A Review of Micro Particles Filled Metal Matrix Composite and Effect on Tribological Properties

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***Abstract*-Now a day's lot of light is focuses in the field of development of advanced material. We need some special qualities in materials that can be utilized for specific purposes. Metal matrix composites (MMCs) have fascinating properties like higher thermal and electrical stability, better physical, chemical and mechanical properties compared to ancient monolithic materials. So the composite materials are one of the best suited materials for a wide range of engineering applications such as automobile industries, airbuses, artificial limbs, electrical appliances, space subtle etc. This paper amalgamates the different mechanical and tribological properties of micro reinforced metal alloy composites (MACs) that put such materials into the top priority of 'selection of material' process.**

Key Words: **Metal matrix composites, Micro reinforcement, Mechanical properties, Tribological properties.**

I.INTRODUCTION

In modern era the composites have the widespread applications in various fields like sports, house hold equipment, vehicles, airlines, structures, artificial satellites, etc. Currently the aluminium metal and its alloys are being used very much in the field of development of metal matrix composite because aluminium have the fascinating properties like higher thermal conductivity, higher strength to weight ratio, higher electrical conductivity etc. But some restrictions are also present in the application of aluminium based materials like lower stiffness, low melting point, lower wear resistance and other surface properties etc. These restrictions provoke the researchers to exceed these limits by doing some smart work like adding some foreign materials into base material (matrix) [1].

Composite material is the result of bonding between dissimilar materials having different chemical as well as physical properties. The properties of composite material lie in between the properties of their constituents which are mixed together. The major proportion of constituent is called matrix and the minor proportion of the constituent is called reinforcement. Since the matrix is in majority so it surrounds and binds the reinforcements together by adhesion and cohesion property. The primary purpose of the reinforcement is to achieve the desirable properties for some specific purposes [2]. The desirable properties of MMCs are controlled by the amalgamation of matrix-reinforcement, and the characteristics are determined by analyzing the microstructure, internal interfaces. These characteristics are influenced by the production techniques which are used to make them. The microstructure analysis covers the study of grains, chemical composition, atomic imperfections, etc. The famous hard reinforcements are alumina, silicon carbide etc., and graphite is considered as soft reinforcement. These reinforcing materials when mixed with base material perform different roles in strengthening mechanism. So a lot of researches have been done and still progressing to obtain the optimumresult of desirable properties (mechanical strengths, wear behavior etc.) [3]. The wear resistance and good strength of MMCs can be utilized in various engineering applications especially the places where there is contact between two surfaces and having relative motion between each other. There are various factors are considered which affect the sliding wear behavior and that are quantity and quality of reinforcement, phase of reinforcement, particle size of reinforcement, sliding speed and distance, hardness of the counter face etc. [4]

Wearing or rubbing is a major issue in most of the machinery components which is greatly affected by load, speed and environmental condition. Wear causes a lot of expenditure for repairing or replacing the wear out components [4]. Since currently we are facing the problems of wear in mechanical components so we need some advance technique to get victory on this problem. This paper is an attempt to understand the smart solution to override on wearing property.

II. LITERATURE REVIEW

This literature explains the novel works which have been done on different metals taking discrete reinforcements which results in several aggrandized mechanicals, physical, chemical and wear properties. In this literature survey the main focuses is on mechanical and wears characteristics of metal matrix composite.

2.1 Effect of reinforcement on mechanical and wear behavior of composite.

Wear is the loss of material due mechanical abrasion when two surfaces are in physical contact and having relative motion between each other. The above table is the brief

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explanation of mechanical and wear property of particle reinforced metal matrix composite.

