A REVIEW PAPER ON "**A Study on Mechanical and Tribological Properties of Aluminium Alloy (7075) Reinforced with Nano Silicon Carbide and Red Mud**"

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ABSTRACT

A composite material is a combination of two or more chemically distinct and insoluble phases. Either metals or ceramics or both as well can be embedded with particles or fibers, to improve their properties; these combinations are known as Metal-Matrix composites. Aluminium 7075 alloy widely employed in the aircraft and aerospace industry for the manufacturing of different parts and components, it is due to its high strength to density ratio. The present study deals with the behavior of Al 7075 alloy based composites, reinforced with Nano Sic (particle size of 50 nm) and Red mud. The Nano-particles can improve the base material in terms of wear resistance, damping properties and mechanical properties. To achieve this objective stir casting technique has been adopted and then studying its mechanical and tribological properties such as tensile strength, impact strength and wear behavior of produced test specimen. Experimental set up is developed to carry out the casting of Aluminium MMCs. Experiment has been conducted by varying weight fraction of red mud while keeping Nano Si-C constant . It has been found that the tensile strength and hardness of Al alloy 7075 composites increases with the increase in % wt. of red mud up to certain limit and by addition of more amount of reinforcement the Tensile strength decreases due to poor wettability of the reinforcement material with metal Aluminium matrix.

Keywords: *Nano Sic, Red Mud , metal matrix composites, Al 7075 alloy, Mechanical and Tribological properties and Stirr casting*

1. Introduction

There are more than 50,000 materials available to engineers for the design and manufacturing products for various applications. These materials range from copper, cast iron, brass, which have been available for so many years, to the more recently developed advanced materials such as composites, ceramics and high- performance steels. Due to wide choice of materials, today's engineers are posed with a big challenge for the right selection of material and manufacturing processes for an application.

These materials depending on their major characteristics like stiffness, strength, density and melting temperature, can be classified into four categories. They are (1) Metals (2) Plastics (3) Ceramics and (4) Composites.

Composite materials are defined as "a material systems consisting of mixture of or combination of two or more micro constituents insoluble in each other and differing in form and or material composition". Composites are generally prepared by adding dissimilar materials together to work as a single mechanical unit and the properties of such materials are different in scale and kind from those of any of its individual constituent. Composites can offer a combination of properties and a diversity of applications unobtainable with metals, ceramics, or polymers when used alone.

The aluminum 7075 alloy, zinc is the primary alloying element. It is strong, with a strength comparable to many steels, and has good fatigue strength and average machinability, but has less resistance to corrosion than many

other Al alloys. Its relatively high cost limits its use to applications where cheaper alloys are not suitable. Alloy 7075, a cold finished aluminum wrought product, has the highest strength of all aluminum screw machine alloys.

1.1 Composite Materials

1.1.1 Metals: Metals have been the dominating materials in the past for structural applications. They provide the largest design and processing history to the engineers. The common metals are iron, Aluminium, copper, zinc, magnesium, lead, nickel and titanium. In structural applications, alloys are more frequently used than pure metals. Alloys are manufactured by mixing different elements in right proportions. Alloys offer better mechanical properties when compared with pure metals. Through the principle of alloying, thousands of new alloying composites are developed for various high technical applications. Metals have high stiffness, strength, thermal stability and good electrical conductivity. Due to their higher temperature resistance than plastics, they can be used for applications with service temperature applications

1.1.2 Plastics: Due to their light weight, easy process-ability and corrosion resistance, plastics are widely used for automobile, aerospace and consumer goods. Plastics can be formed into near-net-shaped parts with ease. They provide high surface finish coupled with low production cost.

1.1.3 Ceramics: These are more rigid of all the engineering materials. The major distinguishing characteristic of ceramics compared to metals is that they possess almost no ductility. They fail in a brittle manner. They have the highest melting points. They are generally used for high- temperature and high-wear applications and are resistant to most forms of chemical attack.

1.1.4 Composites: These materials have been utilized to solve the technological problems for a long time but only in the 1960s did these materials start capturing the attention of industries with the introduction of polymeric- based composites. Since then, composite materials have become common engineering materials and are designed and manufactured for various applications including automotive components, sporting goods, aerospace parts, consumer goods, and in the marine and oil industries.

