Effect of Si-C on MMC of Al-Zn Alloy

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Abstract - Al hybrid metal matrix composites are a new generation of MMC's that have the potential of Satisfying recent demands are met due to improve mechanical properties amenability to conventional processing techniques and possibility of reducing production cost of Al hybrid composites. By selecting the different combination of reinforcement Al matrix composites and how it effects mechanical properties, corrosion and wear performance of the material. Then SiC particles are added to the matrix for further work. The composites cast results are tested for their strength, hardness and wear resistance. They can be used for electrical, automotive and astronautic application due to attractive properties such as adjustable thermal expansion coefficient, low density, high wear resistance and high stiffness. It was observed that increasing the reinforcement content within the Al matrix results in significant increases in the UTS and hardness values.

Key Words: composite, SiC, strength, hardness and wear

1. INTRODUCTION

Need for only new wear resistant materials for increase performance tribological applications has been one of the major incentives for the technological development of ceramic particulate reinforced Zinc aluminum alloys during the last few years. Several researchers have reported that the incorporation of hard particles such as Al alloy or SiC in cast Zinc aluminum alloys improve the abrasive wear resistance, sliding of these alloys. Aluminum Zinc metal matrix composites are among the most promising materials for wear and structural applications due to low density, low cost and ease of fabrication of composites.

It has been reported that the abrasive wear resistance of the particle reinforced MMCs were increase with the volume fraction of particles and under both high and low stress abrasive wear conditions. On a weighted adjusted basis, many Zn-Al-based composite materials can outperform cast iron, steel, Al, Mg and virtually any other reinforced metal or alloy in a different applications. Hence, it methinks feasible that metal matrix composites will replace conventional materials in many commercial and industrial applications. The particle reinforced MMCs are appealing since they reveal isotropic characteristics by comparison with the continuously reinforced matrices fabrication of the irregularly reinforced Al-Zn-based MMCs can be derived by ideal metal processing technologies such as powder metallurgy, direct casting, rolling, forging, and extrusion. The products can be drilled, machined and shaped by using primary facility. They can be made accessible in quantities suitable for automobile applications. The main limitation for automotive applications are their inadequate or poor fracture toughness, fatigue performance low and hardness compared to those of the constituent matrix material.

A number of zinc-based conventional alloys having eutectic, eutectoid and monotectoid compositions has been created. The alloys seen good performance not only bronze but also cast iron used in various tribological and engineering applications Zinc-based monotectoid alloys containing Cu and Si have been found to be superior to the alloys based on either eutectoid or eutectic compositions, as long as their tribological and mechanical characteristics are related. Among the copper containing Al–Zn alloys, highest hardness and tensile strength were obtained with Al–Zn–Cu alloys This indicates that the binary Al–Zn alloy can be taken as the basis for preparing and investigating ternary Al–Zn–Cu alloys .However, the effect of copper content on the microstructure and properties of Al–Zn–Cu alloys have not been fully understood.

