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AN EXPERIMENTAL STUDY AND ANALYSIS OF MECHANICAL BEHAVIOUR OF AA 6063 WITH TIC BY USING STIR CASTING ROUTE

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Abstract

In this research hybrid aluminum matrix composite was manufactured for different weight percentages of TiC by using stir casting method. Examination of hardness, compression and micro analysis test of various manufactured hybrid AMCs revealed that mechanical properties were improved by addition with AA 6063 alloy was reinforced with TiC particles. Mechanical characterization shows that the presence of 6% of TiC particles in the matrix improved Mechanical properties than other combination of TiC with matrix material.

Keywords: AA 6063, TiC , hardness, stir casting,

1. Introduction

Metal matrix composites (MMCs) are one of the important and widely known composites because of their large variety of properties offered in combining many possible matrices and reinforcements which allows altering material properties to meet specific requirements [1]. MMCs show greater to conventional materials in terms of improved physical, mechanical, and thermal properties that include high specific strength and modulus, low density, high abrasion and wear resistance and high thermal conductivity [2]. MMCs possess combination of metallic properties of matrix alloys with ceramic properties of reinforcements that leads to superior strength and higher service temperature capabilities [3]. Aluminum, magnesium, titanium, and their alloys are commonly used metallic matrices for the production of MMCs [4]. Among various matrix materials, aluminum matrix composites (AMCs) are very smart on account of their flexibility in processing [5]. AMCs are well-known for their high-specific strength, hardness, and attractive tribological properties. Due to high strength to weight ratio, AMCs are the best suitable material for structural applications in aircraft, automotive and military industries compared to other MMCs [6] Particulate reinforced metal matrix composites (PRMMCs) can be subjected to a variety of secondary forming operations including extrusion, rolling and forging. Due to this character, it can be used for various structural applications and also automotive field [7]. Moreover, PRMMCs consists of a uniform distribution of strengthened ceramic particles embedded within a metal matrix. A. Baradeswaran [8] have expressed that the MMCs exhibits higher strength and stiffness, in addition to isotropic behavior at a lower density, when compared to the unreinforced matrix material. Most economical route for MMCs production is liquid metallurgy technique. In that, stir casting process has some important advantages: the wide selection of materials, better matrix–particle bonding, easier control of matrix structure, simple and inexpensive processing, flexibility and applicability to large quantity production and excellent

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productivity for near-net shaped components [9]. The wear resistance of the composites was higher than that of base alloy. While increasing SiC reinforcement, G.B. Veereshkumar [10] observed that hardness of aluminum composite were increased. Improved hardness results in decrease in wear rate. Kok M. [11] found that hardness and strength of composites increases with the fineness of the reinforcement and matrix grain size which led to lowering of wear rates. Composites with multiple reinforcements called hybrid composites have improved mechanical and tribological properties when compared to single reinforced composites and hence these hybrid composites have found a better substitute for many applications instead of single reinforced composites. UmitCocen et al. [12] noted that Al–SiC–Gr hybrid composites were best suited than Al–SiC composites due to its better mechanical properties and lesser amount of wear. Generally, volume fraction of reinforcements would influence the mechanical properties of aluminum alloys. NParvina [13] and Wang and Zhang [14] found that yield strength and tensile strength were increased, and toughness and ductility were decreased with increase in volume fraction of ceramic particulates. S.Natarajan [15] produced hybrid composites of Al-10 wt. % Al2O3-x wt.% Gr (x = 0, 1, 2, 3, 4 and 5 wt.%) and observed that the surface texture parameters are decreasing as graphite content increases in the matrix. However, the hardness of hybrid composites started to decrease when the graphite content in the matrix was more than 1wt%. O.Yılmaz et al. [16] reported that addition of hard particulates makes them extremely difficult to machine as they lead to rapid tool wear and incorporation of graphite particle into aluminium MMCs improves the machinibility of the composite.

2. Materials and Experimental Method

2.1 Materials characterization

The Titanium Carbide (TiC) is used as the reinforcement materials for fabrication. The SEM test was carried out to show the appearance of TiC.

2.2 Manufacturing of hybrid composites

The hybrid composites of AA 6063 and TiC were manufactured via stir casting. For comparison, pure AA 6063 Al alloy was also manufactured. Before casting, TiC were kept in crucible and heated by pre-heating furnace (30-35 minutes) at 500-5500 ^{0} C for improving the wettability with the matrix and to eliminate the moisture content in the material. After pre-heating the reinforcements, the AA 6063 matrix alloy was melted at 825°C in a crucible.

Figure.1 Melting process

Figure.2 Test specimen

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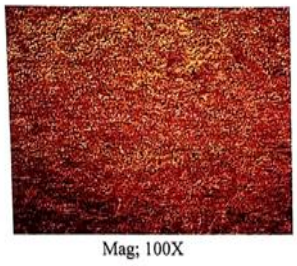
The reinforcements added in to the molten matrix and stirred completely for 10 to 15 mins. The stirring speed was set at 525 rpm. During stirring process, the mixture of preheated reinforcement of TiC particles was fully mixed with MMC. Then, the molten alloy and hybrid composites in crucible were tilted and poured into the preheated permanent steel mould and allowed to cool in atmospheric air.

2.3 Metallography

The manufactured composites were characterized by using scanning electron microscopy (SEM). The selected hybrid composite in as-cast condition was examined using CL/ME/IMAG/15 with model number MVMS 1310 at ambient temperature of 25.6^0 C .It shows the even distribution of TiC into the metal matrix.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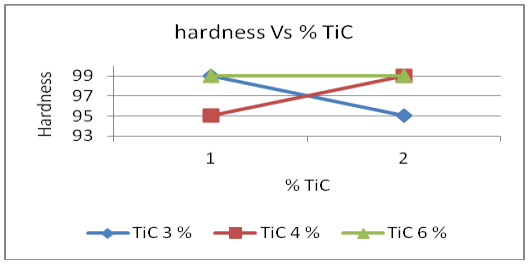

2.4 Hardness

The cast composites were machined and the specimens for the measurement of hardness are measured by CL/ME/BRIN03 model number of AKB 3000.

3. Result and Discussion

3.1 SEM micrographs

The SEM micrographs clearly show that the reinforcement of TiC with AA 6063

3.2 Hardness

The hardness of the hybrid composites is increased with 6 % of TiC added with AA 6063.

4. Conclusions

In the present work, AA 6063 and TiC hybrid composite was successfully fabricated by stir casting method.The effect of TiC reinforcement in the matrix in terms of microstructures, hardness. From the results of this study, the following conclusions were drawn,

1. The scanning electron micrographs revealed the effect of reinforcement on the matrix grain size, distribution of reinforcement and clustering of reinforcement in the matrix.
2. The hardness of hybrid composite increases with increase in percentage of reinforcement up to 6% TiC in hardened condition.

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