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EXPERIMENTAL BEHAVIOUR OF AMMC USING AUTOMOTIVE INDUSTRY

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ABSTRACT

The advancement of composite materials has turn into a defining moment in the historical backdrop of science and innovation as it allows the synergizing of clear properties of its fixings, namely the reinforcement phase and the bulk matrix phase and suppresses the deficiencies of each of them. The composite materials in light of metals and their alloys which are termed as metal matrix composites (MMCs). Aluminum Alloy composites are used in engineering applications such as aircraft, aerospace, automobiles and various other fields due to having excellent mechanical properties such as high strength, high stiffness, high load to weight ratio and better wear resistance. In the automobile sector the components like brake drum, cylinder, cylinder liners, pistons, piston insert rings are manufactured by aluminum composites

Key words: Aluminum metal matrix composites, stir casting, Hardness test, silicon carbide

1. INTRODUCTION

Aluminum alloys are the most widely used because of their outstanding properties such as light weight, high strength, high modulus, low coefficient of thermal expansion and good wear resistance. Depending on final desired properties of composites, different reinforcement is used in aluminum matrix composites[1]. Hard ceramic particulate reinforced AMCs are being proved as potential engineering materials for critical applications which demand lightweight materials with highly wear resistant property, such as connecting rods, pistons, brake drums and cylinder liners etc. Presence of hard particles in the AMCs protects them from severe wear conditions and results lesser wear and lower friction coefficient than those of their monolithic alloys[2]. Composite materials are important engineering materials due to their outstanding mechanical properties. Composites are materials in which the desirable properties of separate materials are combined by mechanically or metallurgical binding them together. Each of the components retains its structure and characteristic, but the composite generally possesses better properties. Composite materials offer superior properties to conventional alloys for various applications as they have high stiffness, strength and wear resistance[3]. Aluminum metal matrix composites (AMMC) has gained more attention as engineering materials because of their higher specific strength, stiffness and in addition to their better wear resistance compared to unreinforced aluminium alloys . Preparation of MMCs chiefly dependents upon the type of reinforcement and matrix materials. AMMCs are mainly used in defense, aerospace, sports and in industries because of many desirable properties like higher stiffness, strength, thermal conductivity and combined properties like wear resistance, fracture toughness and corrosion resistance[4]. Metal Matrix Composites (MMCs) have several advantages over monolithic alloys. Aluminum alloy matrix composites reinforced with hard ceramic particles shows better mechanical properties such as specific strength, specific modulus and increase in wear resistance than unreinforced aluminum alloy[5]. Boron carbide B_4C is one of the most favorable ceramic materials due to its high strength, low density 2.52 g/cm3 , high hardness and good chemical stability [6]. In this investigation we have followed liquid stir casting method to reduce the cost. These aluminium matrix composites are drawing more attention in aviation, aerospace, automobiles and many structural applications due to their good wear resistance with the extraordinary hardness[7]. In recent days, the aluminum metal matrix composites have become the most eligible candidate in the field of structural applications because of their excellent wear resistance and strength. [8]. Less weight of component results with improved performance of the vehicle[9]. Hybrid Aluminium Metal Matrix composites reinforced with particulate ceramics plays a vital role in recent engineering materials having excellent properties of high hardness, less weight and wear resistance. Specifically, they are substituting the iron based materials in auto mobile, defence, aerospace industries [10].

2. MATERIAL SELECTION

2.1. Aluminum Al (8090):

Aluminum is a soft and lightweight metal. Aluminum / aluminum 8090 alloy is a lithium-based wrought alloy. Addition of lithium to aluminum helps to reduce density and increase stiffness. When properly alloyed, aluminum-lithium alloys can have excellent combinations of strength and tough. aluminium alloy Al8090 series due to light weight with high strength and silicon carbide[11]

2.2. Silicon Carbide (Sic):

Low density. High strength. Good high temperature strength (reaction bonded) Oxidation resistance (reaction bonded) Excellent thermal shock resistance. High hardness and wear resistance. Excellent chemical resistance. Low thermal expansion and high thermal conductivity.

