EXPERIMENTAL INVESTIGATION AND MECHANICAL BEHAVIOR OF FLY-ASH AND ALLOYED TIN-TUNGSTEN CARBIDE COMPOSITES

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ABSTRACT
Development of metal matrix composites has become an important area of research interest in Materials Science. In the present work, Tin alloy based particulate Metal Matrix Composite (MMC) with fly-ash and TiC as reinforcements were fabricated. Tin alloy was reinforced with Tungsten Carbide and Fly-ash through Stir Casting Technique. Two different reinforcement samples were prepared as Tin based MMC one with 5% TiC and another with 5% Fly-ash. Then, its mechanical behaviour is investigated by conducting tensile test and hardness test. An attempt was made to analyze and compare the results of the experiments.
KEYWORDS: Mechanical properties, Fly ash, Metal matrix composite

1. INTRODUCTION

A composite material is a macroscopic combination of two or more distinct materials, having a recognizable interface between them. Composite is a multiphase material that exhibits significant proportion of the properties of both constituent phases such that a better combination of properties is realized. Metal Matrix Composites (MMCs) are suitable for applications requiring combined strength, thermal conductivity, damping properties and low coefficient of thermal expansion with lower density. These properties of MMCs enhance their usage in automotive and tribological applications. In the field of automobile, MMCs are used for pistons, brake drum and cylinder block because of better corrosion resistance and wear resistance. MMCs are broadly refers to a composite system which is based on metal or alloy substrate, combined with metallic or non-metallic reinforcements. MMCs are widely used in aerospace industry and other high technology fields. In the past years, MMCs have been extensively studied, especially including the fabrication methods.Combining high specific strength with good corrosion resistance, metal matrix composites (MMCs) are materials that are attractive for a large range of engineering applications. Given the factors of reinforcement type, form, and quantity, which can be varied, in addition to matrix characteristics, the composites have a huge potential for being tailored for particular applications. One factor that, to date, has restricted the widespread use of MMCs has been their relatively high cost. This is mostly related to the expensive processing techniques used currently to produce high quality composites. In this paper, the relatively low cost stir casting technique is evaluated for use in the production of fly-ash and Tungsten Carbide /tin alloy MMCs. The technical difficulties associated with attaining a uniform distribution of reinforcement, good wettability between substances, and a low porosity material are presented and discussed. Particulate reinforced tin alloy composites fabricated by semisolid stirring assisted ultrasonic vibration were subjected to extrusion. The results showed that grains of matrix in the Tin/TiC nano composites were gradually refined while the amount of TiC nanoparticle bands was decreased with the extrusion temperature increasing from 250 to 350 °C. Under the same extrusion conditions, the grain size of the matrix was gradually decreased while the distribution of TiC nanoparticles was improved in the extruded nanocomposites fabricated by decreasing the stirring time. The yield strength and ultimate tensile strength of the nanocomposites were gradually enhanced with increasing the extrusion temperature. Significant improvement of tensile strength was obtained in the nano composites fabricated by decreasing the stirring time. manufacturing of Tin alloy based casting composite materials via stir casting is one of the prominent and economical route for development and processing of metal matrix composites materials. Thus the aim of present paper is to fabricate Tin alloy based particulate metal matrix composite by stir casting method with Fly-ash and TiC as reinforcements. Investigate its mechanical behavior by conducting tensile test and hardness tests.

2. EXPERIMENTAL PROCEDURE

2.1 Materials

Tin Alloy material is composed of 80 to 90% tin, with about 3 to 8% copper and 4 to 14% antimony added. An increase in the copper or antimony increases hardness and tensile strength and decreases ductility. Reinforcement intended to increases the strength, stiffness and the temperature resistance capacity and lowers the density of MMC. In order to achieve these properties, the selection depends on the type of reinforcement, its method of production and chemical compatibility with the matrix. MMC reinforcements can be metallic, such as tungsten and cobalt; non-metallic, most often carbon or boron; or ceramic, Tungstan carbide (TiC), Aluminum oxide (Al2O3), boron nitride, tungsten carbide, titanium diboride.

2.2 Preparation of Composite

The tin-base babbitt pieces were sized to the according to the requirement and convenience for its melting in the furnace.

Fig. 1: Tin alloy

The fly-ash kept in planetary ball milling machine for about five minutes in order to get the even sizing of the material. Then the ball milled fly-ash was sieved using three different sieves of sizes such as 74 microns, 53 microns and 38 microns. Stain steel material is used for fabricating the blade setup with four blades and twist angle of 60°. Gas welding is used for fitting the blade to the stirrer rod. As Tin material is at low melting point the withstanding, the material can’t easily react with the blade the life period of blade will be more. The method chosen for fabricating Tin babbitt /TiC with flyash Metal matrix composite (Tin alloy+10% TiC+10% flyash) is stir casting. stirring at a speed of 350-500 rpm to a time of 6-8 minutes. Meanwhile preheat the mould to avoid shrinkage of casting material. Then the melted matrix and reinforced particles is poured into the preheated mould and the pouring temperature should be maintained at 680°C.Repeat the same procedure for the other two combinations of the reinforcements. Finally withdraw the specimens from the mould after complete cooling. And confirm the solidification of casting before removing from the mould. This is because the processing expenses are low and also a better method to achieve dispersion in a low time and cost. The process of fabrication also includes preheating of die. Here we used a cast iron die, which facilitates two kinds of cavities.

