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Wear Performance Test of SiO_2 & TiO_2 based Hybrid Composite

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ABSTRACT

Wear performance test is carried out to predict the wear resistance of the composite material.Composite material is nothing but it is a material which is produced from two or more different reinforcement materials. Composite materials formed from matrix and reinforcement materials. Present work based on Aluminium alloy-based hybrid Composites. Aluminum based composites are used in many industries. Because it has properties like high ductility, high conductivity, light weight, strength to weight ratio etc. Present work is focused on the study of behavior of Aluminium alloy (Al6061) with different wt.% of Tio2 and Sio2 powder mixed by stir casting technique. Casting is prepared by stir casting method. Then the Wear performance of the Aluminium based hybrid composite material is tested by Pin on disc method. Wear performance is tested at different combinations and Plot the Graph for the wear performance at different combination.

KEYWORDS —Single Point Cutting Tools; Turning Operation; Tool Coating; Chip-Tool Interface Temperature; Performance analysis of coated tool.

1. INTRODUCTION

In the course of the most recent thirty years composite materials, plastics and ceramics havebeen the prevailing arising materials. The volume and number of utilizations of composite materials have developed consistently. Composites are as of now demonstrated their worth as weight-saving materials, the current test is to make them cost /compelling. The endeavors to create monetarily alluring composite segments have brought about a few imaginative assembling procedures at present being utilized in the composites business. For effortlessness, be that as it may, composites can be gathered into classifications dependent on the idea of the network each type has. Strategies for manufacture additionally change as indicated by physical and synthetic properties of the networks and building up strands. List of composites are Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs), Polymer Matrix Composites (PMCs).

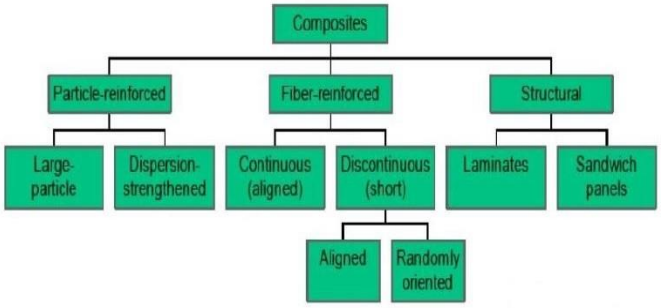

Fig.No: 1.1 Types of Composite Material

2 LITERATURE REVIEW

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Developed the performance of nano-SiC particles of AA2024 with the addition of nano-graphite. The inclusion of silicon carbide increased the wear resistance and the addition of graphite increased it further more. Interfacial bonding was good in the composite as analyzed by XRD. It is evident from the literature review that the wear resistance can be improved by the addition of both silicon carbide and graphite. The composite is defended by the particles of silicon carbide that are prominent on the outer layer of material while the graphite helps in reducing the wear rate when the composite has to be dealt at higher load. Other reinforcements are not as effective as these two and neither there is any consistency in their results.

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Fabricated Al7075-silicon carbide composite and studied the sliding velocity and varying load on wear rate using a pin-disc test. The precipitated heat-treated composite (T6 Aged for 6 hours) showed higher wear resistance at a load of 20 N and sliding velocity of 1m/sec. It was seen that wear increased by 26% when the load was doubled and by 21% when the sliding velocity was doubled. The author also said that wear resistance of the heat-treated composites increased with ageing irrespectiveof load and velocity.

From all the above literature to study the aluminium based hybrid composite wear properties prepare the alternative Aluminium based Hybrid composite material. In this aluminium based composite material SiO2 & TiO2 reinforcement material are using for preparation. To check the wear performance of the material using Pin on disc method

3 MATERIAL AND METHODS

MATERIAL USED

- Aluminium 6061
- TiO2 Powder
- SiO2 Powder

The proposed work approach and methodology has been elaborately shown in the mainsegments related to this project work.

