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A REVIEW ON WEAR BEHAVIOUR OF Al-FLY ASH-WC-Mg HYBRID NANO COMPOSITE MATERIAL

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***Abstract* - A Progressive Research Is Carried Out On Aluminium Alloys With Different Nano Particulate Reinforcements With Various Weight Percentages Of Fly Ash, Magnesium (Mg), Tungsten Carbide (Wc). Because Of Low Cost And Less Weight, The Hybrid Composite Maerial Al-Fly Ash-Wc-Mg Is Used For Weight Reduction Of Automobile And Aircraft Parts. This Paper Present The Results Of Intensive Review On The Researches Carried Out On Nano Composites.The Intensive Review Observes That The Nano Size Of Fly Ash And Other Particles Were Prepared By Ball Milling Methods. Samples Of Aluminium Alloy To Be Tested Are Made Using Stir Casting Techniques. Sufficient Quantity Of Mg Addition Increases The Wettability And Formability Of The Base Metal. The Particle Size And Crystal Structure Was Observed By Means Of Sem (Scanning Electron Microscope), Afm (Atomic Force Microscope) And X-Ray Diffractometer. Improved Properties Such As Tensile, Compressive, Wear And Hardness Were Identified In These Composites.**

KEYWORDS - Nano composites, Ball milling, Stir Casting method, Fly Ash,Tungsten Caride

NOMENCLATURE

ΔV - Volume loss in the wear Test

L - Load Applied in the wear Test

D – Distance of Travel.

(S/N) - Signal to noise ratio

y- Wear rate

n- Number of trials

I. INTRODUCTION

In earlier years before the invention of composites, weight was the major criteria in which most of the industries and earth moving vehicles suffered a lot because of handling and consumption of fuel. This problem was overcome by the introduction of composites in the late 1940's which replaced huge amounts of Iron and Steel parts used in industries, navy and other mobile vehicles. The composites are used mainly for it's high strength to weight ratio and resistance to corrosion and so on. Major types of composites are Ceramic matrix, Metal matrix, Polymer matrix etc. Apart from other types of composites, large developments have taken place in developing new Metal Matrix Composites (MMC's) which are used for a variety of purposes. This paper deals with the researches on Aluminium metal Matrix Composites (AMC's) reinforced with Fly Ash, WC, Mg particulates. These AMC's are used for it's low density, good wear resistance, good tensile strength, and good surface finish as observed by Kumar et al (2014). Srikanth et al (2015) has investigated the Aluminium Alloy of Grade Al6061 as a base metal reinforced with WC and Fly Ash. Babu Rao et al, (2010) reported that fly Ash is the most inexpensive, low density reinforcement received as waste from thermal power plants and hence it can be used advantageously. The specimen preparation is carried out by Stir Casting method which was the most common and cheapest means of manufacturing.

II. EXPERIMENTAL PROCEDURE

A.*MATERIALS USED*

The following are the materials used as the reinforcement in the composite materials with the base alloy Al6061.

1.*FLY ASH*

Fly Ash is the most cheapest material which was available in bulk quantity as industrial waste from thermal power plants. It is mainly used for it's low density, high electrical resistance and low thermal conductivity.

2.TUNGSTEN CARBIDE

Tungsten carbide (WC) is one of the hardest material used mainly for abrasives and cutting operations. It is mainly used for it's high toughness, hardness and strength.

3.MAGNESIUM

Magnesium (Mg) is used as wetting agent and substance for formability with the base metal. It is added from 1 to 10% with aluminium metal matrix composites.

B.*SPECIMEN PREPARATION*

Srikanth et al, (2015), had performed fabrication using Stir Casting method. First step in the process is melting the Al 6061 alloy in the crucible at 600^0C-850^0C. A stirrer rotating at (500-600) rpm is dipped inside the crucible furnace. Preheated reinforcement particles like WC, Fly Ash and Mg of calculated percentages is added slowly into the crucible containing melt. Mechanical stirring action was carried about for (10-15) minutes. Then the molten metal is solidified and casting is removed from the mould. Then, specimens are prepared with simple machining process to carryout various testing as per the ASTM standards.