2.3. Aluminum Oxide (Al_2O_3):

Due to its excellent mechanical, chemical and thermal qualities, alumina stands out from many comparable materials by delivering equal or better solutions for low-cost production and manufacturing. Aluminum oxide is a very hard material, almost to the level of diamonds, so it has excellent wear resistance properties. It has high corrosion endurance and high temperature stability, low thermal expansion and a favorable stiffness-to-weight ratio. Since aluminum oxide has an excellent electrical resistor, it is often used in capacitors as the dielectric, the part keeping charges in the device separated.

3.EXPERIMENTAL WORK

3.1. STIR CASTING

Stir casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring. Stir casting is the simplest and the most cost effective method of liquid stat fabrication. The liquid composite material is then cast by conversional casting methods and may also be processed by conversional metal forming technologies liquid stat fabrication of metal matrix composite involves incorporation of dispersed phase into a molten matrix metal, followed by its solidification.

Figure 1: stir casting machine

Figure 2: Die Sample

Figure 3: Die Setup

3.2. TENSILE TEST

A Universal Testing Machine (UTM) is used to test both the tensile and compressive strength of materials. Universal Testing Machines are named as such because they can perform many different varieties of tests on an equally diverse range of materials, components, and structures.

Figure 4: Tensile Test Machine

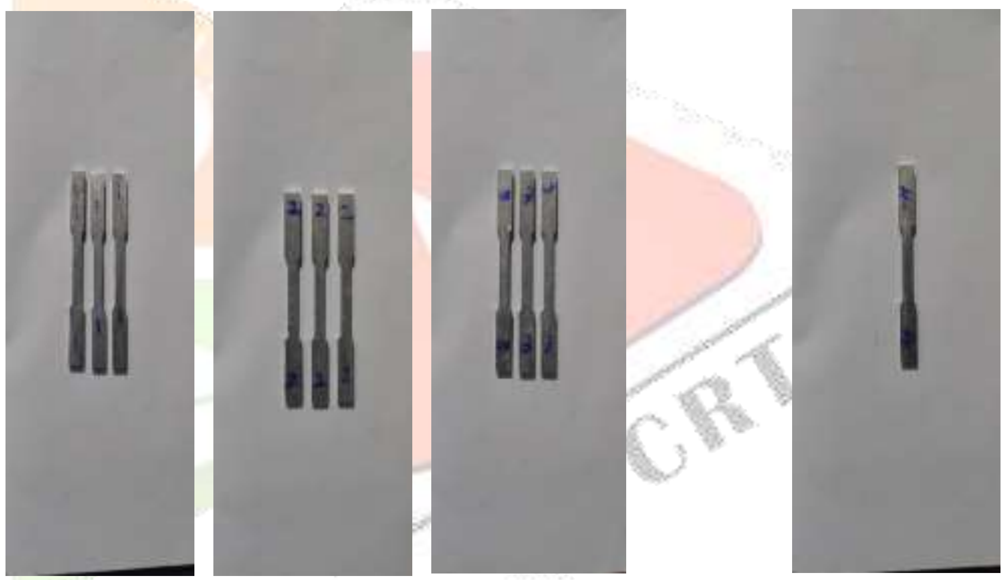


Figure 5: Test Samples

3.3. HARDNESS TEST

Hardness testing is to determine the resistance a material exhibits to permanent deformation by penetration of another harder material. Therefore, when drawing conclusions of a hardness test, you should always evaluate the quantitative value in relation to: The given load on the indenter.