ALUMINIUM 6061:

FEATURES OF ALUMINIUM 6061:

- Very great formability/usefulness making it moderately simple to shape utilizing a machining device.
- Good weldability so it tends to be welded utilizing various strategies and apparatuses. It can be additionally re-tempered to reestablish its hardness nearby the welding focuses.
- A decent braze capacity which implies that two pieces of the material can be consolidated by softening.
- It flaunts incredible erosion protection from the air, just as ocean water. These consumptionobstruction properties are kept up even with vigorously scraped surfaces

Table 3.1: Properties of Al6061

Density	2.7g/cm3
Melting Temperature	585oC (1085oF)
Thermal Conductivity	151-202W/(m*K)
Linear thermal Expansion Coefficient	2.32*10-5K-1
Specific Heat	897 J/(kg*K)

APPLICATION OF ALUMINIUM 6061:

- 6061 aluminum is utilized widely as a development material, most usually in the assembling of auto segments.
- The 6061 compound is appropriate to the development of yachts, cruisers, bike outlines, scuba tanks, camera focal points, fishing reels, electrical fittings, couplings and valves.
- Aluminum-magnesium-silicon amalgams are additionally utilized in wide-range rooftop structures for connect decks and fields.

TITANIUM DIOXIDE(TiO2):

Titanium dioxide, otherwise called titanium (IV) oxide or titania, is the normally happening oxide of titanium, compound recipe TiO2. At the point when utilized as a color, it is called titanium white, Pigment White 6, or CI 77891.By and large, it is sourced from ilmenite, rutile, and anatase

Table 3.2 : Properties of TiO2

Density	4.23g/cm3
Melting Point Temperature	1843oC
Boiling Point Temperature	2972oC
Molar Mass	79.866g/mol

SILICON DIOXIDE(SiO2):

Silicon dioxide, otherwise called silica, is an oxide of silicon with the compound equation SiO2, most regularly found in nature as quartz and in different

living beings. In numerous pieces of the world, silica is the major constituent of sand

Table 3.2 : Properties of SiO2

Density	2.65g/cm3
Melting Point Temperature	1710oC
Boiling Point Temperature	2230oC
Molar Mass	60.08g/mol

METHODOLOGY:

STEP 1: SELECTION OF MATRIX MATERIAL:

Aluminium 6061 alloy is taken as matrix material.

STEP 2: SELECTION OF REINFORCEMENT:

Silicon dioxide (SiO2) & Titanium Dioxide (TiO2) are taken as reinforcement material.

STEP 3: STIR CASTING METHOD

Stir casting is an economical process for the fabrication of aluminum matrix composites. There are many parameters in this process, which affect the final microstructure and mechanical properties of the composites. In this study, micron-sized SiC particles were used as reinforcement to fabricate Al-3 wt% SiC composites at two casting temperatures 680 and 850°C and stirring periods 2 to 6 min. The higher stirring temperature 850 °C also leads to improved ceramic incorporation. In some cases, shrinkage porosity and intensive formation of Al4C3 at the metal/ceramic interface are also observed. Finally, the mechanical properties of the composites were evaluated, and their relation with the corresponding microstructure and processing parameters of the composites was discussed. Stir casting is a type of casting process in which a mechanical stirrer is introduced to form vortex to mix reinforcement in the matrix material.