III. MICROSTRUCTURAL BEHAVIOUR

Srikanth and Amarnath, (2015), have observed the microstructure of the composites by means of SEM (Scanning Electron Microscope) to study the distribution pattern of WC and Fly Ash content in the composite reinforcement. The micrographs of specimens are shown in Fig.1, Fig.2 and Fig.3.

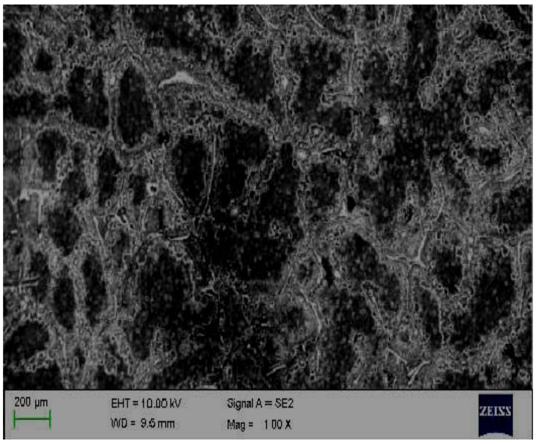

Figure 1. SEM micrograph of Al6061+WC1%+fly ash2%.

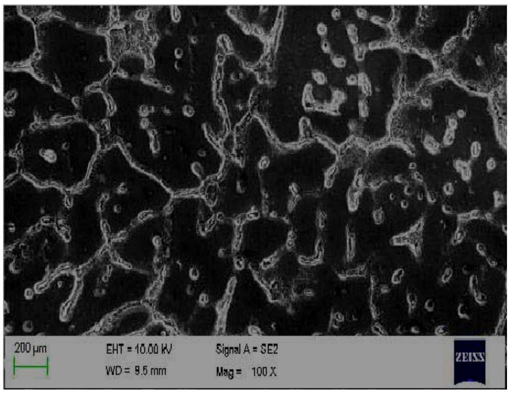

Figure 2. SEM micrograph of Al6061+WC2%+fly ash2%.

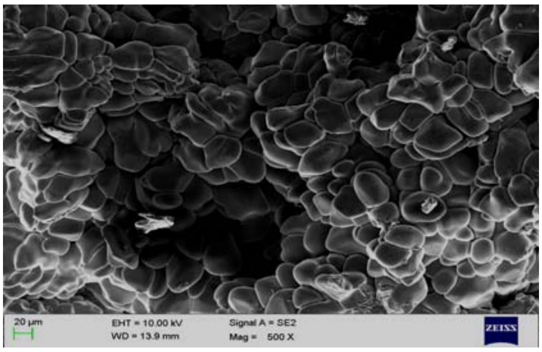

Figure 3. SEM micrograph of tensile fractured surface of Al6061+WC 2%+fly ash 4%.

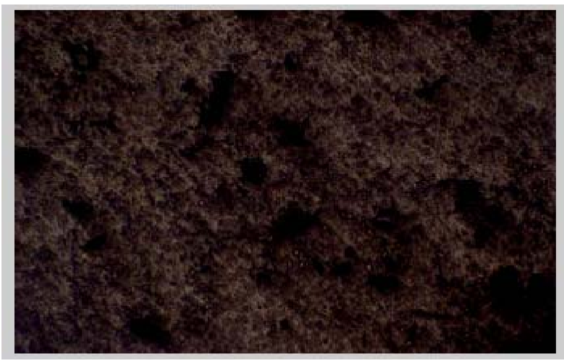

Figure 4. Optical micrograph of Al- 5% Fly Ash

Babu Rao et al, (2010), have reported the microstructure of Al- Fly Ash composites at (5, 10, 15) % respectively. Using Optical Microscopy the microstructure analysis and structural characterization of composite is observed. The microstructural graph of specimens are shown in Fig.4, Fig.5 and Fig.6.

