reinforced hybrid composites. This are studied and presented in detail.

EXPERIMENTAL

HYBRID COMPOSITE MATERIALS AND PROCESSING

Hybrid composite materials were prepared by using (Al5083+TiO_2+$ZrSiO_4$) as reinforcing materials. In this process the samples of TiO_2 is commonly 5% added and different % of $ZrSiO_4$, Al 5083. In this show in Table: 1.

Table 1

SAMPLES	COMPOSITE MATERIALS	HARDNESS HBW
Sample 1	Al 5083 + 5% TiO_2 + 3% $ZrSiO_4$	62.6
Sample 2	Al 5083 + 5% TiO_2 + 5% $ZrSiO_4$	62.6
Sample 3	Al 5083 + 5% TiO_2 + 7% $ZrSiO_4$	52.0
Sample 4	Al 5083 + 5% TiO_2 + 9% $ZrSiO_4$	57.7

Stir Casting

The Casting process was heated at a temperature of 850°C in the Al 5083 Composite material and it was took a time for four hours in the furnace. Then the mixed of TiO_2, and $ZrSiO_4$ pre heat temperature at in 300 °C. In this materials mixed to Al 5083 liquid at 400 rpm speed in the furnace. After the Hybrid Composite liquid was ready. Then it took in the furnace. It was changed in a cylinder shape using die.

Microstructure

The cylinder of Hybrid Composite materials ratio was (10 mm length, 10 mm dia) put in a SEM and EDAX analysis. It gave the micro level graph of Al, Zr, Ti, O_2, .Then we show the object below.

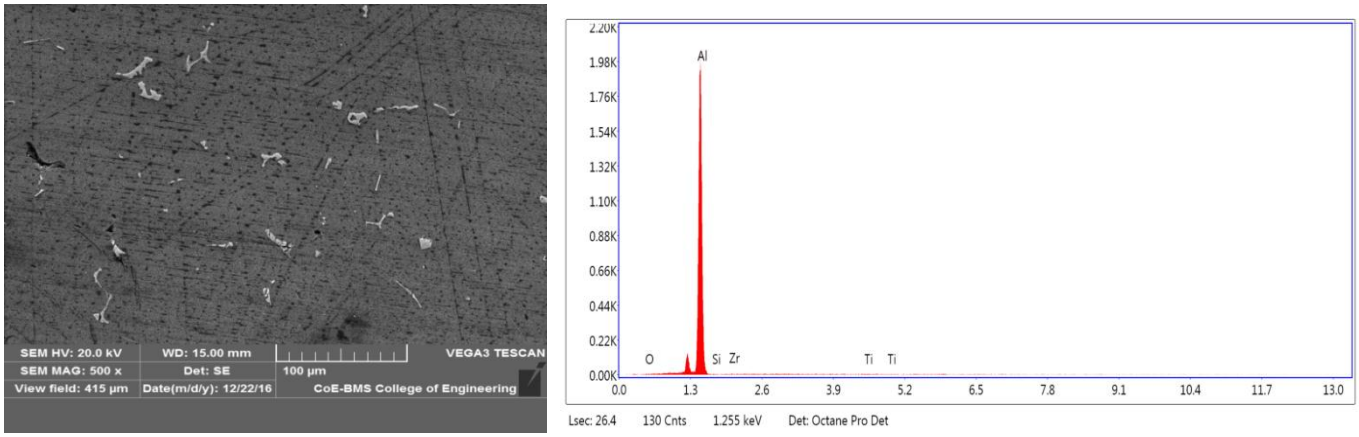

Figure 1. Al 5083 (92%) + TiO_2 (5%) + $ZrSiO_4$ (3%)

