ROPERTIES OF MAGNESIUM ALLOY AZ91D WITH TIC REINFORCED COMPOSITE MATERIAL BASED ON TENSILE AND WEAR TESTS

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ABSTRACT: Metal matrix composites (MMC) have been employed as a composite fabric with a combination of low weight and great engineering power in a range of areas over the years, including aerospace, car, medical, and optics. Micro milling was employed to create the MMC item due of the increased need for miniaturised goods with enhanced mechanical qualities. Alloy AZ91D is a famous magnesium alloy this is utilized in structural and transportation applications. Its fundamental alloying factors are aluminium and zinc. Mg AZ91D alloy and TiC had been used as reinforcement withinside the fabrication of a metallic matrix composite (MMC). The houses of Magnesium Alloy AZ91D with TiC Reinforced Composite Material primarily based totally on Tensile and Wear Tests are defined on this study. The tensile properties of the Mg AZ91D/TiC composite improved over that of the Mg AZ91D alloy. Experiments in the field of have an effect on bolstered ratios of 0,1,2,3, and four weight possibilities of Titanium carbide debris are planned. The mechanical property characterization of the composite material increases the yield strength and ultimate tensile strength with a decrease in the wear rate as the reinforcement ratio of titanium carbide increases. Composite metal matrix properties improve with 0% TiC reinforcement with metal matrix.

KEYWORDS: Magnesium alloy, TiC, AZ91D Mg alloy, yield strength, Tensile and Wear Tests.

I. INTRODUCTION

In the present day scenario metal matrix composites (MMC's) are showing their vital importance in the fields of aerospace and automotives. Because of its advanced properties, the development of MMC in recent years has resulted in specific research in this area [1]. The major problem associated with the manufacturability of these MMC's in non-uniform distribution of various particles due to their density difference. The random orientation of the particulates will show tremendous impact on their mechanical behavior; As a result, it is critical to determine the mechanical properties as well as the particulate distribution in MMC [2]. Metal matrix composites are becoming increasingly popular in industries such as automotive, aerospace, and biomedical applications. Expanding the use of metal matrix composites, particularly Aluminium MMCs requires the development of technologies suitable for cost-effective composites machining [3].

Composites are a macroscopic combination of two or more different materials with a recognizable interface [4]. The resulting composite has a structural balance that goes beyond just a single material. Composites are made up of two or more components that are insoluble in each other. Composites were stronger than individual components. Metal matrix composites are made up of matrix materials like aluminum, copper, and magnesium, and they provide the high strength and lightweight standards that are common in aerospace applications. High strength materials are required for industrial applications in the automotive and aerospace sectors, for which extensive research has been conducted over the last three decades. Extensive research on magnesium-based composites has resulted in better physical and mechanical properties [5].

Several techniques for producing magnesium-metal matrix composites with various reinforcements have recently been developed. The industry employs a variety of processing methods, including solid, semi-solid, and liquid-state processes. The stirring casting process is the simplest, cheapest, and most widely used in various industries, and it is becoming more popular in liquid phase treatments [5]. Correct connection between the matrix and reinforcement is a major challenge in achieving good load transfer between the phases.

The addition of hard reinforcements such as ceramics and metal particles significantly improves the mechanical properties of Mg-based composites [6]. It is a difficult material to cut due to its non-uniform structure and highly abrasive particles. Several attempts have been made to manufacture MMC components using EDM and laser machining. Magnesium (Mg) is the eighth most abundant element in the crust, so there are many resources to start using alloys in a variety of engineering applications. Magnesium alloys have the highest strength-to-weight ratio of any structural alloy, the equilibrium (other than strength) properties such as corrosion, ductility and creep are currently being investigated.

Other advantages of Mg are its excellent implantation capacity, environmental and human toxicity (Mg alloy is suitable for biodegradable implants), high speed milling machine and easy machining by turning (eg, over others). 510 times longer tool life) and compatibility (e.g rollable, collectable) [7]. Depending on the shape, Mg components are die-cast up to 50 ° more than Al components. Finally, when it comes to mechanical and thermal conductivity, Polymers are outperformed by magnesium alloys. Mg is also completely recyclable, which is not always the case with polymers.