1. Kesavulu, *et.al.* investigated the Aluminium alloy matrix composite (AMMC) which is in grained by an industrial waste (fly ash), and found the hardness has increased, the tensile strength increases up to 15% addition of reinforcement. [5]
2. V.Balaji, et.al. used silicon carbide particles (SiC) as reinforcement to add in aluminium alloy (Al-7075) 6-10% by eight and tested the composite for mechanical and wear properties. The properties of composite are found much better mechanical & tribologicalproperties than that of Al-7075 itself, and can be used for making gear. [6]
3. Jitendra K., et.al. investigated copper matrix in filled by graphite powder and the result of testings' shows that wear resistance has increased, but the strength was decreased. [9]
4. M.Ramachandra et.al. characterizes the aluminium matrix composite ingrained with zirconium-di-oxide (ZrO2) and found the increased hardness and wear resistance and this composite can be the substitute of currently working Piston, Cylinder liners and connecting rods. [13]

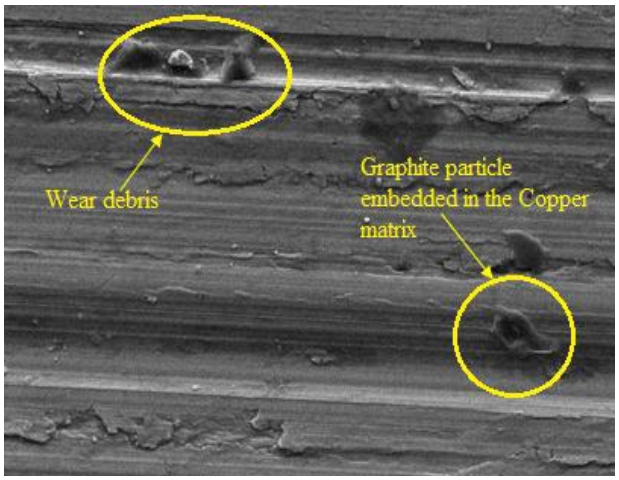

Fig 1: SEM analysis of MMC with 15% graphite and 30 N load (500x). [9]

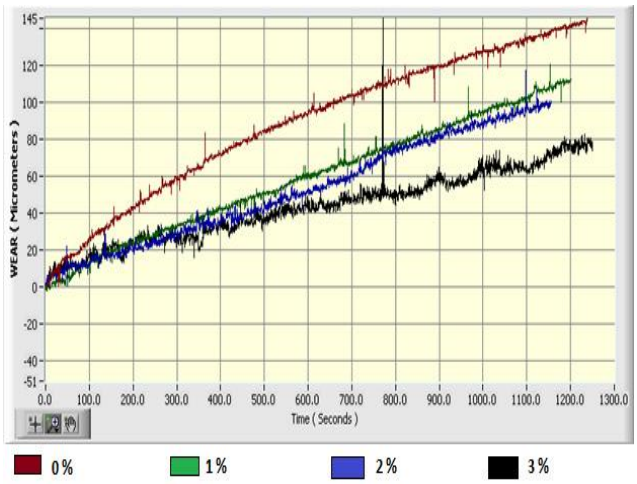

Fig 2: Wear behaviour of Al+ZrO2 composite [13]

TABLE 1:

EFFECT OF REINFORCEMENT ON MECHANICAL AND WEAR BEHAVIOR OF COMPOSITE.

S. No.	Matrix /alloy	Reinforcement	Wt. %	Fabrication Techniques	Testings'	Results	Applications	RefNo.
1	Al Alloy	Fly ash	5, 10, 15, 20	Stir Casting	Tensile, wear & hardness test	HRA continuously increasing, UTS increases up to 15%	Light weight vehicles & aerospace	5
2	Al7075	SiC	6, 10	StirCasting	Mechanical & wear	Better mechanical & tribologicalproperties	Gear	6
3	Al 2024	Gr + B_3N	4 + 4	Stir Casting	Hardness & wear test	Al + Gr have good dry sliding wear resistance than Al + Boron nitride	Centrifugal pump	7
4	Cu	TiC + Gr	5 + 0 10 + 5 15 + 10	Stir Casting	Wear & hardness test	Wear rate decreases	Electrical sliding contact, bearing	8
5	Cu	Gr	5 10 15	Stir casting	Wear & hardness test	Hardness decreases after 5% Gr low strength, wear rate increases	Excellent lubricant electrical wires	9
6	Al 6082	Gr	0 4 8 12	Stir casting	Wear & Hardness test	Hardness decreases on increasing graphiteVHN = 49.5 - 44 BHN = 31.6 - 28.3	Bearing	10
7	Al	SiC + Cu	3 + 0.56 +0.75 9 + 0.1	Stir casting	Wear test, micro-structuralStudy	Wear resistance increases continuously	Aerospace, automotive & structural	11