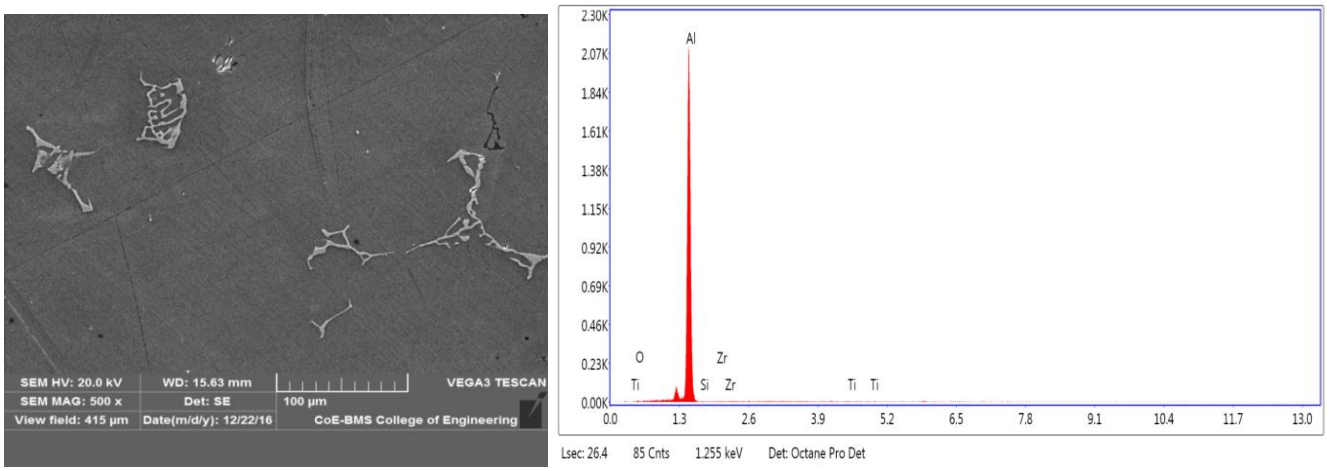

Figure 2. Al 5083 (90%) + TiO_2 (5%) + $ZrSiO_4$ (5%)

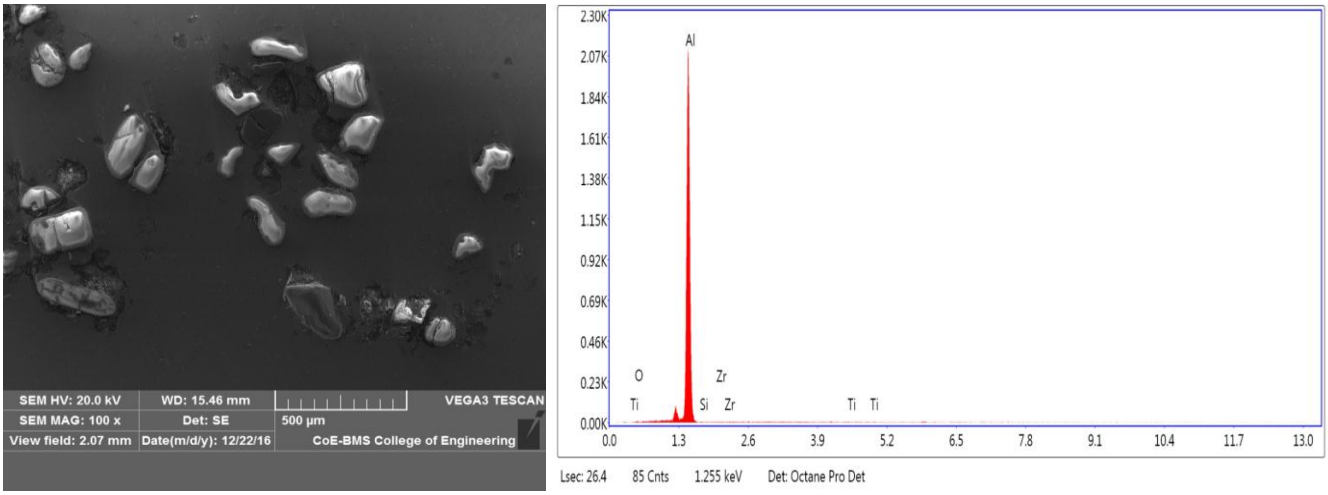

Figure 3. Al 5083 (88%) + TiO_2 (5%) + $ZrSiO_4$ (7%)