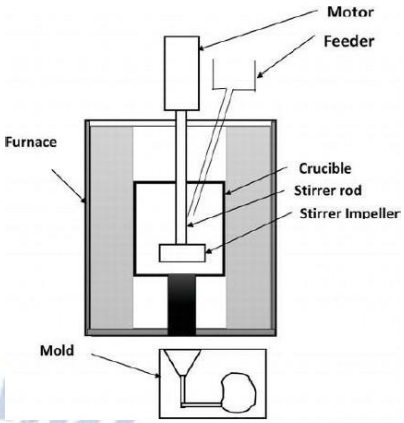

Fig. No : 3.1 Stir casting method

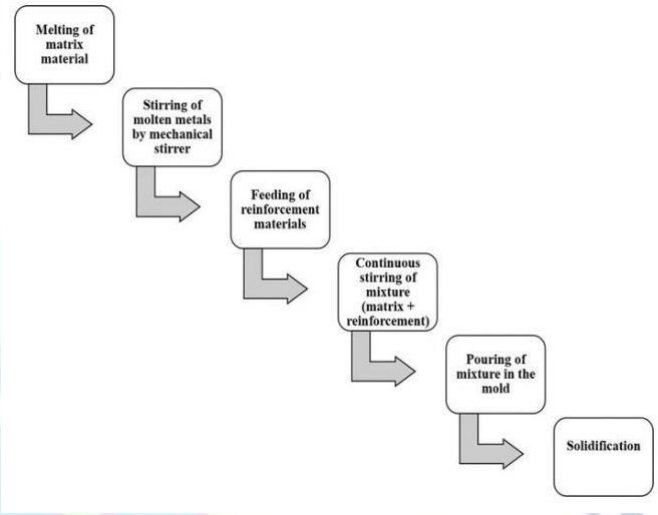

Fig.3.2. Steps in stir casting method

STEP 3: WEAR PERFORMANCE TEST

Grinding and wear (normally wear rates and wear obstruction) portrayal of materials is normally performed utilizing different sorts of tribometers, while nail to circle test being likely quite possibly the most normal. The pin-on-circle tribometer, appeared in Figure, comprises of a level, pin, or circle which is joined to a firm flexible arm that is weighted down onto a covered test with a correctly known weight. The example is turned at a chose speed. The flexible arm guarantees an almost fixed contact point and a steady situation in the grating track shaped by the pin on the test. Figure shows the track and wear trash on a test plaque. With this machine one can handle test boundaries, for example, speed, contact pressure (consequently PV), and time. With the privilege ecological chamber one can likewise control and

measure the impact of mugginess, temperature, and barometrical piece. The pin-on-circle estimation is generally done per ASTM G99-05 Standard Test Method for Wear Testing with a Pin-on-Disk Apparatus

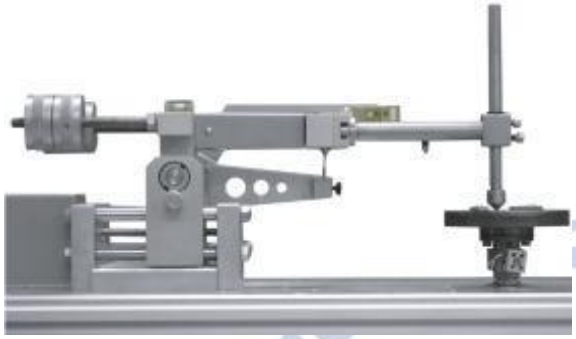

Fig.3.3. Wear performance test

COMPOSITION:

Table.3.5. Composition

FACTORS/LEVELS	1	2	3
Wt% of TiO2	0	1.5	3
Wt% of SiO2	0	1.5	3

SAMPLE COMPOSITION

Fig.3.4. Sample composition

FABRICATIONOF TESTING HYBRID COMPOSITE BASEDMATERIAL

Creation of the testing half breed based composite material was completes by receiving the accompanying Stir Casting Process. At first shifting sort heater is utilized to soften Aluminum 6061 composite at 850OC. All the while, fortifications (SiO2 and TiO2) are preheated in a Box type heater at1000OC temperature to eliminate dampness, pollutions and so forth Both Preheated SiO2 and TiO2 powder are blended in the liquid aluminum compound on shifting type heater. the vortex which drives the blending of the support (SiO2 and TiO2) material which are presented in the soften. After the nonstop mixing of combination, the grid and support blend are pouring in the shape. Accordingly, took into consideration settlingseason of around 30 min – 3 hours, at that point form was delivered. At that point the aluminum-based half and half composite material is created.

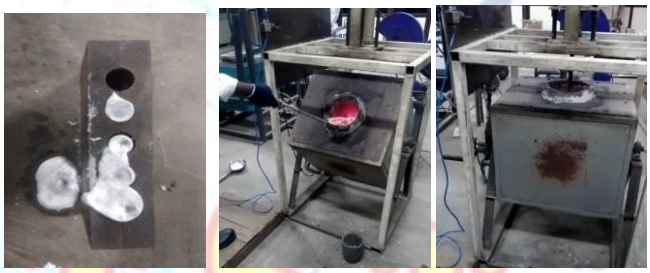

Fig.3.5. Fabrication of Hybrid composite material

4. TESTING AND RESULT.

SPECIMENT PREPRATION:

Aluminium based Hybrid composite material is prepared as per the required dimensions and it is prepared at different combinations.