3. RESULTS AND DISCUSSION

Table 1: Tensile test and hardness results

Sl.No	Specimen	Stress at elastic limit (MPa)	Ultimate strength (MPa)	% of Elongation	RHN
1	Tin Alloy	38	69	4.5	78
2	Tin Alloy + TiC	29	73	4.3	83
3	Tin Alloy + Flyash	33	71	3.9	80

The hardness test results are shown in the below graph 1 for all composite specimens. It was observed that the hardness of the composite linearly increasing with the increase in weight fraction of the Tungsten Carbide particles with Tin Alloy and hardness slightly reduced by addition of flyash with Tin Alloy. This occurs due to increases in surface area of the matrix and thus the grain sizes are reduced. The presence of such hard surface area offers more resistance to plastic deformation which leads to increase hardness. The strengthening of the composite can be due to dispersion strengthening as well as due to particle reinforcement. Thus, fly ash as filler in Al casting reduces cost, decreases density and increase hardness. The reinforcement's fly ash and TiC of 10% weight showed maximum hardness.

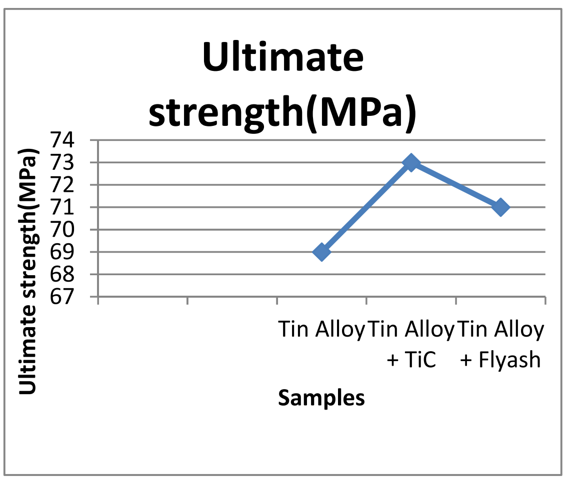

Fig 2 Ultimate Tensile Strength Graph

Tensile test was carried out in Universal testing machine. The three specimens with differ different proportions of the reinforcements given the ultimate tensile strength. From the results it was clear that the increase in weight percentage of the TiC itself leads to improve the tensile strength up to a certain weight proportion. It can be inferred that the tensile strength increased with an increase in the weight percentage of TiC but there was a decrease in the tensile strength of the samples with Fly ash is at 10 % weight proportion.

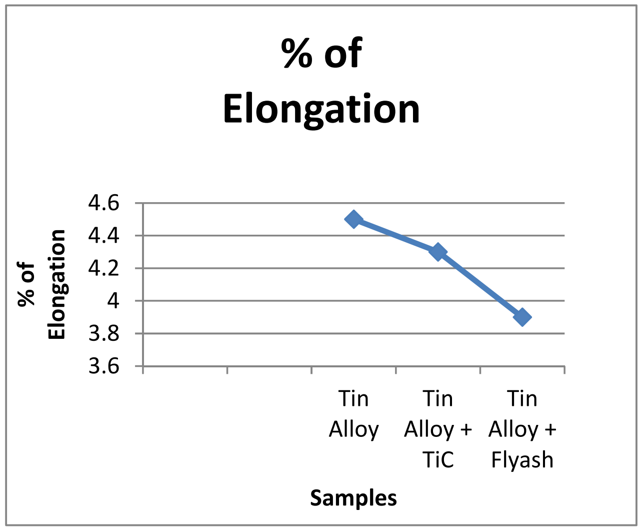

Fig 3 Percentage Elongation Graph

The percentage elongation is the measure of ductility of the material. The ductility can be defined as the property of material by which the material can be drawn into a wire under tensile force. The percentage elongation of the three test specimens are given in the graph. From the above results it is clear that the composite having reinforcements each of 10% weight has more percentage elongation. The percentage elongation decreases with increase in Fly ash and TiC because the increase in weight % of Fly ash decreases the ductility of the composite which leads to the failure of composite under load.

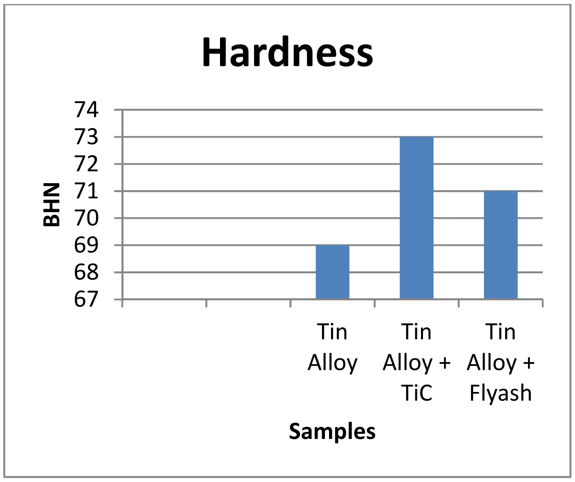

Fig 3 Hardness Test Graph

CONCLUSION

Tin Alloy, Tin Alloy + TiC, Tin Alloy + Flyash composites were successfully fabricated by two-step stir casting process. Wetting of reinforcements with the Tin Alloy matrix was further improved by the addition of magnesium. Based on the experimental observations the following conclusions have been drawn.

The tensile strength of the composite is found to be decreased when Fly ash is increased and is maximum when TiC are taken each of 10% weight.

The percentage elongation decreases with increase in Fly ash and TiC because the increase in weight % of Fly ash decreases the ductility of the composite which leads to the failure of composite under load

The Hardness of MMC increased with increased % of TiC and decreased with increased % of Fly ash.

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