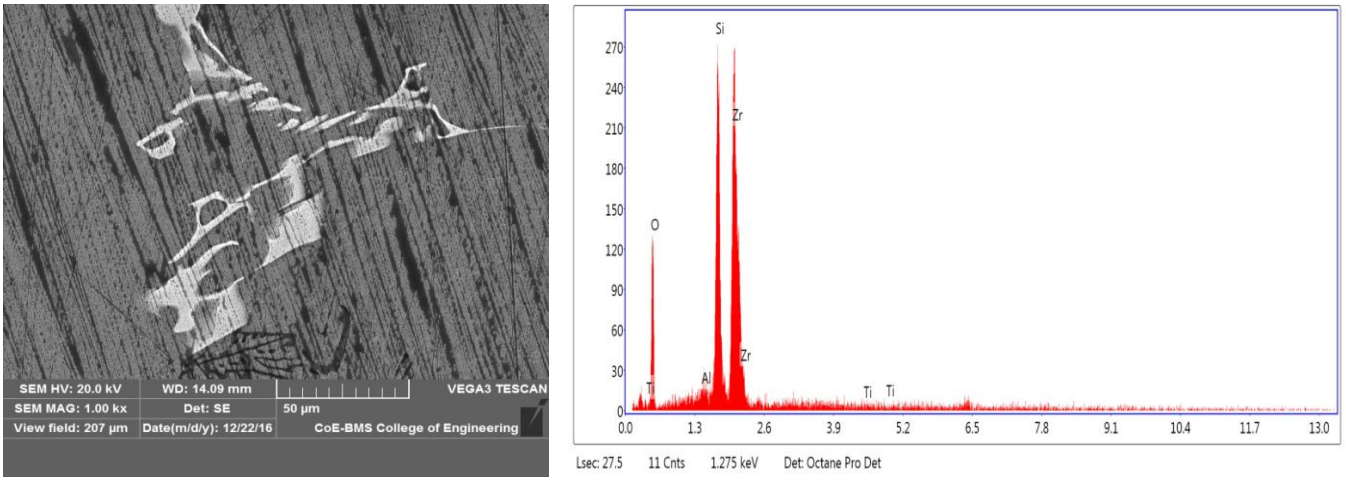

Figure 4. Al 5083 (86%) + TiO_2 (5%) + $ZrSiO_4$ (9%)

Fig: 3, 4 SEM and EDAX image of total four samples are show below. In this samples 10mm length, 10mm diameter of the samples doing Scanning Electron Microscope (SEM) result is done.

Hardness Test

Hybrid Composite materials was test in ASTM. Then prepared the Brinell hardness test. It gave the graph level in below and the test average was 62.6(HBW-5/250) was best. Show in the graph. Fig: 5

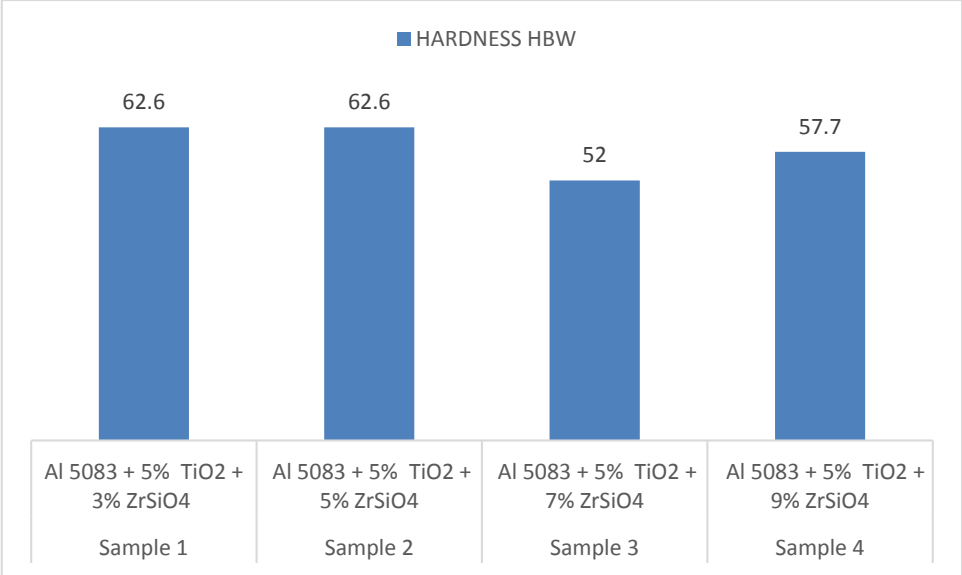

Figure 5. Hardness Test Chart of Hybrid Composite

WEAR TEST ANALYSIS

Hybrid Composite materials cylinder was (30mm length, 10mm dia) taken 12 pieces (in each sample 3) and put it a pin on disc machine. It was tested in two speed and two loads (speed 353, 637 rpm) (load 10, 20N). The result was given wear test, frictional force, and coefficient of friction. Then we make a graph level after found the SEM analysis. The graph level and SEM analysis images was given below.