Aluminium and Its Alloy: Aluminum, the second most plentiful metallic element on earth, became an economic competitor in engineering applications as recently at the end of the 19th century. The emergence of three important industrial developments would, by demanding material characteristics consistent with the unique qualities of aluminium and its alloys, greatly benefit growth in the production and use of the new metal. Table 1.1 shows metal matrices and respective reinforcements

Matrix	Reinforcements
Aluminium and alloys	C, Be, SiO_2, B, SiC, Al_2O_3, Steel, B_4C, Al_3Ni, Mo, W, Z_rO_2
Titanium and alloys	B, SiC, Mo, SiO_2, B_e,ZrO_2
Nickel and alloys	C, B_e, Al_2O_3,SiC, Si_3N_4, steel, W, Mo, B
Magnesium alloys	C, B, glass, Al_2O_3
Molebdenum and alloys	B, ZrO_2
Iron and Steel	Fe, Steel, B, Al_2O_3, W, SiO_2,ZrO_2
Copper and alloys	C,B, Al_2O_3, E-glass

1.1.5 Silicon Carbide: Silicon carbide(Sic),also known as carborundum. Silicon carbide is the only chemical compound of carbon and silicon. It was originally produced by a high temperature electro-chemical reaction of sand and carbon. Silicon carbide is an excellent abrasive and has been produced and made into grinding wheels and other abrasive products for over one hundred years.

1.1.6 Red Mud: Red mud is one of the major waste material during production of alumina from bauxite by the Bayer's process. It is an insoluble product generated after bauxite digestion with sodium hydroxide at elevated temperature and pressure is known as red mud or „bauxite residue". It comprises of oxides of iron, titanium, aluminium and silica along with some other minor constituents.

1.2 Mechanical Properties:

1.2.1 Hardness: Hardness is the resistance of metal to plastic deformation, usually by indentation. However, the term may also be referred to resistance to scratching, abrasion or cutting. In general, addition of hard reinforcement in the matrix alloy results in improved hardness of the composites. However, presence of soft reinforcement in the matrix alloy reduces the hardness of the obtained composites. The

type and extent of incorporation of the reinforcement has a profound influence on the hardness of the composite.

1.2.2 T**ensile Strength:** Tensile properties dictate how the material will react to forces being applied in tension. A tensile test is a fundamental mechanical test where a carefully prepared specimen is loaded in a very controlled manner while measuring the applied load and the elongation of the specimen over some distance. Tensile tests are used to determine the modulus of elasticity, elastic limit, elongation, proportional limit, and reduction in area, tensile strength, yield point, yield strength and other tensile properties.

1.2.3 Ultimate Tensile Strength: The ultimate tensile strength (UTS) or, more simply, the tensile strength, is the maximum engineering stress level reached in a tension test. The strength of a material is its ability to withstand external forces without breaking. In brittle materials, the UTS will at the end of the linear-elastic portion of the stress-strain curve or close to the elastic limit. In ductile materials, the UTS will be well outside of the elastic portion into the plastic portion of the stress-strain curve.

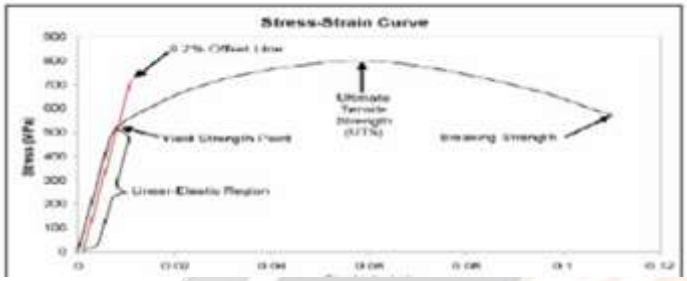

Fig:. Stress Strain Curve of Ductile Material

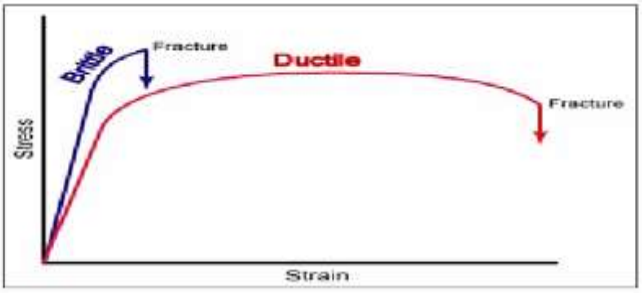

Fig: Fracture Point of Ductile and Brittle material

2.Literature Survey:

Mr. Vijay Kumar S Maga, B S Motagi," A Study on Mechanical Properties of Aluminium Alloy (LM6) Reinforced With Fly Ash, Red mud and Silicon Carbide": This work deals with fabricating or producing aluminium based metal matrix composite and then studying its microstructure and mechanical properties such as tensile strength, impact strength and wear behavior of produced test specimen. In this present study a modest attempt has been made to develop aluminium based MMCs with reinforcing material with an objective to develop a conventional low cast method of producing MMCs and to obtain homogeneous dispersion of reinforced material. To achieve this objective stir casting technique has been adopted. Aluminium Alloy (LM6) and Sic, Fly Ash, Red mud has been chosen as matrix and reinforcing material respectively. Experiment has been conducted by varying weight fraction of Sic, Fly Ash, Redmud. The result shown that the increase in addition of Fly Ash is giving better result when compared with Red mud.

Mr. Prashant Kumar Suragimath1, Dr. G. K. Purohit 2," A Study on Mechanical Properties of Aluminium Alloy (LM6) Reinforced with SiC and Fly Ash": This work deals with fabricating or producing aluminium based metal matrix composite and then studying its microstructure and mechanical properties such as tensile strength, impact strength and wear behavior of produced test specimen. In the present study a modest attempt has been made to develop aluminium based MMCs with reinforcing material, with an objective to develop a conventional low cast method of producing MMCs and to obtain homogeneous dispersion of reinforced material. To achieve this objective stir casting technique has been adopted. Aluminium Alloy (LM6) and SiC, Fly Ash has been chosen as matrix and reinforcing material respectively. Experiment has been conducted by varying weight fraction of Fly Ash (5% and 15%) while keeping SiC constant(5%). The result shown that the increase in addition of Fly Ash increases the Tensile Strength, Impact Strength, Wear Resistance of the specimen and decreases the percentage of Elongation.

Er. Sandeep Kumar Ravesh , Dr. T. K. Garg," Prepration & Analysis For Some Mechanical Property Of Aluminium Based Metal Matrix Composite Reinforced With SiC & Fly Ash": The paper deals with the fabrication of aluminium based metal matrix composite and then characterized their mechanical properties such as hardness, toughness and tensile strength. In the present study a modest attempt has been made to develop aluminium based silicon carbide particulate MMCs with an objective to develop a conventional low cast method of producing MMCs and to obtain homogeneous dispersion of ceramic material. To achieve this objective stir casting technique has been adopted. Aluminium 6061 (97.06% C.P) and SiC, Fly Ash has been chosen as matrix and reinforcement material respectively. Experiment has been conducted by varying weight fraction of SiC (2.5%, 5%, 7.5%, 10%) while keeping all other parameters constant. The result indicated that the developed method is quite

successful and there is an increase in the value of tensile strength, hardness and toughness with increase in weight percentage of SiC.

Md Sadiq Ali, B.S Motgi," A Study on Mechanical and Tribological Properties of Al6063 MMC Reinforced With Nano Sic, Fly Ash and Red Mud": The present study deals with the behavior of aluminium alloy based composites, reinforced with nano size silicon carbide, fly ash and red mud. The nano-particles can improve the base material in terms of wear resistance, damping properties and mechanical strength. To achieve this objective stir casting technique has been adopted and then studying its mechanical and tribological properties such as tensile strength, impact strength and wear behavior of produced test specimen. The main aim involved in the present work is focused on study of mechanical and tribological properties of Al6063 alloy composite having varying weight percentages of 3% - 2% - 2% of nano sized Silicon Carbide, Fly ash and Red mud. The result indicated that the developed method is quite successful and there is an increase in the value of tensile strength, hardness with increase in weight percentage of SiC. Metal matrix composites reinforced by nano-particles are very promising materials, suitable for a large number of applications

