MECHANICAL PROPERTIES OF ALUMINIUM METAL MATRIX COMPOSITE (Al+ SiC + Zn)

Mr.S.RAMPRASAD[1], S.RAMPRAKASH[2], K.REVANTH[3], C.SUBASH[4],M.M.THAMARAI SELVAN[5]

[1]*Assistant Professor, Department of Mechanical Engineering, V.S.B Engineering College, Karur*

[2,3,4,5] *Final year Mechanical Engineering, V.S.B Engineering College, Karur.*

ABSTRACT

The aim of this project is about a brief overview of the historical development of aerospace aluminium alloys. Aluminium matrix composites (AMCs) are potential materials for various applications due to their good physical and mechanical properties. This study is proposed as an introduction to a comprehensive investigation of mechanical properties of aluminium alloy. They have the potential to replace the conventional materials because of obtaining superior properties such as high specific strength, high stiffness, high hardness, high wear resistance and low density. In the past three decades composite materials were playing a vital role in various sectors especially in aeronautical, avionics and automotive sectors. The present works dealt with the mechanical behavior of aluminum metal matrix reinforced with Silicon Carbide and zinc particles in different weight fractions were prepared by sand casting method. The present works dealt with the mechanical behavior of aluminum metal matrix reinforced with Silicon carbide and Zinc particles in different weight fractions 10 % and 10 % were prepared by sand casting method.

Keywords:*Aluminum, Zinc, Silicon Carbide, Metal matrix.*

INTRODUCTION

Composite materials are playing vital and major role in research and development of various engineering and aeronautical sectors. In the past three decades composite materials are replaced most of the traditional materials because of obtaining superior properties such as higher specific strength, high hardness and high wear resistance, high thermal resistance and low density. Specifically aluminum metal matrix composites have preferred in aeronautics, marine and automotive industries for obtaining best result of mechanical properties. Composite materials are manufactured through solid and liquid method. In the liquid metallurgy route following methods are preferred such as stir casting method, electromagnetic stir casting method, centrifugal cast and in-situ method. The particle that is the particulate were reinforced with injection process into liquid matrix through liquid metallurgy route by die casting process. Die casting process is preferred because of less expensive and fit for mass production process. Among the entire liquid state production processes, stir casting is the simple and economical one (Hashim, 1999). Aluminum is one of the elements in boron group with atomic number 13. Pure aluminum has relatively soft material when comparing to the other non-ferrous materials. To overcome this issue of metal can be alloyed with other metals to obtaining superior mechanical and thermal properties. Most of the aluminum available in the market, manufacturers has been alloyed with at least one other element. The typical alloying elements are copper manganese, magnesium, tin and zinc. There are two principal classifications, namely casting alloys and wrought alloys, both of which are further sub divided into the categories heat treatable and non-heat-treatable. Composite materials are classified into based on matrix material such as if matrix material is polymer it is called as polymer matrix composite (PMC), if matrix material is metal it is called as metal matrix composite (MMC) and if the matrix material is ceramic it is called as ceramic matrix composite (CMC) (Surappa, 2003). 7000 series alloys such as 7050 are used in transport applications, like marine, automotive and aviation, due to their high strength and low density. Also used in Rock climbing equipment, bicycle components, inline skating-frames and hang glider airframes are commonly made from 7075 aluminum alloy. The problem exist in the stir casting process is the non-uniform distribution of the reinforcements. Present work is based on the mechanical behavior of Aluminium7050 with graphene as reinforcement produced by stir casting method with different weight % of graphene were used and various tests were conducted on the composite material such as hardness test, tensile test, impact test, optical microscope and scanning electron microscope (SEM) tests were performed on the samples produced by stir casting method.

LITERATURE SURVEY

1. M. Babic(May 2009)The effects of heat treatment on the microstructure, hardness, tensile properties, and tribological behavior of ZA27 alloy were examined. The alloys were prepared by conventional melting and casting route. The heat treatment of samples included the heating up to 370 C for 3 or 5 h, quenching in water, and natural aging. Lubricated sliding wear test were conducted on as-cast and heat-treated ZA27 samples using block-on-disc machine. The friction and wear behavior of alloys were tested in contact with steel discs using combinations of three levels of load (10, 30, and 50 N) and three levels of linear sliding speeds (0.26, 0.50, and 1.00 m/s). To determine the wear mechanisms, the worn surfaces of the samples were examined by scanning electron microscopy (SEM). The heat treatment resulted in reduction in the hardness and tensile strength but increase in elongation. The heat-treated alloy samples attained improved tribological behavior over the as-cast ones, under all combinations of sliding speeds and contact loads. The rate of improvement increased with duration of solutionizing process before quenching in water. Obtained tribological results were related to the effects of heat treatment on microstructure changes of alloy.

