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FABRICATION OF AL2024 WITH SILICON CARBIDE REINFORCED COMPOSITE BY USING CENTRIFUGALLY ATOMISED CASTING

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Abstract: Aluminium alloy based metal matrix composites (AMMC) are widely used for sliding wear applications because of their excellent wear resistant properties. AMMC are fabricated using method liquid state fabrication. It was found that stir casting is an economical method to fabricate AMMC. In the present work, aluminium alloy2024 reinforced with various percentages of Silicon carbide particles (2, 4, 6 wt %) were prepared. At first the stir casting setup was prepared as per the requirement. The objectives of this research work are the fabrication and characterization of Al-2024 with Silicon carbide AMMC which was fabricated using stir casting process and improving mechanical properties. The purpose of this project was to study the wear behavior of Al2024-SiC composite manufactured by centrifugally atomised casting enrooted with varying SiC reinforcement compositions and sintering temperatures. Four different samples (SiC reinforcement compositions 0, 2, 4 and 6 Vol. %) of the composite were made by mixing, cold pressing and sintering. The change in hardness values were noted and studied. Then SEM analysis of the samples was done to study the phases present and their distributions along with idea of composition as well as Wear. Hardness and Wear studies were carried out to judge the surface mechanical properties of the composites prepared.

Keywords: Metal Matrix Composite, Liquid State processing, Wear Resistance

1. Introduction

History is often marked by the materials and technology that reflect human capability and understanding. Many times scales begins with the stone age, which led to the Bronze, Iron, Steel, Aluminium and Alloy ages as improvements in refining, smelting took place and science made all these possible to move towards finding more advance materials possible. Progress in the development of advanced composites from the days of E glass / Phenolic resin structures of the early 1940’s to the graphite/ polyimide composites used in the space shuttle orbiter-is spectacular[1]. The recognition of the potential weight savings that can be

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achieved by using the advanced composites, which in turn means reduced cost and greater efficiency, was responsible for this growth in the technology of reinforcements, matrices and fabrication of composites. If the first two decades saw the improvements in the fabrication method, systematic study of properties and fracture mechanics was at the focal point in the 60's. Since then there has been an ever-increasing demand for newer, stronger, stiffer and yet lighter-weight materials in fields such as aerospace, transportation, automobile and construction sectors[2]. Composite materials are emerging chiefly in response to unprecedented demands from technology due to rapidly advancing activities in aircrafts, aerospace and automotive industries. These materials have low specific gravity that makes their properties particularly superior in strength and modulus to many traditional engineering materials such as metals. As a result of intensive studies into the fundamental nature of materials and better understanding of their structure property relationship, it has become possible to develop new composite materials with improved physical and mechanical properties. These new materials include high performance composites such as Polymer matrix composites, Ceramic matrix composites and Metal matrix composites etc. Continuous advancements have led to the use of composite materials in more and more diversified applications[3]. The importance of composites as engineering materials is reflected by the fact that out of over 1600 engineering materials available in the market today more than 200 are composite. MMCs have the best properties of the two components, such as ductility and toughness of the matrix, wear resistance, high modulus and strength of the reinforcements.

These prominent properties of these materials enable them to be potential for numerous applications such as automotive, aerospace and military industries. Particulate MMCs contain second phase particles ranging from 10 μm up to 500 μm[4]. MMCs with a uniform dispersion of particles in the range of 10 nm to -1 μm are termed Metal Matrix Nano-composites (MMNCs). It has been reported that with a small fraction of Nano-sized reinforcements, MMCs could obtain comparable or even far superior mechanical properties .Fabrication of MMCs by liquid state processing routes include centrifugally atomised casting, infiltration techniques, stirring techniques, rapid solidification, as well as some in-situ fabrication such as liquid-gas bubbling. Liquid state processing is usually energy-efficient and cost effective.

In general, the discontinuous phase is harder and stronger than the continuous phase and is called the „reinforcement"; whereas continuous phase is termed as the „matrix". The matrix holds reinforcement to form the desired shape and bears the major portion of an applied load, while the reinforcement improves overall mechanical properties of the matrix[5].

Reinforcement increases the strength, stiffness, wear resistant and the temperature resistance capacity and lowers the density.