Figure 6: Hardness Test Machine

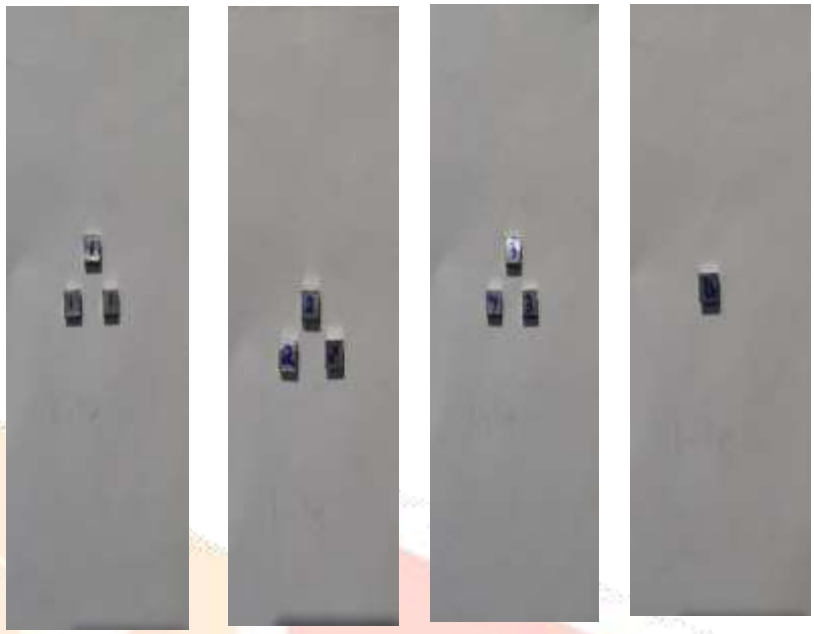


Figure 7: Test Sample

3.4. SCANNING ELECTRON MICROSCOPE

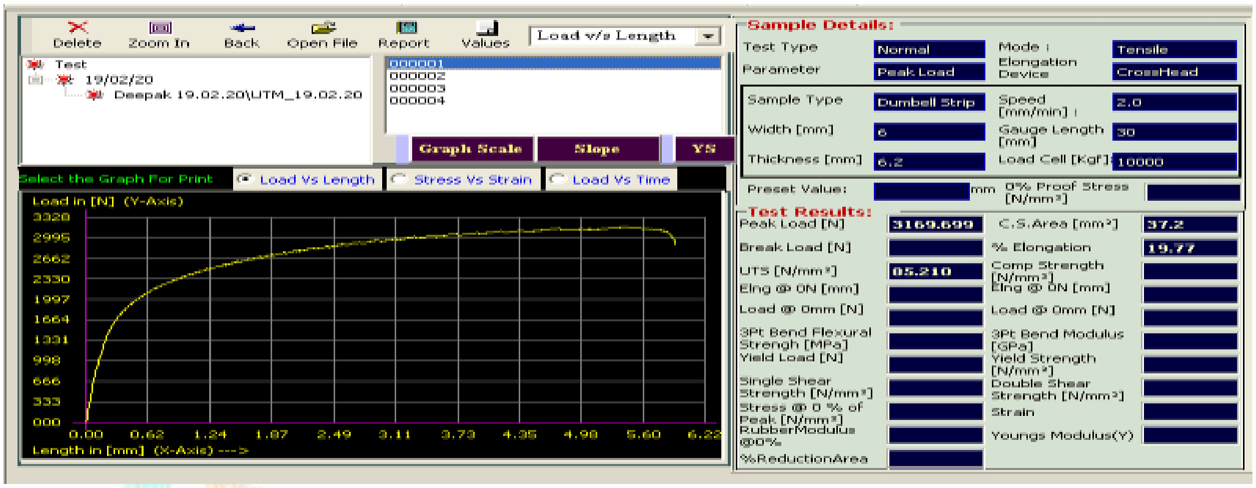
SEM analysis of the post mechanical tests was carried out to study the worn out surfaces under different applied loads. The fractured surfaces were studied for modes of fracture, the failure of the Interface, failure of the matrix, failure of the reinforcement, etc.

