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Review on Al-WC, Carbon Black Hybrid Nano-Composites

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ABSTRACT:Al have a wide variety of applications which can be applied to aerospace, automobiles,shipping etc.The hybrid nano composite made using Al-WC-Carbon black has a great advantage which can be advangeously used in engineering applications. This paper presents the results of the extensive review carried out on the researches carriedout worldwide on Al-WC-Carbon black hybrid nano composites. The extensive review illustrates that hybrid nano composites are prepared using Stir castings method in the proportions of WC (1% , 2% , 3%) carbon black (2% , 4% , 6%) at a very high temperature. Next, the component is machined properly and they are analysed using SEM, AFM and XRD. Then, various mechanical properties are analysed through tensile test, compressive test, hardness test, wear test and the experimental results were discussed and presented in this paper.

KEYWORDS: Nano composites, Liquid metallurgy, Mechanical properties,Stir castings

NOMENCLATURE

Al-Aluminium
WC-Tungsten Carbide
La- Size of Aromatic
XRD-X-Ray Diffraction

I. INTRODUCTION

A composite material is a material composed of two or more constituents. The constituents are combined at a microscopic level and are not soluble in each other.

Generally, a composite material is composed of reinforcement (fibers, particles/ particulates, flakes, and/or fillers) embedded in a matrix (metals, polymers). This paper focus mainly on review of the nano composite consists of base material aluminium with that tungsten carbide and carbon black powder are added as the reinforcements.The extensive review observe that this composite is prepared using stir casting method.Then its various mechanical properties were studied using various tests.

II. MATERIALS USED

The followings are the materials used in the reinforcement of the composite materials with the base alloy Al6061,

TUNGSTEN CARBIDE

Tungsten carbide (chemical formula: WC) is a chemical compound (specifically, a carbide) containing equal parts of tungsten and carbon atoms

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CARBON BLACK

Carbon black (subtypes are acetylene black, channel black, furnace black, lamp black and thermal black) is a material produced by the incomplete combustion of heavy petroleum products such as FCC tar, coal tar, ethylene cracking tar, and a small amount from vegetable oil.

SPECIMEN PREPARATION

First step in the process is melting the Al 6061 alloy in the crucible at 600⁰C-850⁰C. A stirrer rotating at (500-600) rpm is dipped inside the crucible furnace. Preheated reinforcement particles like Al-WC-Carbon black in calculated percentages is added slowly into the crucible containing melt. Mechanical stirring action was carried about (10-15) minutes and is removed from the setup. Then the molten metal is solidified and casting is removed from the mould. The specimen is prepared for simple machining to undergo various testing as per the ASTM standards.

MECHANICAL CHARACTERISTICS

The results of the several investigations regarding the Al-WC and carbon black are as follows

1.Hardness

Kenneth Kanayo Alanemea and Kazeem Oladiti Sanusia(2015) observed that there is a general decrease in hardness with increase in the weight ratio of RHA in the composites. This is reflected by the decrease in hardness from the A to E series in the Figure which have been used as designations for increasing weight ratio of RHA. It is also observed that for each composite series (A, B, C, D and series) the hardness of the composites decreases with increase in the graphite content of the composites (that is from A0 to A3, B0 to B3, C0 to C3, D0 to D3, and E0 to E3). The reduction in hardness with increase in RHA and graphite content is as a result of the lower hardness possessed by both reinforcing materials compared to alumina .

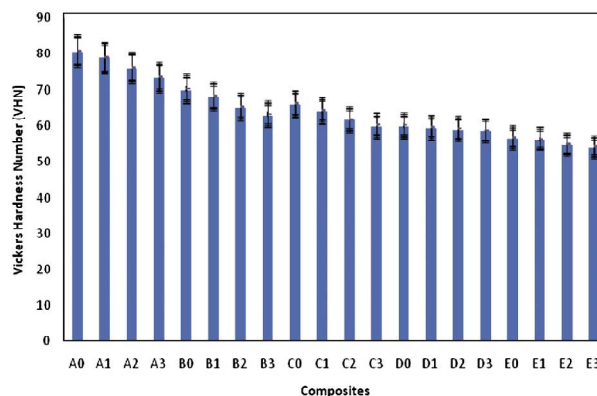


Figure 1: Variation of hardness value of the composites

2.Wear

D.Felhos et al (2007)reported that that the Friction and wear characteristics were determined in POP configuration using a steel pin with a hemispherical tip of 10mm diameter.

