EFFECT OF ROLLING ON MICROSTRUCTURE OF ALUMINIUM METAL MATRIX COMPOSITES WITH MAGNESIUM PARTICULATES-AN EXPERIMENTAL STUDY

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ABSTRACT

The objective of the investigation is to fabricate a composite material, which is to be used as an alloy wheels in automobile vehicles. The Metal Matrix Composite includes two metals, which includes aluminium, and copper. Aluminium is chosen because of its superior strength to weight ratio. Magnesium is chosen because of its strength-weight ratio. The fabrication of composite material is done through stir casting method. Deformation of composite done using manual rolling after the casting of composite. Further analysis of composite includes microstructural study, hardness values and machinability results. The specimens are collected for every work to analyse the composite.

Key words: Matrix matrix composite, rolling process, Microstructure analysis.


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1. INTRODUCTION

As with all engineering materials, composites have particular strengths and weaknesses, which should be considered at the specifying stage. Composites are by no means the right material for every job. However, a major driving force behind the development of composites has been that the combination of the reinforcement and the matrix can be changed to meet the required final properties of a component. For example, if the final component needs to be fire-resistant, a fire-retardant matrix can be used in the development stage so that it has this property. Stiffness and strength can also be influenced at the development stage. The material
structure can be engineered so that the directionality of the reinforcement material is arranged to match the loading on a given component. A wide range of coatings and paints are available to match appropriate environmental conditions, which can be highlighted in the initial development stage or applied later should it be decided that a particular property or standard needs to be met further down the line. Cost is ever present in the engineering equation and it is the balance of cost, performance and life-cycle analysis that should determine whether or not to use polymer composites over an alternative structural material option.

Aluminum is the familiar matrix for the metal matrix composites (MMCs). The Al alloys are quite useful due to their low density, good corrosion resistance, high thermal and electrical conductivity, and high damping capacity. They offer a large variety of mechanical properties depending on the chemical composition of the Al-matrix. There are two principal classifications, namely casting alloys and wrought alloys. About 85% of aluminium is used for wrought products. Aluminum alloys are used extensively in aircraft due to their high strength-to-weight ratio. On the other hand, pure aluminum metal is much too soft for such uses, and it does not have the high tensile strength that is needed for airplanes and helicopters. Copper is one of the best alloying element since the beginning of the aluminum metal matrix composites. In the cast alloys the basic structure consists of dendritic in nature and possess aluminum solid solution, with a variety of particles at the grain boundaries or interdendritic spaces, forming a brittle components with eutectics in nature. Most alloying elements can improve the modulus of elasticity of aluminum, but the increase is not remarkable for the aluminum-magnesium alloys.

2. LITERATURE REVIEW
The review of the physical and the economical evaluation and the production process was articulated and have shown the successfullness of the adaption of the composite have been made[1].The review of the processing and the microstructure, properties and the applications has been discussed by some researchers[2]. The novel method of the fabrication of the Aluminum Magnesium metal matric composite has been published by reducing the amount of energy consumed and the as the alternative to the powder metallurgy [3].The utilization of the magnesium as the oxygen scavenging from the dispersoid by showing the increase in the wetting has studied [4]. Improvement of the aluminum by the addition of the magnesium nanoparticle has been made and have shown the increase in the strength and the ductility of the formed composite [5].The mechanical properties of the Aluminum magnesium particulate reinforcement by varying the percentages of the particulate has investigated[6]. The microstructural and the mechanical properties of the Aluminum magnesium based metal matrix composites which has been fabricated using the powder metallurgy has been evaluated [7].