2. P. K Jayashree (2013)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 composites. These composites initially replaced Cast Iron and Bronze alloys but owing to their poor wear and seizure resistance, they were subjected to many experiments and the wear behavior of these composites were explored to a maximum extent and were reported by number of research scholars for the past 25 years. In the present study, based on the literature review, the effect of Silicon carbide on Stir cast Aluminium Metal Matrix Composites is discussed. Aluminium Metal Matrix Composites with Silicon carbide particle reinforcements are finding increased applications in aerospace, automobile, space, underwater, and transportation applications. This is mainly due to improved mechanical and tribological properties like strong, stiff, abrasion and impact resistant, and is not easily corroded. In the present scenario, a review of different researchers have been made to consolidate some of the aspects of mechanical and wear behavior of Aluminium Metal Matrix Composites reinforced with Silicon carbide particles in both untreated and precipitation hardened condition.

3. A. Chennakesava Reddy (2013)The material selection criteria involve the requirement of high strength and good corrosion resistance aluminum alloys for the matrix materials. The mechanical properties have been determined for different metal matrix composites produced from Al 6061, Al 6063 and Al 7072 matrix alloys reinforced with silicon carbide particulates. The yield strength, ultimate strength, and ductility of Al/SiC metal matrix composites are in the descending order of Al 6061, Al6063 and Al 7072 matrix alloys. Mg has improved the wettability between Al and SiC particles by reducing the SiO_2 layer on the surface of the SiC. The fracture mode is ductile in nature.

4. K.K. Alaneme(2014)The mechanical and corrosion behaviour of Zn-27Al alloy based composites reinforced with groundnut shell ash and silicon carbide was investigated. Experimental test composite samples were prepared by melting Zn-27Al alloy with pre-determined proportions of groundnut ash and silicon carbide as reinforcements using double stir casting. Microstructural examination, mechanical properties and corrosion behaviour

were used to characterize the composites produced. The results show that hardness and ultimate tensile strength of the hybrid composites decreased with increase in GSA content. Although the % Elongation somewhat decreased with increase the GSA content, the trend was not as consistent as that of hardness and tensile strength. The fracture toughness of the hybrid composites however, increased with increase in the GSA content of the composites. In 3.5 % NaCl solution, the composites were resistant to corrosion with some of the hybrid composite grades containing GSA exhibiting relatively superior corrosion resistance to the grades without GSA. In 0.3M H_2SO_4 solution, the composites were generally a bit more susceptible to corrosion (compared to 3.5 % NaCl solution), but the effect of GSA content on the corrosion resistance of the composites was not consistent for the Zn-27Al alloy based composites.

5. Kiran TS (2013) The mechanical behavior of as-cast ZA-27 alloy and hybrid composite reinforced with graphite (Gr) of constant 3% by weight and silicon carbide particle (SiCp) varying from 0-9% by weight in steps of 3% was carried out. Vortex method of production was employed in which thoroughly mixed Gr and SiC particles were poured into the vortex created by means of mechanical stirrer. The melt was cast using a pre-heated permanent mold box. Microstructure showed fine distribution of the reinforcements in the specimen. Tensile and hardness tests were carried out as per ASTM standards. The results reveal that, as the percentage of SiC was increased, UTS and hardness increased with reduction in ductility

OBJECTIVE

To make metal matrix by selecting metals like Aluminium,SiliconCarbide,Zinc to produce comparatively high strength material.

PROBLEM STATEMENT

To overcome this issue of metal can be alloyed with other metals to obtaining superior mechanical and thermal properties.

MATERIAL AND ITS PROPERITIES

MATERIAL: Aluminium, Zinc, Silicon Carbide.

PROPERTIES

- High specific strength,
- High stiffness,
- High hardness,
- High wear resistance,
- Low density.

METHODOLOGY

STUDYY OF DIFFERENT COMPOSITE MATERIAL

Aluminium- The yield strength of pure aluminium is 7–11 MPa, while aluminium alloys have yield strengths ranging from 200 MPa to 600 MPa. Aluminium has about one-third the density and stiffness of steel. It is easily machined, cast, drawn and extruded.Aluminium atoms are arranged in a face-centered cubic (fcc) structure. Aluminium has a stacking-fault energy of approximately 200 mJ/m2. Aluminium is a good thermal and electrical conductor, having 59% the conductivity of copper, both thermal and electrical, while having only 30% of copper's density.

Zinc-Zinc is more reactive than iron or steel and thus will attract almost all local oxidation until it completely corrodes away.[105] A protective surface layer of oxide and carbonate ($Zn_5(OH)_6(CO_3)_2$) forms as the zinc corrodes. This protection lasts even after the zinc layer is scratched but degrades through time as the zinc corrodes away. The zinc is applied electrochemically or as molten zinc by hot-dip galvanizing or spraying. Galvanization is used on chain-link fencing, guard rails, suspension bridges, light posts, metal roofs, heat exchangers, and car bodies.

