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EFFECT OF VARIOUS COMPOSITION OF BORON CARBIDE POWDER REINFORCED WITH ZIRCON SAND IN ALUMINIUM MATRIX COMPOSITE

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Abstract— ***The Aluminum alloys 5xxx group contains magnesium is when it is used as a major alloying element or with manganese, the result is a moderate-to-high-strength work-hardenable alloy. Aluminum alloys in this series (5005, 5052, 5083, 5086, etc.) possess good welding characteristics and relatively good resistance to corrosion in marine atmospheres. A metal matrix composite (MMC) is composite material with at least two constituent parts, one being a metal. The other material may be a different metal or another material, such as a ceramic or organic compound. When at least three materials are present, it is called a hybrid composite. Composite materials are a mixture or a combination of two or more constituents differing in form and/or material composition and that are essentially insoluble in each other. Aluminium alloys have been gaining great importance as structural materials, but for many applications it is necessary to improve their wear resistance. In particular, uses of aluminium alloys in automotive applications have been limited due to their inferior strength, rigidity and wear resistance, as compared to those of ferrous alloys. Particle reinforced aluminium composites; nevertheless, offers reduced mass, high stiffness and strength and improved wear resistance.***

Index Terms—Aluminium alloys 5xxx group, MMC, Zircon sand

I. INTRODUCTION

Stir Casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles) is mixed with a molten matrix metal by means of mechanical stirring. Stir Casting is the simplest and the most cost effective method of liquid state fabrication. The liquid composite material is then cast by conventional casting methods and may also be processed by conventional Metal forming technologies.

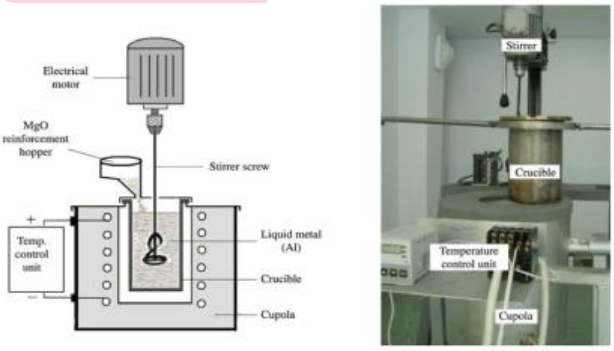


Fig.1. Melt stirring test apparatus

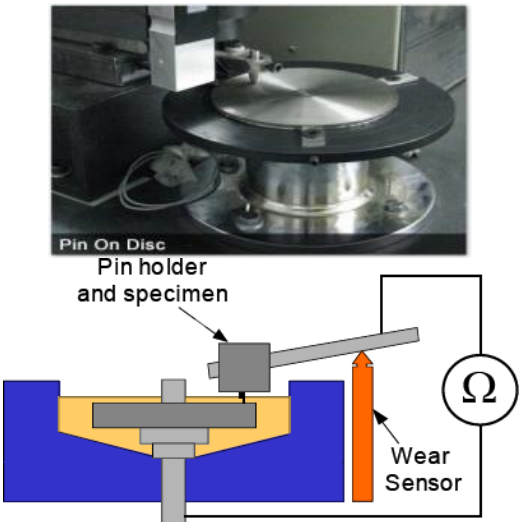


Fig.2. Pin On Disc Dry Sliding Wear Test

Wear is defined as progressive loss of material volume from a solid surface due to the damage caused as a result of relative motion between the surface and an external surface/substance in contact. Dry sliding wear test usually performed on materials is a type of Adhesive wear. Dry sliding wear tests will be carried out on the pin-on-disc wear- testing machine. Dry sliding wear involves sliding of one surface over other under the application of a load normal to the plane of motion. Adhesive wear involves

material transfer from one surface to another due to direct contact and plastic deformation.

Tensile tests are conducted in tensile test machines, providing controlled uniformly increasing tension force, applied to the specimen. The specimen's ends are gripped and fixed in the machine and its gauge length L_0 (a calibrated distance between two marks on the specimen surface) is continuously measured until the rupture. Test specimen may be round or flat in the cross-section.