In general, composites are classified according to the type of matrix material andthen nature of reinforcement at two distinct levels.

Based on type of matrix material

- Metal-matrix composites (MMC)
- Polymer-matrix composites (PMC)
- Ceramic-matrix composites (CMC)

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- Carbon – carbon composites (CCC)

Based on size-and shape dispersed phase as Particle –reinforced composites

- Fiber-reinforced composites
- Structural composites

2. Literature Review:

Research gaps identified from the Literature Review

1 The characterization of Al-6061 Alloy is base metal with combination of silica, Rice husk, Fly ash powder etc, and reinforcement materials are used.

2 In this composites many materials are repeated and improving the composite results and comparing their result by using of different casting process.

3 Using stir casting process aluminium alloys are done by combination of different reinforcements.

4 These composite metals are completely done their testing process and finalizing the metal can be applicable in engineering industrial appliances, automobiles, and some other applications.

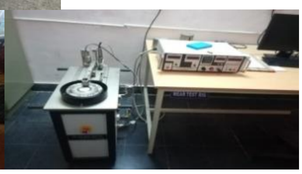
5 These metal composite metals are improving their thermal conductivity, density, wear, strength, hardness, structure bonding, and other physical, chemical, mechanical properties adding of different reinforced materials.

6 While process of composite metal using magnesium for fine surface finish purpose of the metal and improving strength of the metal.

3. Experimental Pictures:







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4. Results:

Hardness Result

S.No	Sample Name	Trail-1 (Seconds)	Trail-2 (Seconds)	Trail-3 (Seconds)	Hardness Values(N/mm^2)
1.	Al -2024	1.2	1.4	1.6	47.515
2.	Al-2024 with 2% silicon carbide	1.3	1.4	1.4	50.609
3.	Al-2024 with 4% silicon carbide	1.2	1.2	1.4	59.194
4.	Al-2024 with 6% silicon carbide	1.2	1.4	1.4	60.749

4.1 Time Vs Wear Result:

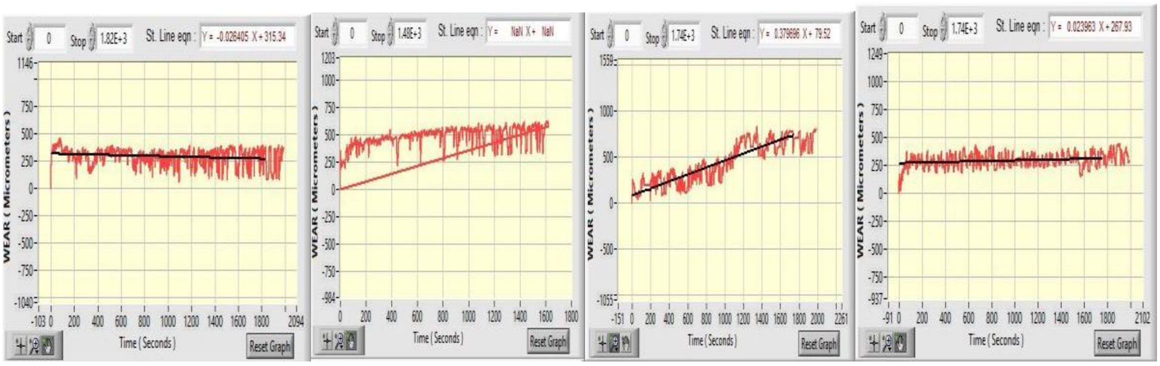

Fig. 1 Wear Graphs for Pure Al 2024 without Reinforcement as well as with 2%, 4% and 6% SiC Reinforcement

The above fig. 1 shows consecutive graphs of Time Vs Wear of Pure Al 2024 without Silicon Carbide Reinforcement as well as with 2%, 4% and 6% SiC Reinforcement which shows that at 4% silicon carbide reinforcement represents the wear resistance berated is high.