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8	Cu	SiC	20 40 60	Sintering and forging	Dry sliding wear & hardness test	Wear rate decreases & hardness increases	Electrical appliances & aerofoil	12
9	Al	ZrO2	1 2 3 4	Powder metallurgy	Hardness, wear & micro structural analysis	Hardness & wear resistance increased	Piston, cylinder liner, connecting rod	13
10	Ti-6Al-4V	B_4C	0 5 10	Powder metallurgy	Mechanical & corrosion testing	Density decreases hardness & corrosion resistance increases with increase in B_4C, Wear rate decreases	Aerospace & automotive	14

1. Shaaz A. et.al. investigated the copper metal as matrix and hybrid reinforcement of SiC and Alumina (Al2O3) and found very good enhancement in tensile strength and hardness both. [16].
2. Anil K.B. et.al., investigated for a hybrid AMMC reinforced with SiC and Boron Carbide (B4C), the properties are found as increase in micro hardness as increase in amount of reinforcement. [20]
3. K. Yoganandamet.al., found that reinforcing the TiO2 (titanium dioxide) into aluminium alloy (Al 6082) improves the mechanical properties and as the amount of TiO2 increases in aluminium alloy, the mechanical properties continuously increases.

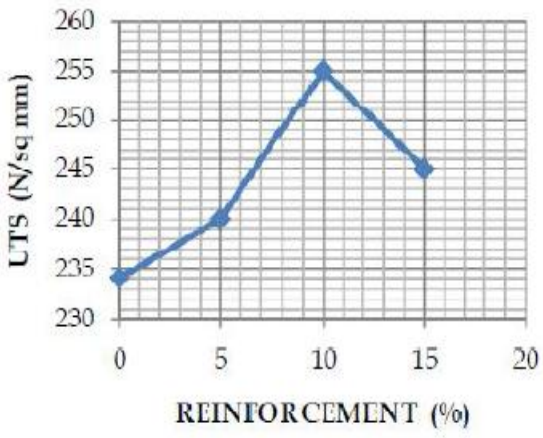

Fig 3: Ultimate tensile strength curve for different combinationsof reinforcement [16]

TABLE 2:

EFFECT OF REINFORCEMENT ON MECHANICAL PROPERTIES OF BASE CONSTITUENT.

S.N.	Matrix /alloy	Reinforcement	Wt. %	Fabrication Techniques	Testings'	Results	Applications	Ref No.
11	Al 6061	SiC	25	Stir Casting	Mechanical testing & micro-structural Studies	Stainless steel cylinder can be replaced, wt. reduction = 65.73 %	Hydraulic Actuator	15
12	Cu	SiC + Al_2O_3	2.5+2.5 5+5 7.5+7.5	Stir Casting	Tensile and hardness test	UTS increases but after 10% decreases, hardness increases electrical & thermal conductivity increases	Electrical appliances	16
13	Al 6082	TiO_2	0 3 6 9	Semi solid compo casting	Hardness & tensile test	Mechanical properties increases on increasing TiO_2	Automotive Application	17
14	Al 6061	ZrO_2	0 2.5 5 7.5	Stir casting	Hardness, tensile & impact test	Tensile strength = 157 (MPa) Elongation % = 3.8 HRB = 26 (MPa) at 7.5 wt. %	Aerospace, structural, marine	18
15	Al 1100	ZrO_2	0.5 0.75 1	Accumulation roll bonding	Tensile, compressive & hardness test	Tensile & compressive strength increased	Naval ship	19
16	Al	SiC + B_4C	8+2 5+5 3+7	Sintering of mechanical alloyed power (ball milling) in powder metallurgy process	Hardness Test	Micro hardness of MMC increased VHN % = 21.2 22.36 32.7	automotive industries	20

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III. CONCLUSION

The main focuses of this paper is about the mechanical and wear behavior of metal matrix composite. Composites are precluded to have essential applications in automobile, aerospace, machinery components, sports, electrical appliances (where variable resistance (rheostat) is used), etc. The agglomeration and clustering of reinforcement restrict the slipping of molecular planes and this imparts a great strength in composite. The reinforcement like SiC, Al2O3, etc. imparts the mechanical strength; reinforcement like graphite enhances the wear resistance properties by acting as solid lubricant.

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