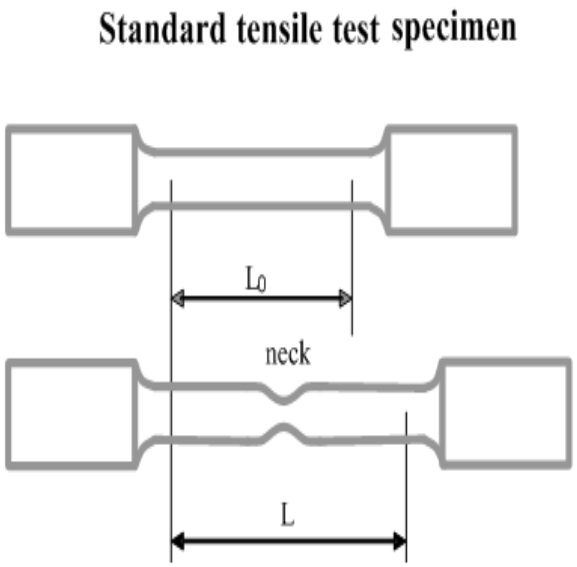


Fig.3. Tensile specimen

The initial straight line of the curve characterizes proportional relationship between the stress and the deformation (strain). The stress value at the point P is called the limit of proportionality. Tensile strength measures the force required to pull something such as rope, wire, or a structural beam to the point where it breaks. The tensile strength of a material is the maximum amount of tensile stress that it can be subjected to before failure. The definition of failure can vary according to material type and design methodology. This is an important concept in engineering, especially in the fields of material science, mechanical engineering and structural engineering.

II. LITERATURE SURVEY

Hossein Abdizadeh [1] et.al has studied about the Metal–matrix composites (MMCs) that are known as the most useful and high-tech composites in our world as well as aluminum (Al) as the best metal for producing these composites. Combining aluminum and zircon ($ZrSiO_4$) will yield a material with the best corrosive resistance and mechanical properties like strength at high temperatures. Also, the abrasive wear behavior of these composites will be improved. In the present investigation, a study on aluminum/zircon composites has been carried out. Micro-structures of these composites in powder metallurgy conditions show different size distribution of zircon with different proportions in the composite. Also, there is a case-study about density and compressive strength and hardness of aluminum/zircon composites. The green specimens prepared by isostatic pressing of prepared powders with different zircon percentages, were sintered at two temperatures. These specimens were then investigated by different physical and mechanical testing methods to observe in which conditions the best properties would be obtained. The most improved compression strength was obtained with the specimen including 5% of zircon sintered at 650◦C.

PR Berndt [2] et.al has studied about the aluminium alloy, Al5083-H321, in which magnesium is the principle alloying element, is a solid solution strengthened material. The material exhibits favourable welding characteristics and resistance to corrosion, making it attractive for application in the marine environment. As the material is a non-heat treatable alloy, the precipitates in this alloy have not received much attention to date. Little is known about the effect that Al5083-H321 precipitates may have on the integrity of a friction-stir weld (FSW). The FSW processing of Al5083-H321 is currently under investigation. In this preliminary study, the precipitates in the parent alloy are characterized using transmission electron microscopy (TEM). The composition and structure of the various precipitates in the matrix are identified using energy dispersive X-ray spectrometry (EDS), electron diffraction, and electron diffraction simulation software. Thorough characterization of the parent alloy is an essential first step to reaching a better understanding of the micro structural evolution that occurs during friction-stir welding of Al5083-H321. Christo Ananth et al. [3] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