4.RESULTS AND DISCUSSION

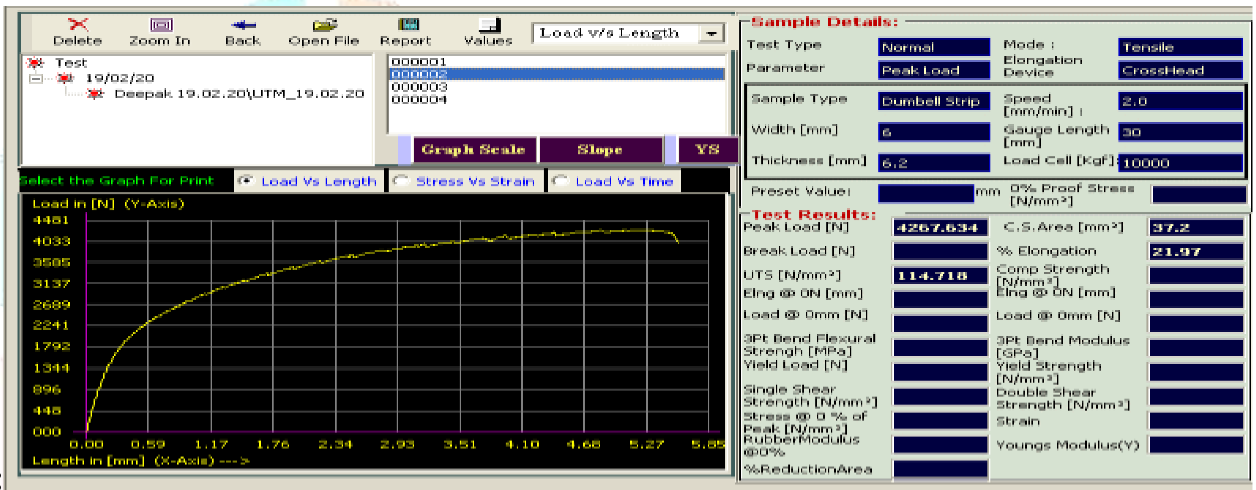
In this chapter presents the mechanical properties of the Al8011 and Al_2O_3 and B_4C composites prepared for this present investigation. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The results of various characterization tests are reported here. This includes evaluation of wear and SEM analysis has been studied and discussed. The interpretation of the results and the comparison among various composite samples are also presented.

4.1. TENSILE TEST

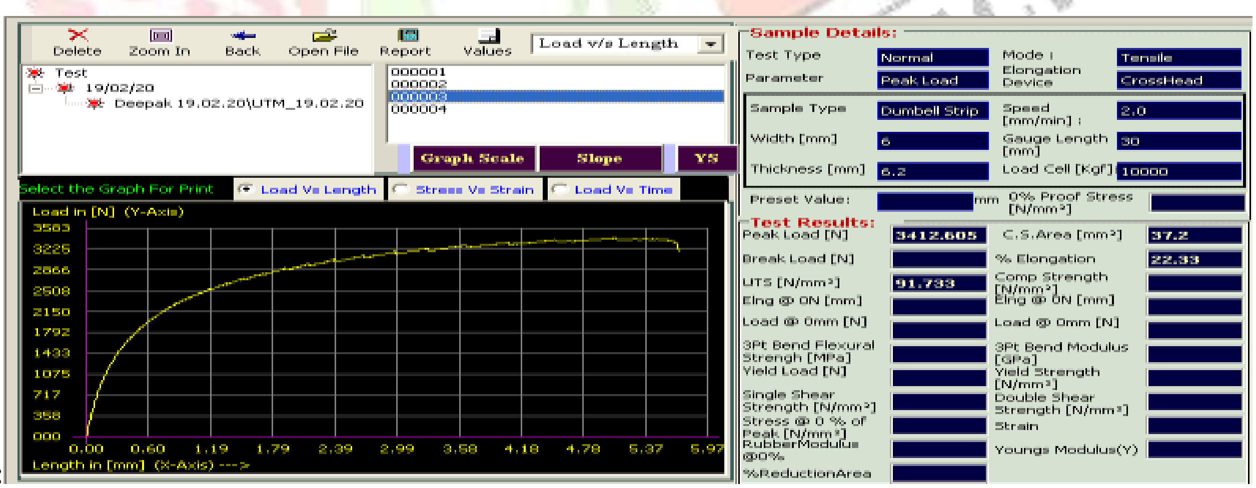
As such no strict quality control measures have been affected to control the width or thickness of the specimen within close tolerance at the gauge length portion.[13]



Sample1.