PIN ON DISC TEST:

PURE ALUMINIUM 100%:

Before test	After test
5.57198	5.56841
5.52832	5.52235
5.49262	5.48596

Table 4.1 Pure aluminium.

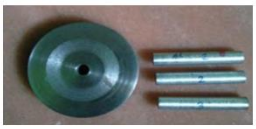

Fig. 4.1 Pure aluminium

ALUMINIUM WITH(SiO2+TiO2) 3%:

Before test	After test
5.98882	5.98689
5.79812	5.79418
5.59853	5.59477

Table 4.2. Aluminium with (SiO2+TiO2) 3 %

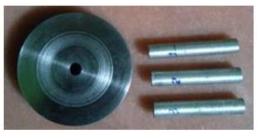

Fig. 4.2 Aluminium with (SiO2+TiO2) 3 %

ALUMINIUM WITH(SiO2+TiO2) 6%:

Before test	After test
5.32983	5.32726
5.81417	5.81049
5.91492	5.91402

Table 4.3. Aluminium with (SiO2+TiO2) 6 %

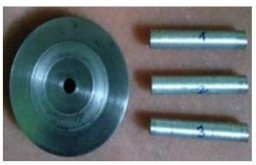

Fig. 4.3. Aluminium with (SiO2+TiO2) 6 %

TEST WEAR PERFORMANE OF COMPOSITE MATERIAL

Arranged composite material is fixed in the Pin on plate machine prior to fixing the material, compute the heaviness of the material. Composite material is pivoted at the chose speed. The versatile arm guarantees an almost fixed contact point and a steady situation in the grating track shaped by the pin on the example. The motor erosion coefficient is resolved during the test by estimating the avoidance of the versatile arm, or by direct estimation of the adjustment in force by a sensor situated at the rotate place of the arm. Wear rates for the pin and the plate are determined from the volume or weight of material eliminated during the test.

S.No.	Material	Load kg	Time Sec	Initialwt in gm	Finalwt in gm	Speed rpm	Volume mm3	Wearrate mm2/kg	Wear coefficient
1.	Al	1	480	5.571	5.56	673	1.332	1.420 *10-6	4.5676
2	Al+(SiO_2+TiO_2) 3%	1	480	5.5989	5.598	673	0.2015	2.165 *10-7	0.696
3.	Al+(SiO_2+TiO_2) 6%	1	480	5.3298	5.3272	673	0.2682	2.88 *10-7	0.9265
4.	Al	2	480	5.528	5.522	673	2.211	1.187 *10-6	3.819
5.	Al+(SiO_2+TiO_2) 3%	2	480	5.7981	5.794	673	0.4112	2.2091 *10-7	0.1102
6.	Al+ (SiO_2+TiO_2) 6%	2	480	5.8141	5.8104	673	0.3841	2.063 *10-7	0.6634
7.	Al	3	480	5.492	5.485	673	2..4667	8.8349 *10-7	2.8404
8.	Al+(SiO_2+TiO_2) 3%	3	480	5.5985	5.5947	673	0.3817	1.3671 *10-7	0.4395
9.	Al+(SiO_2+TiO_2) 6%	3	480	5.9149	5.9140	673	0.0939	3.3632 *10-8	0.1081

Table 4.4 WEAR PROPERTIES OF Al+(TiO_2+SiO_2) 6% at Weight 3kg.