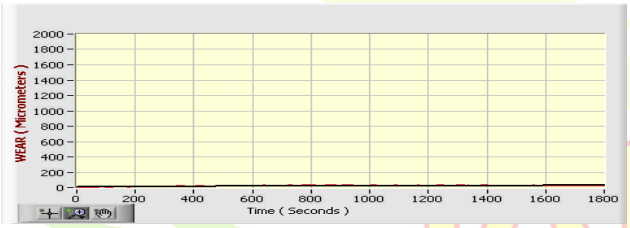
III. EXPERIMENTAL WORK

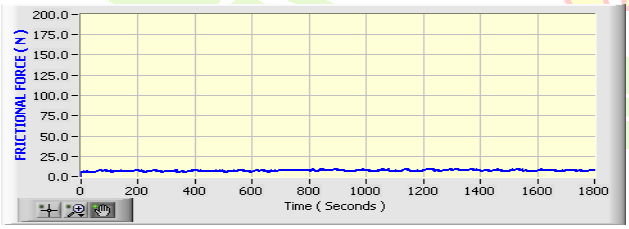
To attain the main objectives of the present investigation, the experimental work has been planned in the following sequence. From the above literature survey we have concluded that the reinforcement of boron carbide and zircon sand with aluminium alloy shall be prepared in proposed composition and carry out tests to prove its improved wear resistance and mechanical properties.
Here four samples are to be prepared such that,

- Sample A – Aluminium alloy Al 5083 + 0 wt.% $ZrSiO_4$ + 0 wt.% B_4C
- Sample B – Aluminium alloy Al 5083 + 5 wt.% $ZrSiO_4$ + 3 wt.% B_4C
- Sample C – Aluminium alloy Al 5083 + 5 wt.% $ZrSiO_4$ + 5 wt.% B_4C
- Sample D – Aluminium alloy Al 5083 + 5 wt.% $ZrSiO_4$ + 7 wt.% B_4C

These specimens are prepared by stir casting process in which the aluminium alloy is molten in crucible and zircon sand of wt 5% is added in common to all the samples. The boron carbide of various compositions is added to each specimen as mentioned above.

Followed by casting process the samples are cleaned and surface prepared and the following tests are performed with each sample. Abrasive wear test using PIN ON DISC dry sliding wear testing equipment, Tensile test, Compression test and Hardness test. The specimen undergone above tests are studied in micro scale for determining their structural changes using scanning electron microscope (SEM) technique and resulting images (after testing) are analysed for formulation of result. Wear occurs as a natural consequence when two surfaces with a relative motion interact with each other. Wear may be defined as the progressive loss of material from contacting surfaces in relative motion. Scientists have developed various wear theories in which the Physico-Mechanical characteristics of the materials and the physical conditions (e.g. the resistance of the rubbing body and the stress state at the contact area) are taken in to consideration.





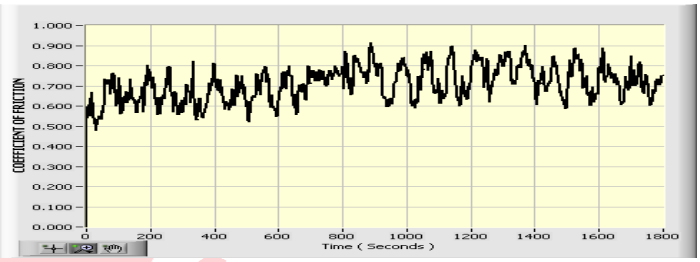


Fig.4. Sample - (1kg, 353rpm, 30min)

IV. CONCLUSION

The Aluminum alloys 5xxx group contains magnesium is when it is used as a major alloying element or with manganese, the result is a moderate-to-high-strength work-hardenable alloy. Aluminum alloys in this series (5005, 5052, 5083, 5086, etc.) possess good welding characteristics and relatively good resistance to corrosion in marine atmospheres. A metal matrix composite (MMC) is composite material with at least two constituent parts, one being a metal. The other material may be a different metal or another material, such as a ceramic or organic compound. When at least three materials are present, it is called a hybrid composite. Composite materials are a mixture or a combination of two or more constituents differing in form and/or material composition and that are essentially insoluble in each other. Aluminium alloys have been gaining great importance as structural materials, but for many applications it is necessary to improve their wear resistance. In particular, uses of aluminium alloys in automotive applications have been limited due to their inferior strength, rigidity and wear resistance, as compared to those of ferrous alloys. Particle reinforced aluminium composites; nevertheless, offers reduced mass, high stiffness and strength and improved wear resistance.

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