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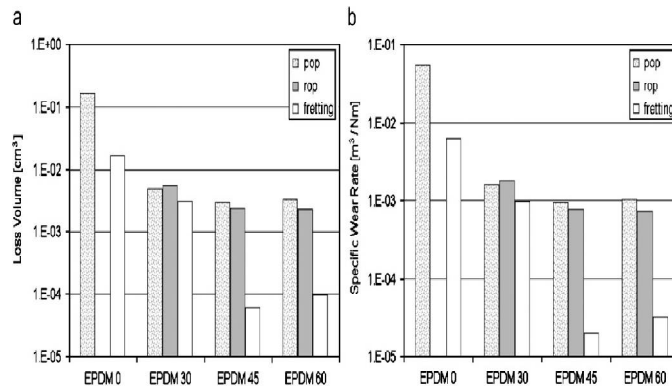


Figure 2: Comparison of the loss volume (a) and specific wear rate (ws) (b), measured in different test rigs, for the EPDM rubbers studied.

This pin rotated along a circular path (diameter: 33 mm) in the applied Wazau tribometer. The results are given in the graph. The worn surfaces of the specimens were inspected in a scanning electron microscope (SEM; JSM6300 of JEOL, Tokyo, Japan). Prior to SEM investigation, the specimens were sputtered with an Au/Pd alloy using a device of Balzers (Lichtenstein). (Berlin Germany). the wear rates of all

3. Tensile Properties

Hiroshi sato et al (1998) found out the tensile strength of coke was studied to obtain a better understanding of coke strength and its relation to coal properties. The tensile strength was examined by considering coke as a porous material with two influential factors, namely, the matrix strength and the porous structure, which were estimated from the measured tensile strength and porosity. The coke carbon matrix was evaluated in the light of the structure of the coke carbon estimated using X-ray diffraction on the basis of the concept of graphitic and non-graphitic carbon. It was found that the coke matrix strength becomes stronger as the coke carbon structure approaches that of non-graphitic carbon.