Silicon carbide-Silica (SiO_2) in the form of sharp flints were among the first tools made by humans. The ancient civilizations used other forms of silica such as rock crystal, and knew how to turn sand into glass. Considering silicon's abundance, it is somewhat surprising that it aroused little curiosity among early chemists.

RAW MATERIALS PREPARATION

Aluminum 6063 and zinc were prepared by liquid metallurgy route such that stir casting method. Electric induction furnace has been used for getting liquid metal, reaching of 500°C raw materials were put into the furnace to getting liquid metal. Reaching of liquid state of molten aluminum add with the preheated zinc reinforcements in the separate chamber. Maintain the constant process parameters during stirring such as melting temperature 820°C, stirring time 5 to 10 seconds and stirring speed 400 rpm. After pouring into the preheated die to obtaining casting.

COMPOSITE TECHNOLOGY

Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties which remain separate and distinct on a macroscopic level within the finished structure.

In an advanced society like ours we all depend on composite materials in some aspect of our lives. Fiber glass, developed in the late 1940s, was the first modern composite and is still the most common. It makes up about 65 per cent of all the composites produced today and is used for boat hulls, surfboards, sporting goods, swimming pool linings, building panels and car bodies. You may well be using something made of fiberglass without knowing it. Composite materials are formed by combining two or more materials that have quite different properties. The different materials work together to give the composite sunique properties, but within the composite you can easily tell the different materials apart – they do not dissolve or blend into each other. Put more technically, it has both good compressive strength and good tensile strength. Composites exist in nature.

Uses of composites

- The greatest advantage of composite materials is strength and stiffness combined with lightness. By choosing an appropriate combination of reinforcement and matrix material, manufacturers can produce properties that exactly fit the requirements for a particular structure for a particular purpose Modern aviation, both military and civil, is a prime example. It would be much less efficient without composites. In fact, the demands made by that industry for materials that are both light and strong has been the main force driving the development of composites

- . It is common now to find wing and tail sections, propellers and rotor blades made from advanced composites, along with much of the internal structure and fittings. The airframes of some smaller aircraft are made entirely from composites, as are the wing, tail and body panels of large commercial aircraft.

- In thinking about planes, it is worth remembering that composites are less likely than metals (such as aluminum) to break up completely under stress. A small crack in a piece of metal can spread very rapidly with very serious consequences (especially in the case of aircraft). The fibers in a composite act to block the widening of any small crack and to share the stress around.

- The right composites also stand up well to heat and corrosion. This makes them ideal for use in products that are exposed to extreme environments such as boats, chemical-handling equipment and spacecraft. In general, composite materials are very durabl

- Another advantage of composite materials is that they provide design flexibility. Composites can be molded into complex shapes – a great asset when producing something like a surfboard or a boat hull.

CASTING

In this project we have used sand mold casting for produce the requirement size. **Sand casting**, also known as **sand molded casting**, is a metal casting process characterized by using sand as the mold material.

It is relatively cheap and sufficiently refractory even for steel foundry use. A suitable bonding agent (usually clay) is mixed or occurs with the sand. The mixture is moistened with water to develop strength and plasticity of the clay and to make the aggregate suitable for molding. The term "sand casting" can also refer to a casting produced via the sand casting process. Sand castings are produced in specialized factories called foundries.

Over 70% of all metal castings are produced via a sand casting process.

Basic process

There are six steps in this process:

1. Place a pattern in sand to create a mold.
2. Incorporate the pattern and sand in a gating system.
3. Remove the pattern.
4. Fill the mold cavity with molten metal.
5. Allow the metal to cool.
6. Break away the sand mold and remove the casting.

Fig. Aluminium Silicon carbide and zinc raw materials

Fig. Pattern making in sand casting

RESULT AND DICUSSION

Tensile test

The tensile tests were carried out according to the ASTM E8 standard by universal testing machine to determine the amount of tensile strength to withstand during fracture.

Compression test

The compression tests were carried out in according to ASTM standard by universal testing machine to determine the amount of compressive strength to withstand during fracture. Compression test conducted with the three different samples which is prepared by wire cut machine.

Hardness test

The hardness tests were conducted by Brinell hardness tester in accordance to the ASTM E10 standard with the ball indenter diameter 10mm, load applied 500 kg and 20 seconds. The test were carried out in the room temperature atmosphere in the range of 30 to 32°C and measurements of hardness were obtained from five different places on each sample then considered as average hardness value.

CONCLUSION:

Hardness of the material is increased and strength to weight ratio is increased.

