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A Study on Tribological Behaviour of Aluminium Based Nanocomosite

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ABSTRACT

In this project a study has been attempted to find the mechanical properties and triboloigcal behavior of the aluminium based nano composite materials. A comparison of the Aluminium (Al) and Copper oxide ($CuO_{3)}$) has been done to find the suitability of material for aerospace and automobiles industries. The reinforcing of the materials were studied by comparing on Aluminium (Al) and Copper oxide ($CuyO_{3)}$ in which ratio propositional were taken has 1, 1.5, 2.5 and test were conducted .Composites are fabricated through 'Stir Casting Method'. Depending on the need of properties reinforcement can be done to find a suitable combination of materials various for particular application.

This has resulted in a vast research and study for Mechanical properties of the samples are measured by usual methods such as Hardness, Tensile .The tested samples are examined using Scanning Electron microscope (SEM) for the characterization of microstructure on the surface of composites. Based on the mechanical properties the wear resistance test were performed on the sample using pin on disk method and the result obtained were tabulated.Nanocomposite involves control of feature of grain size of both matrix and reinforcement to be measured in nanometers (109m).Fine grain sizes

INTRODUCTION

Concrete and Material Company" in Jackson, Mississippi, formed by the company now known as "Dunn Investment Company" located in Birmingham. In1932 .1961 name changed to "Mississippi Materials Company" under President Ellis Hoff pauir. The field of Ai/SiC whisker composites began in the mid-1960s with the realization that whiskers or discontinuous fiber reinforcements can be competitive with continuous fibre reinforced material from the stand point of mechanical properties. [1]

In1981. Thereafter, began study on the machinability ofAl/SiC/Grp composites for their potential industrial application. Since then a good number of researches are being made to machine Aluminum metal matrix composite using various machining process in the practical material machining field. [2]

In 2012 V. N. Gaitonde1, S. R. Karnik, M. S. Jayaprakash was conducted on theSome Studies on Wear and Corrosion Properties of Al/Al2O3/Graphite Hybrid Composites an at- tempt has been made in the proposed work to study the effects of Graphite (Gr) and Aluminium oxide (Al2O3) on alu-minum hybrid composites involving both hard and soft reinforcements on wear and corrosion properties.The experimental results on Al5083-Al2O3-Gr hybrid composites revealed that the addition of reinforcement improves the hardness and reduces corrosion and wear rates.[3]

In 2012 Gheorghe IACOB, Gabriela POPESCU, Florin MICULESCU, Mihai, BUZATU production of Al/Al2O3/Gr powder composites using mechanical alloying the resulting products have low mechanical properties due to the structural un homogeneity of the obtained material. Aluminum, alumina and graphite elemental powders have been mechanically alloy. Powder mixtureswere mill for two hours Experiments

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indicate that this method is appropriate for obtaining composites with better homogeneity.[4]

Cast metal matrix particulates composites (CMMPCs) are attractive because it is easy to fabricate the engineering components at competitive price. LM 4 alloy is attractive where abrasion and wear rate is prime important, but still better control on properties is achieved after longer duration of heat treatment. In order to have better performance during applications, addition of copper oxide and Aluminum Oxide has been evaluated. In the areas of CMMPCs reaction between molten aluminum and metal oxides such as TiO2 (1), 2SiO2 (2), B2O3 (3), Fe2O3 (4) have been reported. The present work is intended to investigate the microstructure and mechanical properties of cast composite obtained by dispersing different amount of Copper Oxide and Al_2O_3 into the molten LM 4 metal. Sequence of addition of magnesium metal and oxide particles is important to control the mechanical properties and microstructure of the resulting composite. Studies on the synthesis and characterization of nano-scale alumina dispersed copper metal matrix composites have been attracting scientific interest in recent years, since nanostructure-type materials are expected to have special physical and mechanical properties. In the copper–alumina system, the nano-scale Al2O3particulate dispersion can provide unique characteristics, such as high thermal and electrical conductivities, as well as high strength and excellent resistance to high temperature annealing. Therefore, Cu-based metal matrix composites are being used in many industrial applications such as: contact supports, frictional break parts,electrode materials for lead wires, spot welding[5].

The main requirement for structure of these materials is a homogenous distribution and small size of oxide particles on copper matrix[6,7].Many manufacturing processes have been used for producingsuch composites. In general most metal matrix composites are produced by squeeze or stir casting, spray forming or by powder metallurgy techniques.

In these methods the reinforcements are incorporated ore added into the matrix by ex situ methods. The reinforcement particulates are usually coarse and rarely below. They tend to agglomerate together leading to non-homogenous distribution and poor wettability of reinforcement oxides,which badly influences the mechanical and electrical propertiesof obtained composites.. A few trials such as mechanical alloying or rapid solidification have been tried to overcome the agglomeration of reinforcements and obtain dispersed nanoparticles, buthave often shown a contamination and poor economicalefficiency[8–10]. Secondary processes such as extrusion and other forming techniques were also used to overcome these drawbacks but they have often showed limited success, homogenous reinforcement and strong bonding of reinforcements with matrix will certainly improve mechanical properties. The in situ method in which the reinforcements are created by chemical reactions during composite fabrication has beenemployed in this study. Mechanochemical milling has been used to eliminate agglomeration of reinforcements and obtain dispersed nanoparticles[11]. However the mechanisms responsible for the in situ formation of reinforcement phases in some reaction systems are not well understood[12–14].