In this images are done the wear test pin on disc samples SEM analysis using Scanning Electron Microscope (SEM). fig : 5,6,7 show the hybrid composite materials (Al5083+TiO_2+$ZrSiO_4$) in the SEM images and Average Wear Test, Frictional Force, and Coefficient of Friction Results are verify is done.

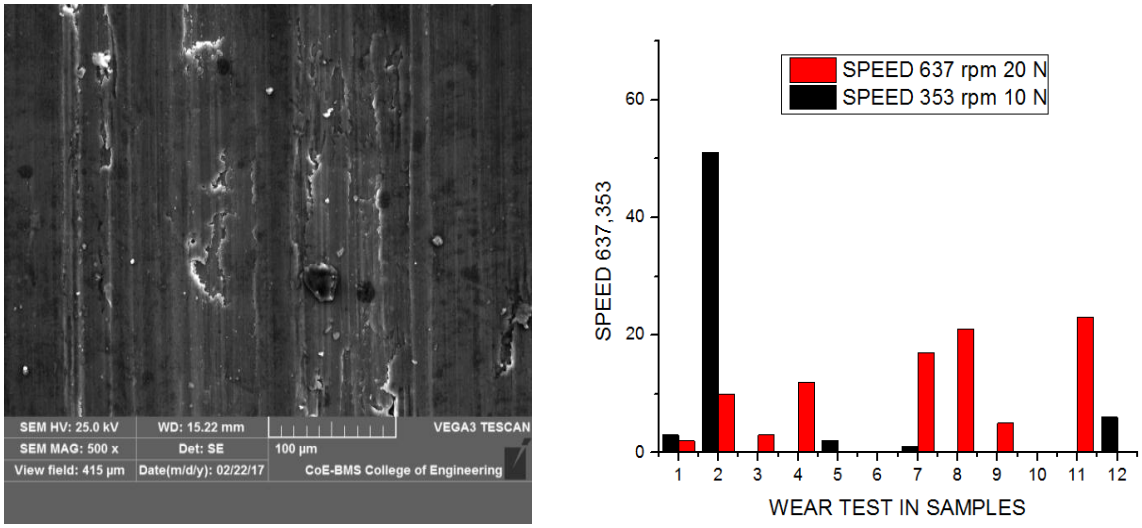

Figure 6: Al 5083 (92%) + TiO_2 (5%) + $ZrSiO_4$ (3%) Wear Graph

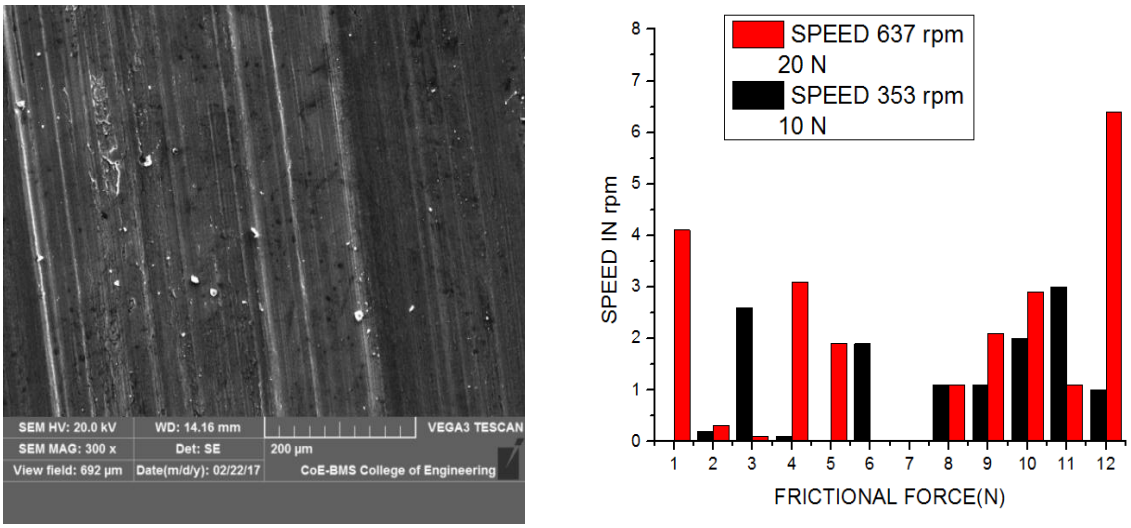

Figure 7: Al 5083 (90%) + TiO_2 (5%) + $ZrSiO_4$ (5%) Wear Graph

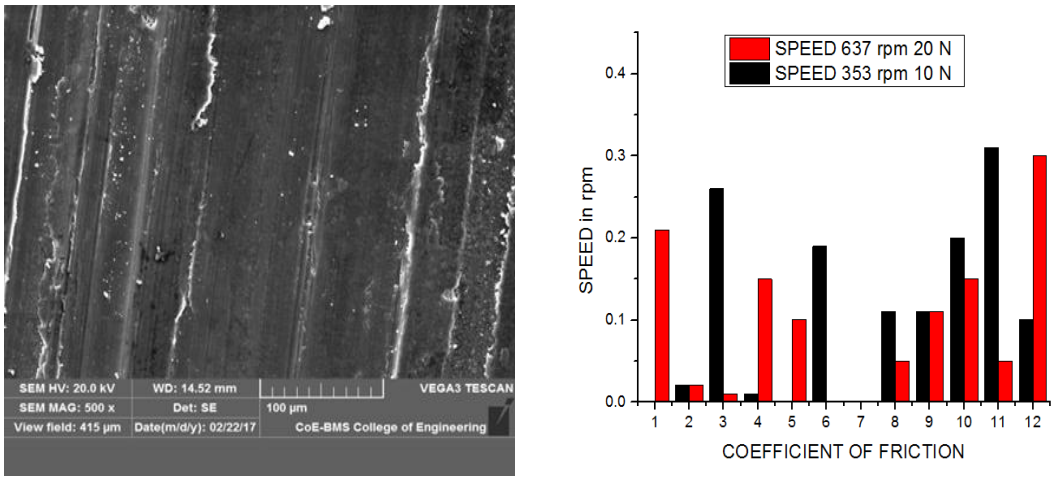

Figure 8: Al 5083 (88%) + TiO_2 (5%) + $ZrSiO_4$ (7%) Wear Graph

Fig. 5,6,7 SEM images of four Samples Hybrid composite materials in wear test samples. The graph are done the wear test, frictional force, and coefficient of friction using pin on disc machine. The fore samples are hybrid composite materials (Al5083+TiO_2+$ZrSiO_4$) using pin on disc machine in the Result verifies is done.

CONCLUSION

In the Current investigation, an attempt has been creating to study the effects of Hybrid Composite materials. The properties of Hybrid Composite materials were characterized using Brinell hardness tests, tensile tests; Scanning Electron Microscope (SEM) analysis, EDAX, and Wear test analysis that show an increase in withstand capacity up to the limits. The conclusion from the current experimental findings are as follows:

1) The Hybrid Composite materials are tested in Brinell hardness tests machine. In this machine, the result was carried out average hardness values (62.6, 62.6, 52, 57.7) show in the display. In this best hardness value is 62.6 Al 5083 (90%) + TiO_2 (5%) + $ZrSiO_4$ (5%) Hybrid Composite material.

2) SEM Analysis was microstructure showed in the samples. In these images was microstructure shown Al, Ti, O_2, Zr, and SiO_4.

3) Wear test analysis worked was using the pin on disc machine. The samples are done by (30 mm length and 10 mm diameter) cut and surface shine before using wear test. Wear weight reduction and friction coefficient diminished with reducing the force applied during sliding. Also, reducing the diminishing the applied force prompted to decreasing surface depressions and scratches and the signs of delamination mechanism. The wear resistance of Hybrid Composite created by apparatus pivot rate of 353, 637 rpm was observed to be better than those of Al 5083 + TiO_2 + $ZrSiO_4$ composite at a connected heap of 10 and 20 N. It ascribed to the steady, which averted metal to metal contact and lessened the wear of the composite.

4) The pin on disc machine are tested in the samples show the graphs are done by the wear test, frictional force, and coefficient of friction Result verify is done.

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