REFERENCES

[1] M. Babic, A. Vencl, S. Mitroviü, I. Bobiü, Influence of T4 Heat Treatment on Tribological Behavior of Za27 Alloy Under Lubricated Sliding Condition, Tribology Letters, Vol.36, No.2, pp. 125-134, ISSN 1023-8883, 2009

[2] M. Babiü, S. Mitroviü, R. Ninkoviü, Tribological Potencial of Zinc-Aluminium Alloys Improvement, Tribology in Industry, Vol.31, No.1&2, pp. 15-28, ISSN 0354-8996, 2009

[3] M. Babic, S. Mitrovic, B. Jeremic, The influence of heat treatment on the sliding wear behavior of a ZA-27 alloy, Tribology International, Vol.43, No.12, pp. 16-21, ISSN 0301-679, 2010

[4] M. Babic, S. Mitrovic, D. Dzunic, B. Jeremic, I. Bobic: Tribological Behavior of Composites Based on ZA-27 Alloy Reinforced with Graphite Particles Tribology Letters, Vol.37, No.2, pp. 401-410, ISSN 1023-8883, Doi 10.1007/s11249-009-9535-2, 2010

[5]. P. K Jayashree , M. C Gowri Shankar , Achutha Kini, S. S Sharma and Raviraj Shetty, "Review on Effect of Silicon Carbide (SiC) on Stir Cast Aluminium Metal Matrix Composites", International Journal of Current Engineering and Technology, 2013.

[6]. D Manoj Singla, Deepak Dwivedi, Lakhvir Singh, Vikas Chawla, "Development of Aluminium Based Silicon Carbide Particulate Metal Matrix Composite", Journal of Minerals & Materials Characterization & Engineering, Vol. 8, No.6, 2009, pp 455-467.

[7]. M. Yilmaz and S. Altintas, "Properties of Al-Mg-SiC Composites Produced by a Modified Compo Casting Technique", In Proceeding of the 2nd Bienniel European joint conference on Engineering Systems, 1994, pp 119-124.

[8]. W. Zhou, Z. M. Xu, "Casting of SiC Reinforced Metal Matrix Composites", Journal of Materials Processing Technology,Vol. 63 , 1997, pp 358-363.

[9]. V. M. Kevorkijan and B. Sustarsic, "A new production Technology For Discontinuously reinforced Al-SiC Composites", Key. Eng. Mater, 1997, pp 127-131.

[10]. C. Neelima Devi, N. Selvaraj, V. Mahesh, "Micro Structural Aspects of Aluminium Silicon Carbide Metal Matrix Composite", Int. Journal of Applied Sciences and Engineering Research, Vol. 1, No. 2, 2012.

[11]. A. Chennakesava Reddy and Essa Zitoun,. "Matrix Al-alloys for Silicon Carbide Particle Reinforced Metal Matrix Composites", Indian

Journal of Science and Technology, Vol. 3, No. 12, 2010.

[12]. Dr Ali Hubi, Newel muhammed Dawood, "Silicon Carbide Particles Reinforced Aluminium Matrix Composite Prepared by Stir Casting" , Babylon University , Material Engineering College.

[13]. G. B. Veeresh Kumar, C. S. P. Rao, N. Selvaraj, M. S. Bhagyashekar, " Studies on Al6061-SiC and Al7075 - Al2O3 Metal Matrix Composites", Journal of Minerals & Materials Characterization & Engineering, Vol. 9, 2010, pp 43-55.

[14]. S. Das, R. Behera, A. Datta, G. Majumdar, B. Oraon, G. Sutradhar, "Experimental Investigation on the Effect of Reinforcement Particles on the Forgeability and the Mechanical Properties of Aluminum Metal Matrix Composites", Materials Sciences and Applications, 2010, pp 310-316.

[15]. Alaneme KK, Fatile BO, Borode JO (2014) Mechanical and corrosion behavior of Zn27Al based composite reinforced with groundnut shell ash and silicon carbide. Tribol in Ind 36(2):195–203

[16]. Kiran TS, Prasanna Kumar M, Basavarajappa S, Vishwanatha BM (2013) Mechanical properties of as-cast ZA-27/Gr/SiC_p hybrid composite for the application of journal bearing. J of Eng Sci and Technol 8(5):557–565

[17]. Alaneme KK, Adama SI, Oke SR (2014) Mechanical properties and corrosion behavior of Zn-227Al based composite reinforced with silicon carbide and bamboo leaf ash. LEJPT 25:58–71

[18]. Alaneme KK, Olusola JA (2017) Microstructure and mechanical behavior of stir-cast Zn-227Al based composite reinforced with rice husk ash, silicon carbide and graphite. J of King Saud Univer-Eng Sci 29(2):172–177

[19].Bobic B, Mitrovic S, Bbaic M, Vencl A, Bobic I (2011) Corrosion behavior of the as-cast and heat treated ZA27 alloy. Tribol in Ind 33(2):87–93