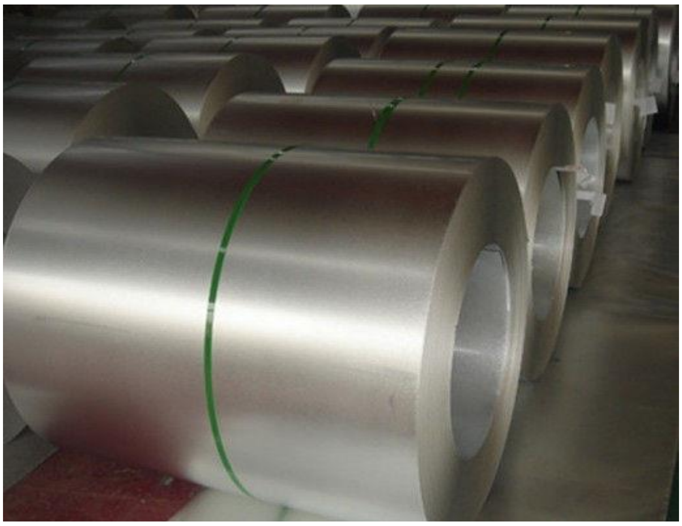

Figure No. 1-Al-Zn Alloy Material

Aluminum matrix composites (AMC) exhibit better mechanical properties than unreinforced aluminum alloys. It has been used as tribological parts in few vehicles for years due to better wear resistance 3.4 and their good ratio of strength/density. Rapid solidification techniques have been used to produce high performance matrix powders and the mechanical properties of aluminum matrix composites were enhanced greatly. It is difficult to shape AMC in a lathe with conventional cutting tools because ceramic particles in AMC cause more wear of the cutting tools and Al is prone to adhesion to cutting tools and decreases the service life and cutting efficiency of cutting tools. On the other hand, the ever increasing concern for environmental protection and restricted use of specific chemical compounds demand the development of non or less-polluting metal working fluids 7%. In this study, the tribological characteristics of SIC particulate reinforced AMC are derived in a inverse friction tester under water lubrication and dry sliding conditions. The wear mechanisms are proposed and discussed as in this research.

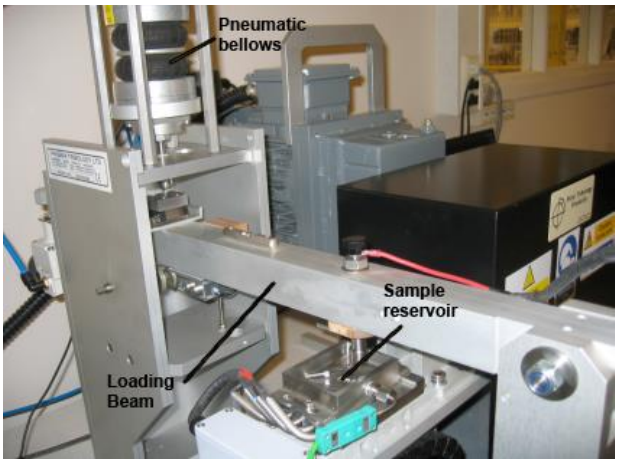

Figure No. 2-Wear Testing Machine

Wear testing is a faculty for assessing sideways displacement or erosion of material from its ideal position and derivative on a solid surface performed by the action of another surface. This test is commonly used as a simple determine of workability of material. It has been important to conduct mechanical tests which simulate the condition of material will realized in actual use. Wear testing is typically carried out on the Al alloy.

The forces and loads acting on materials are compressive in nature and their ability to withstand such loads and forces without failure is a determine of their credibility. The wear testing machine for materials is the primary step to effective good manufacturing practice and quality control.

The foreign wear machines are expensive, rarely available and beyond the reach of the investigators. The need to evolve a multipurpose effective wear machine with 100% indigenously sourced components and materials which will be readily available and cheap to surface study and quality control, will improve productivity, good manufacturing practice in the building material industry, the design and fabrication of a wear testing machine is determined. Pin on disc wear test machines is to be constructed and designed. Pin on disc wear tests are conduct by using a constant load in the contact and disc is rotated at constant speed. The weight loss is regularly determined and saves to calculate the wear rate. The aim of this study was to evaluate the effect of changing the load on the rate of wear, by design a device to find out the rate of material removed under the effect of different loads.

Design and calculations were established and the machine was fabricated with well materials and components all sourced locally. The performance of the fabricated machine was finally evaluate against a standard wear machine in the Standards Organization using statistical methods and the result showed that the locally fabricated machine is 97% effective.

2. METHODOLOGY

2.1 Hardness Testing:

Hardness tests (BHN) were conducted on all the polished component for micro structural measurement. Specimens used for hardness tests were selected at the cold end of the casting.

2.2 Wear Testing:

Abrasive wear tests were conducted on a rubber wheel abrader machine. The specimens were of the size 10 mm diameter and 25 mm length of dimensions. Dry abrasive wear tests are performed by using sand as the abrasive medium.

2.3 Slurry Testing:

Slurry wear tests were conducted on a slurry wear testing machine. Sand was used along with water to form the slurry and was confirmed to ASTM G-75 standards.