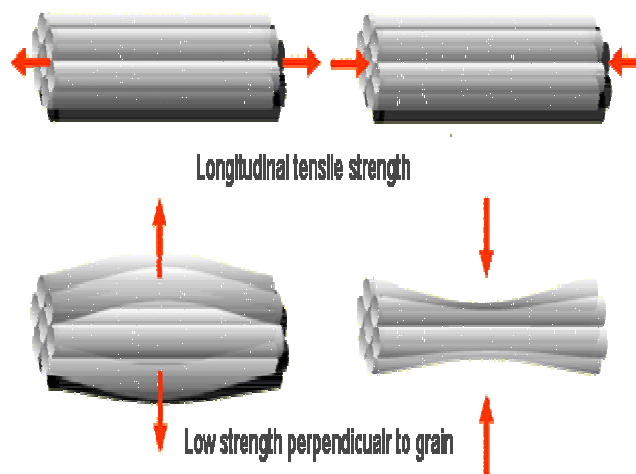


Figure 3: Tensile test specimens,

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4. Compressive Properties



Figure 4 : Compressive test specimen

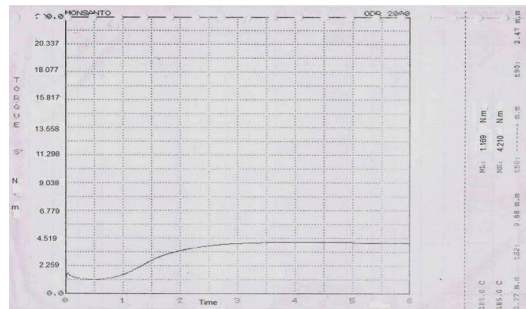


Figure 5: Rheograph for blend with N375

Dr. Mohsin noori hamzah (2013) had studied the effect of Carbon black. He experimented on the test specimen as shown in figure 4 in which the device used in the test consists of a force application spring and two parallel compression plates assembled by means of a frame or threaded bolt in such a manner that the device shall be portable and self-contained after the force has been applied and that the parallelism of the plates shall be maintained. The force may be applied in accordance with the calibrated spring force application. The required force shall be applied by a screw mechanism for compressing a calibrated spring the proper amount. The spring should be of properly heat-treated spring steel with ends ground and perpendicular to the longitudinal axis of the spring. The spring should be calibrated at iron box with temperature $23 \pm 5^\circ\text{C}$. He has drawn the Rheograph which is shown in figure 5.

5. SEM Test

Hari prasada rao et al (2013) reported that in SEM test tungsten carbide possessed good retention characteristics. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. Good retention of tungsten carbide particles was clearly seen in the microstructures of Al/WC composites.

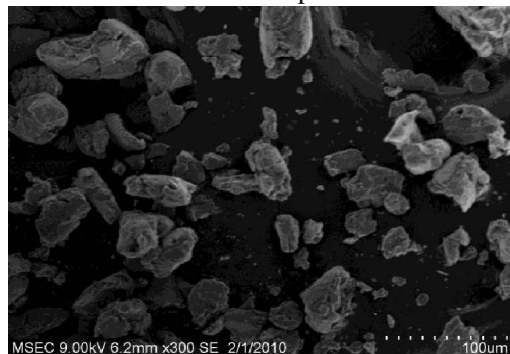


Figure 6: Sem Image For 10% Tungsten Carbide With Aluminum

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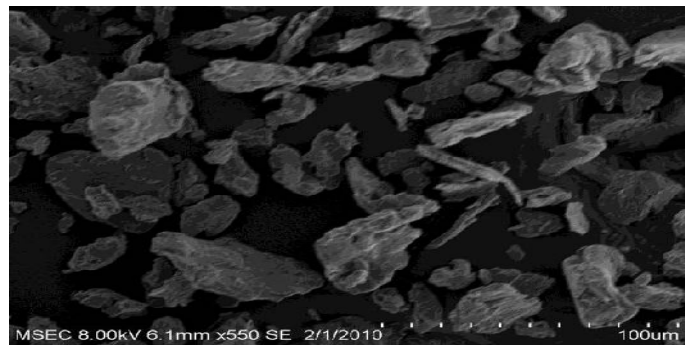


Figure 7: Sem Image For 5% Tungsten Carbide With Aluminum

6.XRD TEST

Qian dong et al.(2015) has experimented the Aromatic structure analyses of Zhundong coal and chars were carried out by X-Ray Diffraction (XRD) spectrometer technique. Original patterns of Zhundong coal and chars are shown in Fig. 1. It can be seen that there are two wide bands around $2\theta \approx 25^\circ$ and 44° , which represent the parallel orientation of char aromatic and the size of aromatic (L_a), respectively. When the pyrolysis time is 30 minutes, increasing the pyrolysis temperatures can result in the narrowing of 002 band width..

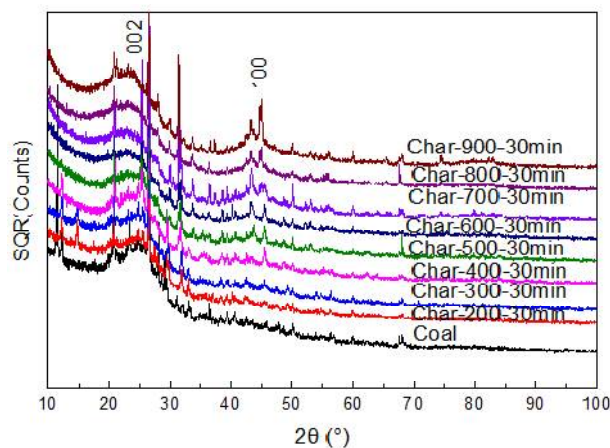


Figure 8: X-ray diffractogram of Zhundong coal and char

7.THERMAL CONDUCTIVITY TEST

Zhaoguo meng et al., (2012) have found that the thermal conductivity of nanofluids increases linearly with the increasing carbon black volume fraction at the same temperature ranging from 15°C to 55°C. This is in good agreement with some reported researches. The effective medium (solid particles) increases with the increasing volume fraction. Therefore, the thermal conductivity increases as the carbon black volume fraction increases.