Sample2:

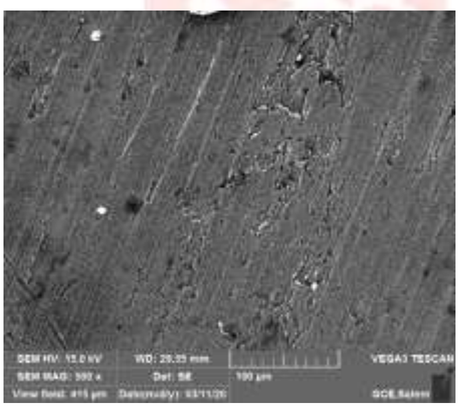


Sample3:

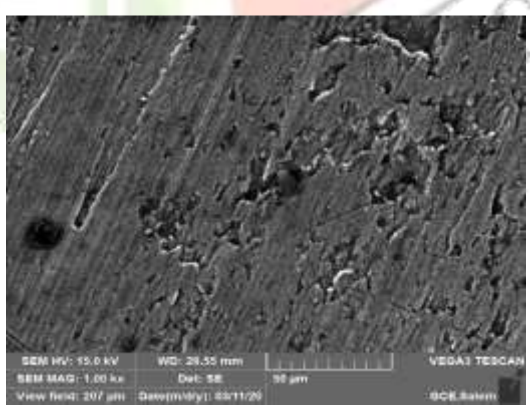
4.2. Hardness test

S.No	Micro hardness (Vickers)HV(H)	Average HV (H)
1	54.7	
2	63.8	61.83
3	67.8	
4	57.8	
5	56.1	56.36
6	55.2	
7	57.6	
8	60.0	59.43
9	60.7	
10	63.8	
11	62.9	64.33
12	66.3	

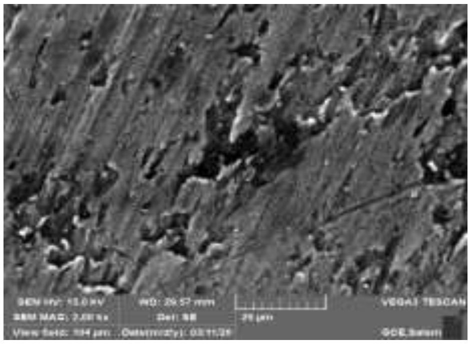
4.3. SEM Images

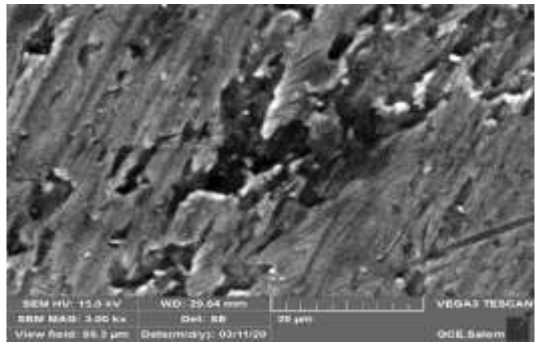


a) Specimen 1 at 500x



b) Specimen 2 at 1000x





c) Specimen 3 at 2000x

5)Conclusion:

Due to the Weight reduction and stress, stiffness criteria, drive shaft is proposed to be replaced with silicon caribe and alumina composite drive shaft as per plotted results above. Taking into considerations the weight saving, deformation, shear stress. it is evident that silicon carbide and alumina composite has the most encouraging properties to act as replacement for steel out of the considered three materials.

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