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DEVELOPMENT AND EVALUATION OF MECHANICAL PROPERTIES OF HYBRID ALUMINIUM METAL MATRIX COMPOSITES

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ABSTRACT

The principal objective of the current investigation is to evaluate the effect of addition of reinforcement or dispersoid (Graphite and fly ash) in different weight percentage produced by stir-casting technique. In the field of engineering, metallurgists are looking for way to improve the mechanical properties of the materials. By doing so it is possible to improve the quality of the material which in turn gain the international market share. Therefore an investigation in the present research was made to fabricate and evaluate the Tensile and Compression strength, and hardness of Al matrix and Graphite and flyash particles as reinforcement in the matrix. Reinforcement being added ranges from 2 to 8 wt., % in step of 2%.

Keywords: Graphite, Flyash, Stir Casting, Tensile Strength, Hardness

I. INTRODUCTION

In the continuing quest for improved performance, which may be specified by various criteria including less weight, more strength and lower cost the materials being used currently often reach the limit of their usefulness. This resulted in the emergence of composites.The tailor made specific properties of materials for better overall performance is so great and diverse that no one material is able to satisfy the conflicting requirements of constructive properties. This has lead to the research on materials, which is able to satisfy the varying demands from the different industries. This naturally leads to the resurgence of the ancient concept of combining different materials in an integral composite material to satisfy the user requirement. There are more than eighty thousand materials represented in the market, and this figure is rapidly increasing. Advanced materials are being developed to an increasing extent [1]. Among these materials one finds prominently used composite. The development of composites as a new engineering material has been one of the major innovations in the field of materials in the past couple of decades [2]. The MMCs are a new range of advanced materials used in applications where conventional materials and alloys are not suitable for use.

This outstanding benefit of composite materials is that they can be tailored to produce various combinations of stiffness and strength [3, 4]. It is possible to develop new material with a unique combination of properties previously unattainable with conventional materials. This ability to engineer materials with specific properties for specific applications represents a great potential advantage of composites.

It is also possible to selectively reinforce particular areas of components, thus providing development of materials properties only in area, which is truly necessary.

In material science, composites are described as consisting of at least two discretely separable components. In the broadest sense this may be taken to include even chemically or mechanically engineered products such as duplex phase alloys. However, composites have come to be known as that family of materials resulting from the reinforcement of one component with another [5-9].

The strength and stiffness of composites very much depends on the reinforcing material. Dispersion strengthened metals are a kind of composites in which only the concentration of the strengthening particles is controlled, not their exact dimensions or orientation. In general, a hard dispersoid when used as reinforcement in a soft matrix reduces the impact strength of the matrix, at the same time improves other mechanical properties, whereas a soft dispersoid in a hard matrix improves impact strength and adversely affects other properties [10].

II. EXPERIMENTAL DETAILS

The fabrication was done in a three-stage resistance sort 12 KW limit furnace. The maximum temperature of the furnace is 1200^0 C with a precision of 10^0 C fitted with seven segmented light emitting diode read out and partially integrated differential digital temperature controller.It is fitted with an alumina melting pot at its inside and it can be angled by 90^0 on its orientation axis empowering pouring of the melt.Muffle furnace was used to preheat the Flyash and Graphite particulates to a maximum temperature of 400°C and the time period for preheating is about 1 hour. The preheating of the reinforcements is vital with a specific end goal to decrease the temperature gradient and to enhance wetting between the liquid metal and the particulate support.

The liquefying temperature of Al-6Mg composite is 550-620^0C. A known amount of the Al-6Mg ingots were cured in 10% NaOH arrangement at room temperature for ten minutes. Surface taints were taken off by pickling. The filth formed was cleared by submerging the ingots for few seconds in a blend of one section Nitric acid and one section water, and then washed in methanol. pickled ingots were dried and placed into the crucible for melting purpose. Melt was heated to a temperature of 720^0 C. Temperatures were recorded using thermocouple.

The Molten metal was heated to red hot condition and was continuously stirred using a graphite impeller to create a vortex. Vortex was created in the molten metal due to high speed of the stirrer, the speed was around 500rpm.The graphite rod was immersed to a depth of approximately one third the height of the molten metal from the bottom of the crucible The pre-heated reinforcement particles were introduced into melt.

The wetting of the particles and the matrix was ensured by constant stirring which was carried out for more than 20 minutes to avoid agglomeration. The scum powder was used as slag removing agent and degassing tablet HexaChloroethene was added to completely remove any gases in the molten metal and continued reheating to a super heated temperature (730°C), then it was poured into the pre heated metal mould to reduce the porosity and enhance the mechanical properties, and finally the castings were obtained.

All mechanical tests were conducted in accordance with ASTM standards. Tensile tests were conducted at room temperature using universal testing machine (UTM) in accordance with ASTM E8M-16A. The tensile specimens Fig 1 of diameter 9 mm and gauge length 45 mm were machined from the cast composites with the gauge length of the specimen parallel to the longitudinal axis of the castings. The specimens were tested and average values of the UTS and Yield stresses were measured.

Figure 1. Tensile Specimens

The compression tests were conducted on specimen Fig 2 of 13 mm diameter and 20 mm long machined from the cast composites. In these tests, the compressive loads were applied gradually and the compression strength was measured at the failure of the specimen. This test was conducted according to ASTM E9 standard on the UTM at room temperature.

Figure 2.Compression Specimens

The static indentation test (Brinell Hardness Tester) was the type of test used in the present study to examine the hardness of the specimens in which a ball indentor was forced into the specimens. The relationship of the indentor force to the indenting area provides value of hardness. Brinell hardness number (BHN) is expressed as the ratio of applied load to surface area of the spherical indentation mode. In this process of hardness determination when the metal is indented by a spherical tip. The tip first overcomes the resistance of the metal to elastic deformation and then a small amount of plastic deformation upon deeper indentation of the tip. It overcomes large deformation. For the BHN test, the surface of the specimen Fig 3 on which the impression is to be made should smooth, clear, dry and free from oxides and scales to permit accurate measurement.

Figure 3.Hardness Specimens

The hardness of the specimens was measured using a standard Brinell hardness testing machine as per ASTME-10. An indentor diameter 2.5 mm was used and a load of 31.25kg was applied over the specimens for a period of 30 seconds. Three readings were taken for each condition.

III.RESULTS

There is increase in the ultimate tensile strength and Yield Strength of the Flyash-Graphite particulate composite which could be due to the diffusion of segregated components to produce a more uniform composition by homogenization, some residual stresses might have developed during preparation, the soft matrix might have been hardened by addition of dispersed particles.The dislocation density increases with reinforcement and causes improved compressive strength. Presence of tough Flyash and Graphite particles opposes deforming stresses, there by compressive strength of composite enhances.The hardness of the composite increases marginally with the increase of Reinforcements addition. Owing to higher percentage & densification of the tough particles of Flyash and Graphite in composite. The hardness values varied from 53 BHN to 69 BHN.

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