Magnesium alloys have recently acquired popularity due to their appealing qualities Low density, high specific strength, damping capacity, strong electrical and thermal conductivity, etc. [8]. Magnesium and magnesium alloys are widely used in construction and transportation due to their low density. The advantages of using magnesium and its alloys as a composite matrix are high specific strength and stiffness, improved bulk properties, and dimensional stability. The mechanical and tribological behavior of various MMCs has received a lot of attention. Some studies have shown that the addition of hard ceramic fibers or particle reinforcements to Mg alloys can improve their wear properties.

II. LITERATURE SURVEY

Pankaj Sharma and Amit Kumar Bindal [9] Investigated the Mechanical and Metallurgical Development of AlSic Reinforced Metal Matrix Alloys. The tensile strength of a mixture containing 10% Sic and 5% fly ash is significantly higher (146 MPa). However, high levels of Sic (> 10 wt%) can weaken the composite due to the aggregation of carbide particles and result in uneven distribution of reinforcements in the matrix. Abbas [10] the surface composite of the AZ91 magnesium alloy was created using FSP. As reinforcements, SiC particles and Al2O3 particles were used to create two types of surface composites. The FSP sample outperforms the AZ91 in terms of wear properties. The findings revealed that increasing the FSP pass number by up to four digits reduced the wear rate. This is due to the lower hardness of as-received material versus processed samples.

Cui Fan-dong et. al. [11] presents the microstructure and properties of the Ti base laser coating on the magnesium alloy surface of computer parts. The alloy coating's hardness, wear resistance, and corrosion resistance were also evaluated. The average microhardness increased by 625 HV 0.05, the wear resistance doubled, the polarisation curve's dynamic corrosion potential increased by 0.194 V, and the corrosion current density decreased by 0.093 A / (cm^2). When the performance of the topcoat and substrate was tested, the 3.5% NaCl solution improved the corrosion resistance by about 96%.

Yu and Huang [12] investigated the effects of load, wear time, diameter, and senosphere fly ash (FAC) content on the wear behaviour of scramble cast AZ91D / FAC composites. Under dry skid conditions, the wear test was carried out on a Pinondisk wear tester. The disc used had a speed of 60 rpm. The applied loads were 5, 10, 20, and 30 N, with wear times of 10, 20, 30, and 50 minutes, respectively. Under the above test conditions, the results show that the AZ91D / 6 ° C composite is more wear resistant than the AZ91D.

Hongyu Xu et. al. [13] During heat treatment, the microstructure of a semi-rigid AZ91D magnesium alloy recycled from waste chips was studied. Waste shavings from the AZ91D magnesium alloy were recycled to make semi-solid billets in this study. While the billet was still hot, the shavings were placed into it. After that, the billets went through a series of isothermal heat treatments with varying retention times. The evolution of its semi-solid microstructure during heat treatment has been studied. As the retention time increased, the solid particles became more spherical and the volume increased during the semi-solid isothermal treatment until the solid-liquid system reached equilibrium. Due to the decrease and effect of interfacial energy, the cells gradually became spherical and began to grow as the retention time increased.

Chen et al. [14] successfully prepared a Tribological homes of a floor composite layer strengthened with the aid of using SiC debris at the thixoformed (TF) AZ91D alloy with the aid of using FSP had been investigated. The microstructural evolution of the thermomechanically affected zone (TMAZ) is undeniably apparent during the FSP of the thixoformed AZ91D alloy. In terms of wear and tear resistance and friction coefficient, the composite floor surpassed the equivalent eternal mould casting alloy and the TF alloy without a composite floor.

D. S. Mehta et. al. [15] the wear properties of magnesium and aluminum alloys for automotive applications are being studied. Despite the fact that magnesium alloys can be used as an alternative material for a variety of automotive applications, little research has been done to assess wear properties under different weights and operating conditions. In this study, a wear test was performed using a Pinondisk device. In this study, two magnesium alloys AS21 and AZ91D and one aluminum alloy AlCA313 were used as disc materials. The pins are made of sintered ferroalloy material derived from spur gears in gear pumps. Results include wear rate analysis, wear scar properties, and microstructural studies of test alloys.

III. EXPERIMENTAL PROCEDURE

The experimental procedure of Magnesium Alloy AZ91D with TiC Reinforced Composite Material is as shown in Fig. 1.