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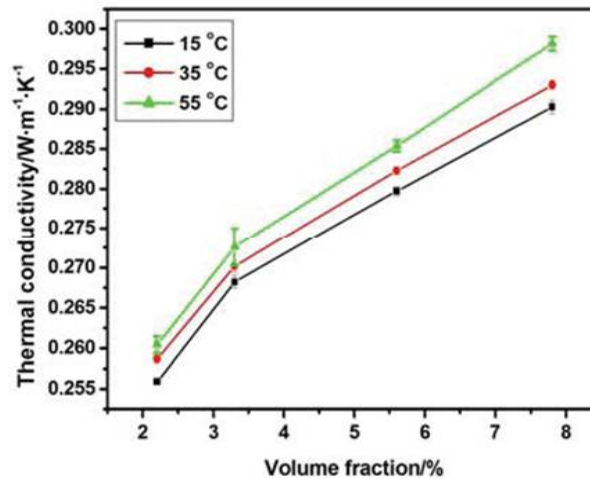


Figure 9: Thermal Conductivity graph

8. FUNCTIONAL GROUP ANALYSES

Qian dong et al.,(2015) studied the evolution of the functional groups of the chars at different pyrolysis conditions of coal. Broad band at 3700–3200 cm⁻¹ is attributed to OH group for Zhundong coal and chars. Figshows that single absorption bands are at 3694 cm⁻¹, 3620 cm⁻¹, and broad bands with middle wavenumbers at 3400 cm⁻¹, 3500 cm⁻¹ for Zhundong coal. The intensity of bonds at 3694 cm⁻¹, 3620 cm⁻¹ decreased with pyrolysis temperature increase, and no obvious change can be found when the temperature reaches 500°C.

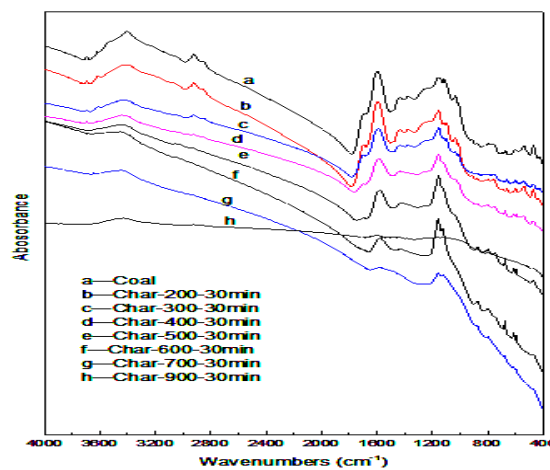


Figure 10: Effect of pyrolysis temperatures

III. CONCLUSION

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

- The thermal conductivities of carbon black nanofluids increased with the volume fraction and temperature. The nanofluids performed a shear thinning behavior.
- The shear viscosity increased with the increasing carbon black volume fraction and decreased as the temperature increased at the same shear rate.

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- It is observed that increase in WC composition invariably increases the density of Al.
- The addition of tungsten carbide with Al, increases the impact resistance of the reinforced Al by reducing the cracks and voids in the crystal lattice which was observed in the XRD analysis
- Micro structure analysis shows the distribution pattern of tungsten carbide particles in the Aluminum. The microstructure reveals the interfacial bond between Al matrix and tungsten carbide particles.

IV. ACKNOWLEDGEMENTS

We acknowledge with deep sense of gratitude to the researchers for their commendable contributions in new materials development whose contributions have been reviewed in this manuscript. Their valuable contributions serve as the guidance for the researchers pursuing the research on new materials development

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