The in situ chemical process has several advantages over the abovementioned methods, such as more homogenous reinforcement, excellent surface bonding, pureinter-phase, and appears to be a suitable method for preparingCu–Al2O3 nanocomposite[15–18]

In the present work, Cu–Al2O3nano-scale composites have been prepared using MechanoChemaical Process and the same has been dispersed Using Stir Casting Techniques.

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Aluminium alloy in the furnace. Again reheating of the aluminum matrix composite is done until it reaches complete liquid state. Mean while argon gas is introduced into the furnace through a provision in it for few minutes. During this reheating process stirring is done by means of a mechanical stirrer which rotates at a speed of 150 rpm. The aluminium composite material reaches completely liquid state at the temperature of about 800°C as the melting point of aluminium is 700ºC.

3. METHODOLOGY:

The conventional experimental setup of stir casting essentially consists of an electric furnace and a mechanical stirrer. The electric furnace carries a crucible of capacity 2.5kg. The maximum operating temperature of the furnace is 1000ºC. The current rating of furnace is single phase 230V AC, 50Hz. The aluminium alloy (LM4) is made in the form of fine scraps using shaping machine. It amounts to about 2.25 kg. The metal scraps are poured into the furnace and heated to a temperature just above its liquidus temperature to make it in the form of semi liquid state (around 600ºC). The mixing of aluminium alloy is done manually for uniformity. Then the reinforcement powder that is preheated to a temperature of 500°C is added to semi liquid aluminium alloy in the furnace. Again reheating of the aluminum matrix composite is done until it reaches complete liquid state. Mean while argon gas is introduced into the furnace through a provision in it for few minutes. During this reheating process stirring is done by means of a mechanical stirrer which rotates at a speed of 150 rpm. The aluminium composite material reaches completely liquid state at the temperature of about 800°C as the melting point of aluminium is 700ºC. Thus the completely melted aluminium metal matrix composite is poured into the permanent moulds and subjected to compaction to produce the required specimen

3.2.1. HARDNESS TEST

Type of Test	Sample ID	Observed Value
Vickers Hardness Test	Sample B	(46.6 to 48.1)HV
	Sample C	(63.9 to 66.0) HV
	Sample D	(55.2 to 58.8) HV
	Sample E	(78.4 to 80.7) HV

Table 1-Result of Hardness Test

3.2. TENSILE TEST

The specimens are prepared according to ASTM E8 Standards. The gauge is 24 mm long and having diameter of 6 mm. The total length of the specimen is 80 mm. The equipment used to test tensile strength is Universal Testing Machine (UTM).

Sample Identification	Observed Value		
	Tensile Strength (N/mm²)	Yield Strength (N/mm²)	Elongation (%)
Sample B	245	212	26
Sample C	265	242	25
Sample D	202	150	33
Sample E	214	159	33

Table -Result of Tensile Test

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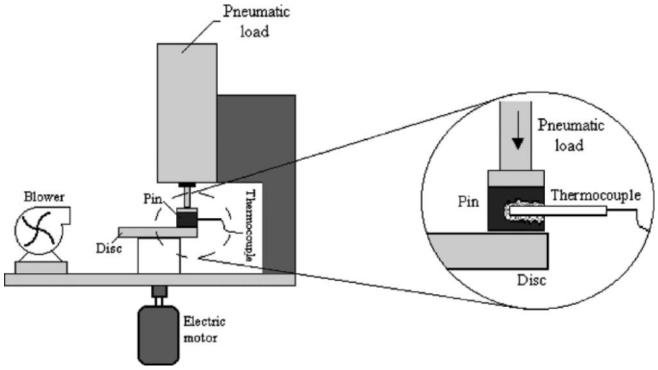
PIN ON DISC MACHINE



The wear tests were carried out in a pin-on-disc wear-testing machine and the friction force and wear of the GI250 given in table 1 under various pressures. Figure shows the friction force at various pressures, from that figure clearly shows the friction force at high pressure.

WEAR TEST

Type of Test	Sample ID	Observed Value
Wear Test Pin on disc	Sample B	0.0046mm3/m
	Sample C	0.0037 mm3/m
	Sample D	0.0039mm3/m
	Sample E	0.00416mm3/m

Table -Result of Wear Test

4. CONCLUSION

The present study deals with tribological behaviour of the aluminium alloy based composites, reinforced with silicon carbide particles and solid lubricants such as graphite/(PPS). The first one of the composites consists of Al. with Silicon Carbide particles (SiCp) and graphite.

The composites are fabricated through ‘Stir Casting Method’. Mechanical properties of the samples are measured by usual methods such as Hardness , Tensile .Tribological properties are measured through pin on disc method. The Main Aim is to be results of the proposed Hybrid composites to find its suitability in a wear resistant condition.

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