Figure 5. Optical micrograph of Al-10% Fly Ash

Figure .6. Optical micrograph of Al- 15% Fly Ash

IV. MECHANICAL BEHAVIOR

A.*WEAR TEST*

Figure 7. Pin- On- Disc apparatus

The sliding wear behavior of the specimen is studied using Pin- on- Disc apparatus. Pin- on- Disc apparatus is shown in fig.7,

Kumar et al, (2014), has investigated the wear test on the sample size of specimen as ø10*35mm. The surface to be tested is well polished using different grades of abrasive paper, and made contact with the steal disc. Acetone is used as the cleaning agent to clean the specimen. Wear test is conducted for various speed ranges of (1000, 1500, 2000) for a constant load of 30N. Then the sliding wear loss of the specimen is measured.

The wear loss is given by the relation,

$$\textbf{Specific wear rate} = \Delta V/(L*D)$$

Where ΔV is the Volume loss, L is the Load and D is the Distance.

Another investigation was done by Prasad et al, (2013) on wear test, using computerized Pin- on- Disc apparatus. The specimen size ø 6mm and 30mm long is prepared with different weight percentages of Fly Ash with Al. A load of 9.81N is applied on the specimen at a speed of 500 rpm with track radius 40mm. The experiment is conducted by means of signal to noise ratio (S/N). the S/N ratio of loss function is given by the relation,

$$S/N = -10 \log [1/n (\Sigma y2)]$$

where y is the wear rate and n is the number of trials.

Shivaprakash et al, (2013), has conducted wear test on the specimen size of 8mm diameter and 27mm length. The experiment is conducted for various ranges of loads (10, 25, 35) N and speeds of (200, 300, 400) rpm on 8 different specimens at the rate of 6 hours for each wear test. It was found that upto 15% of Fly Ash content, the wear increases and afterwards it decreases with increase in Fly Ash contents.

B.*HARDNESS TEST*

The hardness test of specimen is generally carried out in Rockwell hardness testing machine or Vickers Hardness Tester.

Kumar et al, (2014), had tested the specimen using Vickers Hardness tester at about 2 or 3 locations in the specimen. He observed that the hardness value found to be of maximum for 20% of Fly Ash content present as reinforcement in the composite.

Babu Rao et al, (2010), had investigated the specimen using Rockwell Hardness Testing Machine.The load of 100kg is applied on the specimen with a ball intender of 5mm diameter. He reported that there is increase in hardness of specimen with the increase of amount of Fly Ash contents in the specimen.

Arun kumar and Swamy, (2011), have observed that the hardness of specimen was measured for the effect of Fly Ash in the composites. The specimens where tested using Vickers hardness testing machine at a load of 1N. Hardness test was conducted at 3 locations on the specimen and an average value is taken.

Prasad and Ramachandra, (2013), have reported that the hardness test was conducted using Brinell Hardness tester. About 500kgs of load with a steel ball intender of 10mm diameter is applied on the specimen. The test was carried out at 4 different locations and the average reading is taken. It was found that maximum hardness value depends on maximum % of Fly Ash present as the reinforcement in the specimen.

C.*TENSILE TEST*

Tensile test of specimen was usually performed using UTM (Universal testing machine).

Subrahmanyam et al , (2015), have investigated the tensile strength of the specimen for a three different proportions of Al, Fly Ash samples. It was found that the tensile strength tends to improve at 10% of the Fly Ash content in the composite.

Srikanth and Amarnath, (2015), have observed that the tensile strength increases with increase in weight percentages of Fly Ash and WC. The tensile test is conducted on 10 different samples and the graphs is presented in Fig.8 and Fig.9.