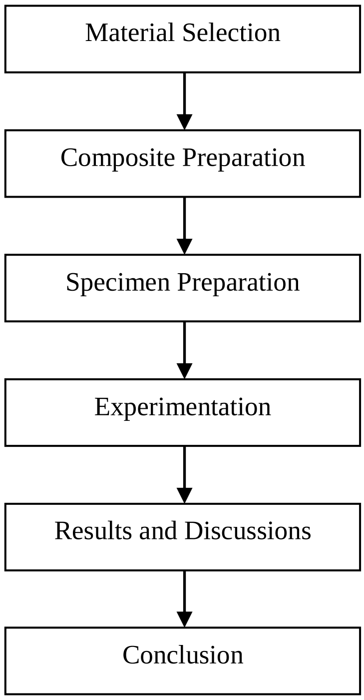

Fig. 1: BLOCK DIAGRAM OF EXPERIMENTAL PROCEDURE

As the steel matrix material, the die-solid plate product of magnesium alloy AZ91D with a chemical composition of 9.03 Al + 0.seventy three Zn + 0.205 Mn + 89.ninety eight Mg became decided on in length 30 mm × 20 mm × 10 mm. It has extremely good corrosion resistance in each everyday and marine environment. When warmth treated, with advanced mechanical characteristics than natural magnesium, the AZ91D Magnesium Alloy turns into one of the maximum extensively used magnesium-primarily based totally engineering materials.

TiC (titanium carbide) particles are used as reinforcement. First, Ti and C powders (molar ratioTi/C=1:1) have been absolutely robotically blended and cooled into preform (diameter Ø = 16.five mm) in a metal mildew with a relative density of 56.6%. In the in-situ reactive infiltration method it's far assumed that every one Ti and C powders are transformed to the TiC section in a pre-shaped molar ratio. The agitation casting process is used to produce composite materials. In an electric resistance furnace, the base material, magnesium AZ91D, is heated and melted in a crucible at 550 ° C. The stirrer is placed in a molten metal bath and rotated at 100-300 rpm to produce a vortex in the liquid metal. Pre-heated titanium carbide (TiC) is added to the molten metal from the vortex side. The stirrer was switched on for 5 min after adding titanium carbide (TiC) to inject the molten metal alloy into the required mold cavities. After the casting process, a magnesium AZ91D metal matrix containing titanium carbide (TiC) particle composite was obtained.

Fig. 2: MOULD CAVITY FOR CASTING PROCESS

Specimens were prepared in accordance with ASTM standard E8 for various composite material reinforcements in order to conduct a computer interface tensile test. In addition, specimens for various composite material reinforcements were prepared in line with ASTM standard G99 for graphical interface framework. Tensile Testing on a Computer Interface to get the requisite mechanical properties, composite samples with varied reinforcements such as 0, 1, 2, 3, 4, and 4% by weight were tensile tested utilising a computer interface according to the ASTM E8 standard. The results and discussion showed the ensuing trends in the needed yield points and stress-strain results for tensile strength, as illustrated in Figure 3.

Fig. 3: COMPUTER INTERFACE UNIVERSAL TESTING MACHINE

Fig. 4: COMPUTER INTERFACE WEAR TESTING MACHINE

As shown in Fig. 4, the preferred composite models for various reinforcements weighing 0,1,2,3 and 4% were placed through a ware test with a computer interface to obtain the required tribological parameters. The obtained results of the required put-on rate, friction coefficient and sliding distance are reported.

IV. RESULT ANALYSIS

Table 1 shows the results of the tensile test. Yield strength and extreme tensile strength results were shown with and without reinforcement. Experimental results clearly show that increasing the weight percent of the reinforcement improves yield and tensile strength, as well as mechanical properties.

Table 1: DETAILS OF TENSILE TEST RESULTS

Weight % of TiC	Yield strength (KN/mm^2)	Ultimate Tensile strength (KN/mm^2)
0	0.1	0.154
1	0.13	0.162
2	0.16	0.189
3	0.18	0.224
4	0.2	0.261

Titanium Carbide (TiC) Particle Reinforcement (1 wt%) test results show yield strength of 0.13 KN / mm2 and tensile strength of 0.162 KN / mm2, clearly demonstrating improved mechanical properties of the composite. The stiffener is properly dispersed by a stirring casting process using a thorough metal matrix.