5.RESULT

Case 1: Wear performance or pure Aluminum

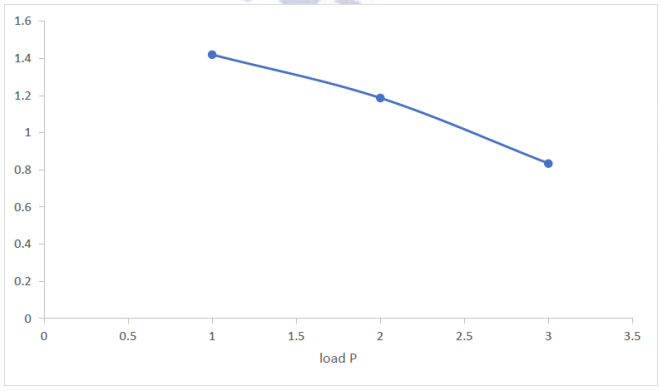

Fig. 5.1: Wear performance or pure Aluminum

Case 2 : Wear performance or pure Aluminum and 3% of SiO_2 and TiO_2

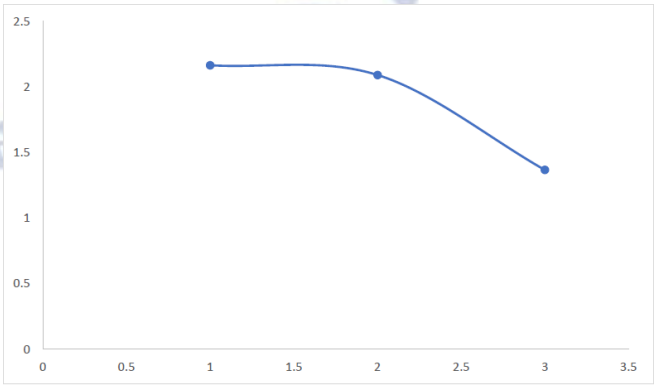

Fig.No. 5.2: Wear performance or pure Aluminum and 3% of SiO_2 and TiO_2

Case 3: Wear performance or pure Aluminum and 6% of SiO2 and TiO2

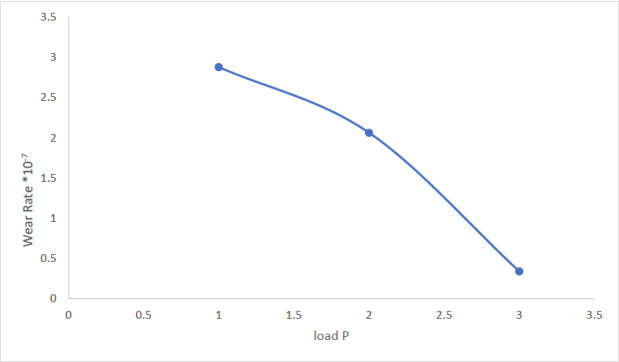

Fig.No. 5.3: Wear performance or pure Aluminum and 6% of SiO2 and TiO2

6.CONCLUSION

This project is used to calculate the wear performance of Al6061. Three casting is done with Al6061 by adding Tio2 and SiO2 with different wt%. By using pin on disk, wear rate is calculated by Al6061, Tio2 and SiO2 0%,3%,6%). The wear rate of the following casting is given below.

Case 1: (Pure aluminium) 100% pure Al6061 is wear tested by using pin on disk machine. Before testing, the weight of the pure Al6061 is 5.57198, 5.52832, 5.49862. After tested, the weight of the pure Al6061 is 5.56841, 5.52235, 5.48596. Wear rate is calculated by using these weights. The wear rates are 0.4207*10-6mm²/kg, 0.22091*10-6mm²/kg, 0.88349*10-6 mm²/kg.

Case 2: (97% Al6061 + 1.5% Tio2 + 1.5% SiO2 97%) pure Al6061 is wear tested by using pin on disk machine. Before testing, the weight of the pure Al6061 is 5.98882, 5.79812, 5.59853. After tested, the weight of the pure Al6061 is 5.98689, 5.79418, 5.59477. Wear rate is calculated by using these weights. The wear rates are 0.2165*10-6mm²/kg, 0.22091*10- 6mm²/kg, 0.13671*10-6mm²/kg.

Case 3: (94% Al6061 + 3% Tio2 + 3% Sio2) 94% pure Al6061 is wear tested by using pin on disk machine. Before testing, the weight of the pure Al6061 is 5.32983, 5.81417, 5.91492. After tested, the weight of the pure Al6061 is 5.32726, 5.81049, 5.91402. Wear rate is calculated by using these weights. The wear rates are 0.2881*10-6mm²/kg, 0.2063*10- 6mm²/kg, 0.033632*10-6mm²/kg. Frome above cases, wear rate is highly reduced in case 3: 94% Al6061 + 3% Tio2 + 3% Sio2.

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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