3. EXPERIMENTAL WORK
Commercial pure aluminium (99%) was used as the base matrix. Chromium (99.9%) was used to prepare the powder. First the Aluminium was melted in a crucible by heating it in a muffle furnace at 800ºC for three to four hours. The copper particles are preheated at 400ºC for one to three hours to make their surfaces oxidised. The furnace temperature was first raised above the melting point of aluminium (750ºC) to melt the aluminium completely and was then cooled down just below the melting point to keep the slurry in semi solid state. Stirring was carried out with the help of stainless steel stirrer coated with fire clay. At this stage, the preheated copper particles were added manually to the vortex. In the final mixing processes the furnace temperatures was controlled around 700ºC. Melt was poured immediately after stirring into the 18 mm diameter finger moulds as shown in fig 1
Standard sample: (deformations 30%, 40%) Sample of Rectangular mould was prepared for iterated hot rolling to reduce the cross sectional area. A 1½ inch length pieces were taken as standard specimens of different reduced areas for further tests like microscopic analysis, hardness tests and machinability tests.

The steps that have been taken to achieve the stir casting process is given as follows, heat treatment and mechanical treatment is made to allow the casting to smoothen the layers.

3.1. Heat treatment given
   1. Homogenization of samples at made at the 100ºC by soaked for 24hr and then air-cooled.
   2. For each deformation samples have been introduce at 450ºC into the rollers.

3.2. Mechanical treatment
Specimens were collected for every reduction in cross sectional area for further studies like microscopic analysis and hardness tests.

   1. Samples are introduced at 450ºC into the rollers, and the deformation of 30% of original area and 1½-inch piece was taken as the standard specimen.
   2. Again the same steps were repeated for collecting standard specimens of 1½ inch reduced cross section areas up to 40%.
   3. These specimens are future used in microscopic analysis for microstructure.

3.3. Casting operation

   1. Composite Specimens, with deformations 30%, 40% and without deformation of dimension 17mm diameter, each ½ inch length were taken for microstructure and hardness tests.

3.4. Optical microscope

The examination of materials by optical microscopy is essential in order to understand the relationship between properties and microstructure. Metallography is the study of metals by optical examination. This is most commonly done using a conventional light microscope. However, useful information can be gained by examination with the naked eye of the surface of metal objects or of polished and etched sections. Structures, which are coarse enough to be discernible, be the naked eye are termed macrostructures. Those, which require magnification to be visible, are termed microstructures.

![Optical microscope](image)

**Figure 1** The metallurgical microscope that has been used for the studying the microstructures.
Microstructure can be observed using a range of microscopy techniques. The microstructural features of a given material may vary greatly when observed at different length scales. For this reason, it is crucial to consider the length scale of the observations when describing the microstructure of a material. Magnification of micrographs is 10X.

Prediction of properties at micro level will give the confidence before physical testing. Microstructural analysis is used in research studies to determine the microstructural changes that occur because of varying parameters such as composition, heat treatment or processing steps. Finding a relation between microstructures and properties that are going to examine. Particle distributions among the composite at microscopic level.

4. RESULTS

**Figure 3** The microstructure of 30% deformed composite

**Figure 4** The microstructure of 40% deformed composite

The Homogenization have improved the specimen properties by removing segregations. Small grains started to form after homogenizing the specimen which will improve the micro hardness. After deformations, micro segregation is low along the transverse directions. This is the reason may be hardness is slightly higher than the value along longitudinal direction. Recrystallization started at 30% deformation, which can be observed from microstructure of specimen. Deformation improves the stability in grain size which will stabilize the properties along the length.

5. CONCLUSION

The Aluminum matrix composites have been successfully fabricated with distribution of fine Mg particles. The Microstructure of the composite specimen shown the uniform distribution of Mg particles and the Homogenization removed the micro segregations of Mg. the molecular Grain variations noticed for every deformation starting from homogenized specimen. The experiment the result of the homogenization is directly proportional to hardness but it may contradict based on homogenization temperature and time span. The change in the Micro hardness suddenly drops from homogenized specimen to 30% deformed specimen because of exposure of specimen to high temperatures before deforming the specimen which might have affected the specimen properties.
REFERENCES