Fig. 5 is a graphical representation of the results of the tensile test. In addition, test results for fortification of titanium carbide particles (TiC) with magnesium AZ91D matrix (2.3 and 4% by weight) clearly show the effect of fortification with metal matrix tends to increase, as do the outcomes of the achieved mechanical properties.

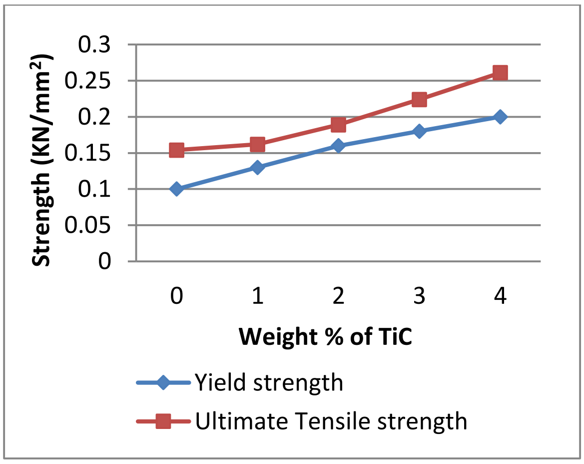

Fig. 5: WEIGHT % of TiC vs. STRENGTH (KN/mm^2)

Table 2 shows the results of the wear test. Abrasion rate and coefficient of friction results are shown with and without reinforcement. The findings of the experiment clearly illustrate that as the weight percent of the reinforcement increases, the wear rate lowers.

Table 2: DETAILS OF WEAR TEST RESULTS

Weight % of TiC	Speed (rpm)	Load (Kgs)	Wear Rate (mm3 /N-m)
0	300	2	4.02
		4	3.84
1	300	2	3.79
		4	3.67
2	300	2	3.24
		4	3.15
3	300	2	3.01
		4	2.64
4	300	2	2.57
		4	2.14

Titanium Carbide (TiC) Particle Reinforcement (1% by weight) launch results showed lower wear prices at various loads and constant velocities. The staircase casting process underscores changes in the tribological properties of composites with consistent and optimal reinforcement distribution along the metal matrix. It may be inferred that adding TiC particles to composites enhances their hardness greatly. The findings of the wear test are graphically depicted in Fig. 6.

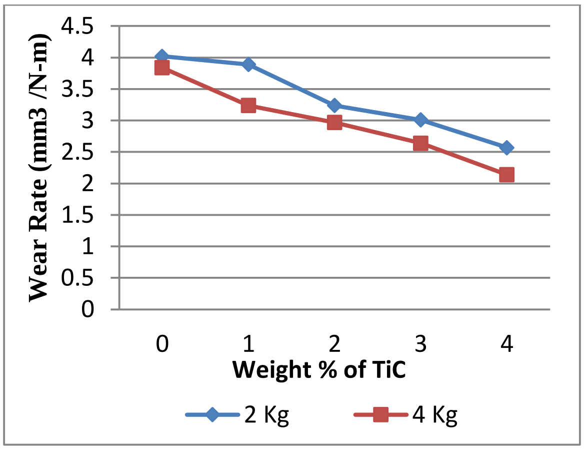

Fig. 6: WEIGHT % of TiC vs Wear Rate (mm3 /N-m)

V. CONCLUSION

Yield electricity, Ultimate Tensile electricity, and Wear Rate for Magnesium AZ91D metallic matrix with TiC reinforcement with the aid of using weight percent of 0,1,2,3, and four have been investigated on this study. Magnesium AZ91D metallic matrix with strengthened boron carbide become correctly fabricated the usage of the stir casting technique at 0%, 1%, 2%, 3%, and four% reinforcement levels. It has been determined that growing the load percent of Titanium carbide particle will increase yield electricity and closing tensile electricity. It is apparent that as the proportion of Titanium carbide will increase with weight load, the wear and tear price decreases. By incorporating TiC particulate into the matrix fabric rather than Magnesium alloy, the composite's hardness and wear resistance have been increased. Composite metal matrix properties are improved when compared to 0% of TiC reinforcement with metal matrix.

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