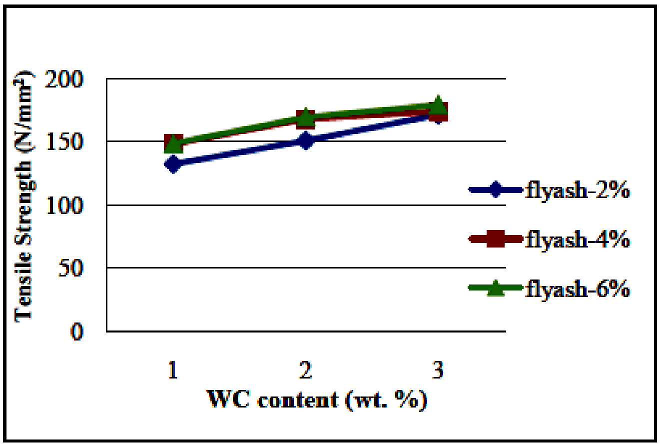

Figure 8. Graph of tensile strength Vs WC with varying Fly Ash content

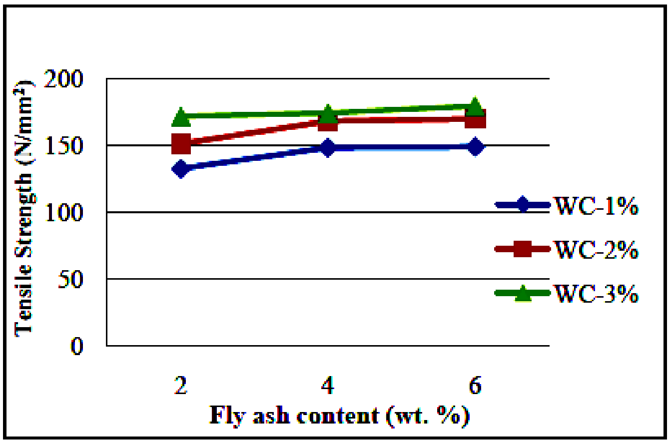

Figure 9. Graph of tensile strength Vs Fly Ash with varying WC content

Arun kumar and Swamy, (2011), have reported that the UTS (Ultimate tensile strength) improves with increase in Fly Ash content in the matrix of the composites. In this way increased % of Fly Ash into the Al6061 alloy increases the yield strength of the composites. A good bonding between the grains of the composite aided by the fly ash favours the strengthening of tensile strength.

D.*COMPRESSION TEST*

Compression test are usually carried out in UTM (Universal testing machine)

Babu rao et al, (2010), have investigated the compression test on Al, Fly Ash composites (5, 10 and 15% of Fly Ash) of a ø 16mm cylindrical specimen. By varying the load on the specimen, compressive strength of 3 different specimens are calculated. Thus increase in compressive strength is due to the increase in reinforcement particles Fly Ash .

Arun kumar and Swamy, (2011), have reported that the composite containing Fly Ash of (2, 4, 6)% is tested using UTM for varying loads. It was found that the compressive strength increases with increase in density of the composite. Stir casting method of fabrication also accounts for increasing compressive behavior.

V. CONCLUSION

Based on the studies made above, the following conclusions are made:

- ✓ Stir casting is used commonly to fabricate the Aluminium Matrix composite material.
- ✓ It was found that upto 15% of Fly Ash content, the composite is found to have increased wear strength and afterwards, itdecreases with the increase of % of Fly Ash in the composite.
- ✓ The microstructural characterization of the composites by means of SEM and Optical Microscopy helps to identify the particle distribution of the reinforcement and base metal Al6061.
- ✓ It was observed that the Fly Ash content upto the maximum of 20% can be added to provides maximum hardness to the material.
- ✓ Equal percentages of WC and Fly Ash content improves the tensile strength of the composites.
- ✓ It was clear that the increase in density of the composite material increases the compressive strength of the material.

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