2.4 Pin on Disc tests:

The pin-on disc machine were used to carried out friction and wear test. The main components of machine are a pin, a disc, and a loading system, its mounting system and temperature measurement system and a friction force. The disc was made of SAE 1045 steel with a hardness of 50 ± 1 HRC and a diameter of 200 mm. Wear tests is carried out under a sliding speed of 1 ms-1 and a constant pressure of 1.5 MPa. The friction force was determined using a S-50 type load cell and the coefficient of friction of the alloys determined by dividing friction force by load. The wear and friction tests were conduct for a 2500 m sliding distance. The temperatures of the wear samples were monitored by putting a Cu-Ni thermocouple in a hole at a distance of 1.5 mm from the rubbing surface. Each specimen was ultrasonically weighed and cleaned before wear tests with an accuracy of 0.01. The wear samples were removed after every 500 m sliding distance, weighed to measure the mass loss. The determine values of mass loss for all the components tested is converted into volume loss using the calculated density of the alloys. The surface of the wear samples subtract were examined using SEM.

3. RESEARCH OVERVIEW

There has been an increasing demand from aerospace, space and automobile industries for materials possessing high specific strength and better wear resistance stability at high temperatures. The process of increasing the properties of engineering materials has led to the method of ceramics, reinforcing polymers and metals with particles, whiskers and fibers thus leading to the production of composites. Due to ease of fabrication and the higher ductility than ceramic matrix composites and better environmental stability and stiffness than polymer matrix composites, MMCs have become popular and are commonly used. In this paper outlines we came know the various production techniques and mechanical properties of MMCs. It shows that Al-Zn based composites exhibit huge development in all mechanical properties as compared to the unreinforced base alloy.

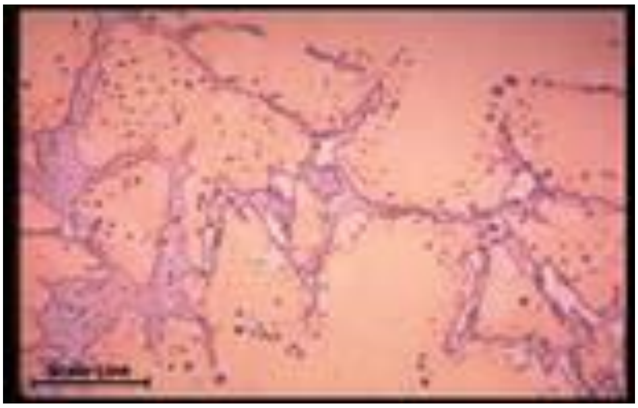

Figure No. 3. SEM Microstructures of reinforced Al- and Zn-based composites.

The arrangement of fibres in the matrix is one of the factors which determines the mechanical properties of a fibre-reinforced composite. The dispersion technique (disseminating the fibres in a liquid medium) to produce fibre preforms seems to have a control over the fibre spacing as it allows the fibres to arrange themselves in planar random orientation. Intermetallic phases containing impurities are brittle in nature and they always crack earlier than the matrix thus leading to failure of the composite at lower loads. The presence of silica binder in the preforms increases the possibility of producing a brittle interfacial bonding and also results in macroscopic and microscopic segregation of alloying elements.

4. SUMMERY

The hardness of Al–Zn–Cu alloys continuously increases with increasing Cu content, but % elongation seen a reverse trend. The tensile strength of these alloys increased with increasing Cu 3%, but above this level it less as the copper content more. It was related to two opposite effects solid solution hardening of a phase and weakening effect through cracking tendency due to y phase. This technique of material process is more effective at copper contents beyond 3%.

As the sliding distance increases the volume loss, the friction coefficient and temperature of alloys achieved constant levels following an initial increase and a decrease in temperature and only an initial increase in volume loss, an initial decrease in friction coefficient. The volume loss of Al–Zn–Cu alloys decreased with increasing copper content up to 3%, but showed an increase above this level. Therefore, among these alloys, the highest tensile strength and wear resistance (inverse of volume loss) were attained by the Al–Zn–Cu alloy. The wear loss of the Al–Zn–Cu alloys was found to be inversely proportional to their tensile strength. It seen a same change with % elongation up to 3% Cu, above which the trend inverse and hardness produced a mixed effect on it. Adhesion was most effective wear mechanism for the Al–Zn–Cu alloys.

ACKNOWLEDGEMENT

It is contentment for us to present this paper where guidance performs a precious key and provides a concrete platform for completion of the paper.

We would also like to thank our guide Asst. Prof. Ghodake A. P., Department of Mechanical Engineering, for his valuable constant scrutiny and incitement without which we wouldn't have looked deeper into our work and realized both our feats and shortcomings. This work would not have been possible without him.

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