Gurvishal Singh, Harwinder Lal, Daljit Singh and Gurdeshbir Singh," An Approach for Improving Wear Rate of Aluminium Based Metal Using Red Mud, SiC and Al2O3 Matrix Composites": In this paper we describe the behavior of Metal matrix composites. As we know that these metal matrix composites are used mostly in liberty ships, aerospace, automotive, and nuclear. In the present paper the study on sharp show off activities of Aluminum metal matrix composite reinforced with Red Mud, SiC and Al2O3 has been carried out. There are various production technique offered where the value fraction of reinforcements could be inflamed and are likely to vary the wear performances of the composite. Composites posses excellent Strength and Stiffness and this describes that these are very light Materials. So this paper describes that these possess high resistance to oxidization, chemicals and other weather agents. Our paper also describes the advantages of MMC's as it provides Dimensional stability, Wear and Corrosion resistance, Reduced Weight. As we know that Red mud emerges as the major waste material during production of alumina from bauxite by the Bayer's process. Enormous efforts have been directed worldwide towards red mud management issues, i.e., of utilization, storage and disposal. Different avenues of red mud utilization are more or less known but none of them have so far proved to be economically viable or commercially feasible. It is studied that micro hardness and resistance to wear of MMCs is produced by reinforcement and also the wear properties are improved remarkably by introducing hard intermetallic compound into the aluminum matrix.

3. Matrix Materials and Methods:

3.1 Al 7075: The aluminum 7075 alloy, zinc is the primary alloying element. It is strong, with a strength comparable to many steels, and has good fatigue strength and average machinability, but has less resistance to corrosion than many other Al alloys. Its relatively high cost limits its use to applications where cheaper alloys are not suitable. 7075 aluminum alloy's composition roughly includes 5.6–6.1% zinc, 2.1–2.5% magnesium, 1.2–1.6% copper, and less than half a percent of silicon, iron, manganese, titanium, chromium, and other metals. It is produced in many tempers, some of which are 7075-0, 7075-T6, 7075-T651. Alloy 7075, a cold finished aluminum wrought product, has the highest strength of all aluminum screw machine alloys. The -T6 and -T651 tempers have a typical tensile strength of 83 ksi, which is higher than many mild steels.

Characterstics of Al 7075:

High strength, Good wear resistance

Poor corrosion resistance, Non-magnetic

Non-sparking High specific modulus, low

Co-efficient of thermal expansion and

Physical Properties:

Density 2.81g/cc

3.2. Reinforcement Material:

3.2.1. Silicon carbide: It is used in abrasives, refractory ceramic and numerous high performance applications. The material can also be made an electrical conductor and has application in resistance

heating, flame igniters and electronic components. Silicon carbide is composed of tetrahedral of carbon and silicon atoms with strong bonds in the crystal lattice. Structural and wear application are constantly developing. This produces a very hard and strong material. In this experiment Silicon Carbide (Black) having grain size 50 nm is used. Silicon carbide particles are shown in Fig.3.1

Fig. 3.1 Silicon Carbides as reinforcement

3.2.2. Red Mud: Red mud is the caustic insoluble waste residue generated by alumina production from bauxite by the Bayer's process at an estimated annual rate of 66 and 1.7 million tons, respectively, in the World and India (Prasad and Acharya, 2006). Under normal conditions, when one ton of alumina is produced nearly a ton of red mud is generated as a waste. This waste material has been accumulating at an increasing rate throughout the world.Composites containing 2, 4and 6 percent of red mud are prepared according to ASTM standards.

Fig 3.2 Red Mud as Reinforcement

4.Problem Statement:

From the literature review it reveals most of the works are carried with a micro reinforcements, now we have developed Al MMC with nano reinforcement. It has been observed that number of works has been done on the properties of Al alloy 7075. But very few papers revel about the addition of nano Sic + red mud. So scope is there in this area to find the properties and applications of the developed composites. Metal matrix composites (MMCs) are a range of advanced materials that can be used for wide range of application within the aerospace, automotive, nuclear, biotechnology, electronic and sporting goods industries. The work was carried out by preparing the samples of different percentage. Tensile test is carried out on UTM, Charpy impact test and Wear under dry sliding condition.

5.Experimental Setup:

5.1. Weighing Machine for weighing the alloy Al7075 and reinforcing material.

5.2. Matrix (Al7075 Alloy)

5.3. Reinforcements (nano silicon carbide, fly ash)

5.4. Electric Induction Furnace for melting the composites

5.5. Crucible (Graphite) is used to carry out the composites in induction furnace

5.6. Die Mould (Mild Steel)

5.7. Stirrer (Stainless Steel Rod) is used to stir the molten composite to get homogeneous distribution

5.8. Lathe Machine is used to prepare tensile and wear test samples

5.9. Shaping Machine is used to prepare impact test samples

5.10. UTM (Tensile test)

5.11. Izode and chorpy machine (Impact test)

5.12. Pin On Disc Machine (Wear test).

5.13. XRD machine (atomic and molecular structure)

5.14. SEM (microstructure)

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