4.2 Time Vs Coefficient of Friction:

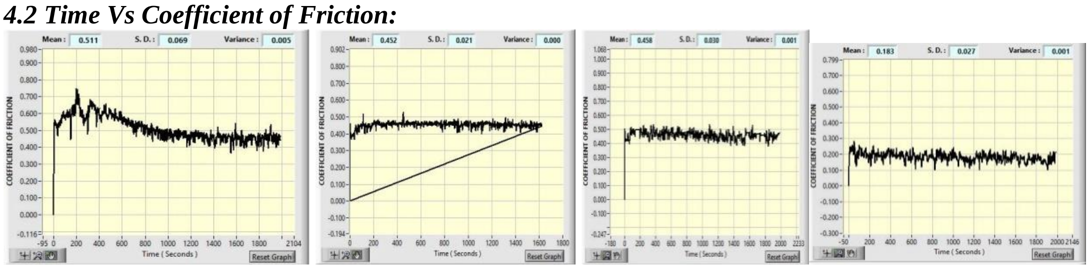

Fig. 2 Coefficient of Friction Graphs for Pure Al 2024 without Reinforcement as well as with 2%, 4% and 6% SiC Reinforcement

The above fig. 2 shows consecutive graphs of Time Vs Coefficient of Friction for Pure Al 2024 without Silicon Carbide Reinforcement as well as with 2%, 4% and 6% SiC Reinforcement which shows that at 2% and 4% silicon carbide reinforcement represents the coefficient of friction berated is high.

4.3 Time Vs Frictional Force:

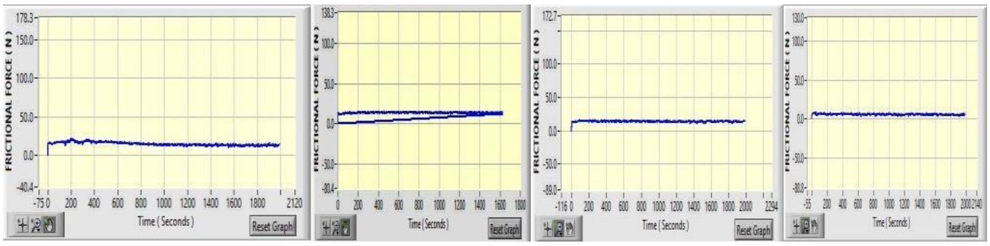

Fig. 3 Frictional Force Graphs for Pure Al 2024 without Reinforcement as well as with 2%, 4% and 6% SiC Reinforcement

The above fig. 3 shows consecutive graphs of Time Vs Frictional Force for Pure Al 2024 without Silicon Carbide Reinforcement as well as with 2%, 4% and 6% SiC Reinforcement which shows that at 4% and 6% silicon carbide reinforcement represents the coefficient of friction berated is high.

Conclusion:

Al-2024 with silicon carbide composite material was prepared successfully in 2%, 4% and 6 % weight percentage silicon carbide reinforcement through stir casting process. Mechanical Characterization was studied on Vickers hardness, compression strength, tensile strength and microstructure behaviour of Al-2024 with silicon carbide composite material was studied and results are summarized and given below:

1. The particle size of composite material &microstructure examined, the size and shape of the Al-2024 and adding of wt% of silicon carbide develops the specimen in 4% and 6% have high distribution in material compared to Pure Al-2024. Based on results 2% of specimen doesn’t form the perfect structure in composite and seems to form a high porosity property in the composite due to casting effects.
2. The Vickers hardness of Al-2024 with silicon carbide composite material increases with increase in addition of silicon carbide reinforcement, As per result based on values this project improved the hardness property in 4% and 6% of the specimen.
3. The Tensile Strength and Compressive Strength of Al-2024 with silicon carbide composite material increases which shows the uniform distribution of silicon carbide thus reducing the internal granule space in the AMMC and also increases in compressive strength shows good physical bond between Al-2024 with silicon carbide composite. As per result based on values this project improved the property in 4% and 6% of the specimen.
4. The Wear of Al-2024 with silicon carbide composite material increases with increase in addition of silicon carbide reinforcement; further increase in wear resistance at certain time period shows good physical phenomenon between Al-2024 with silicon carbide composite. As per result based on values this project improved the property in 4% and 6% of the specimen compare to Pure Al-2024 as well as 2 %.

Based on result of those parameters, 4% of silicon carbide reinforced of composite is much better than 2% and 6% of silicon carbide composite.

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