JOURNAL OF ADVANCEMENT IN ENGINEERING AND TECHNOLOGY

Journal homepage: http://scienceq.org/Journals/JAET.php

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A Review on Fabrication and Mechanical Characterization of Aluminium Metal Matrix Composites

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Received: May 29, 2018, Accepted: July 06, 2018, Published: July 06, 2018.

ABSTRACT

Even though several production processes available for producing metal matrix composites the process stir casting got more importance and plays a prominent role. The main merits in stir casting are simplicity, applicability and flexibility with bulk mass production in low cost criteria. The significant issue of this procedure is to get adequate wetting of molecule by fluid metal and to get a homogenous scattering of the particulates. This review is on the process utilized in stir casting such a role as, how the base metal is liquefied, at what temperature and state it is to be kept up, what conditions the particulates are included and how the mixing time and mixing speed influence the final composite material. in this paper how the stirrer design and mechanism of feeding effects the final prepared composite also presented. Some limitations of stir casting process are also discussed in this paper. Mechanical characterization of aluminium metal matrix composites also discussed in this paper.

Keywords: *matrix , stir casting, ,TiB2 ,TiC,Al7075,Al6061, reinforcement*

1. INTRODUCTION

Demanding changes in the Science and technology causing the development of innovative materials. The material which is created by the mixing two or more various materials in order to get a new material is called composite material. On comparison with base material composite material gives Higher strength and stiffness. Matrix and reinforcement are the two main elements in the composite material. The matrix will give the shape to the composite material on the other hand reinforcement will lead to improve mechanical properties. Based upon the matrix used composite materials are divided into ceramic matrix composites, polymer matrix composites and metal matrix composites

In 1970 the concept of metal matrix composites was developed. According to Sasimurugan et al. (2011) the metal matrix composite consists of at least two constituents, in which one must be metal, and another material is ceramic or organic compound [1] . MMC's were found applications in aeronatical, automobiles, bicycles, electronic goods e.t.c. Manoj Singla et al. (2009) Produced Al-SiC MMC's, from this work hey reported that the increase in SiC weight percentage increases the strength of the base material [2]. Alaneme et al. (2011) analyzed corrosion performance of AA6063/Al2O3 and reported that solution heat treatment improved corrosion resistance [3]. Jillella vadla mohanachari et al. (2018) developed the Al-Sic metal matrix composites by varying the Sic percentage in steps of 0%, 4%,8% and 16% and after that they found from their experimental results as Sic percentage increases the hardness was also increased.

STIR CASTING

Generally liquid metallurgy route or stir casting technique is used to fabricate the metal matrix composites [5,6]. In the method of stir casting the reinforcement phase is mechanically mixed with liquid matrix phase before the solidification of melt occurs. some parameters like different particle size ,shape ,pouring time and development of an electrical discharge entire mixing may lead to agglomeration [7].In this method proper mixing of reinforcement and matrix is very important to get uniform distribution of reinforcement into matrix material.

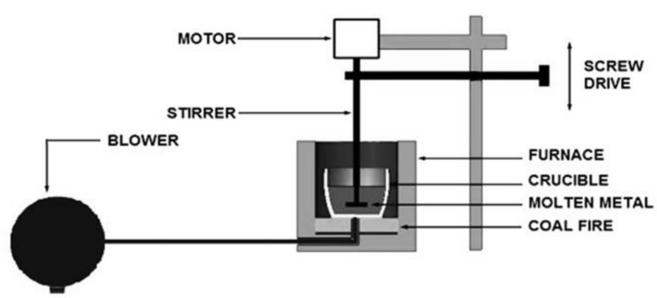

Fig.1: Basic stir casting process [8]

The above figure indicates with the help of crucible furnace the matrix material was heated to its melting point temperature. By using stirrer which is at the top of the motor we can start the stirring. Usage of rock and pinion arrangement gives the up and motion of the stirrer. After stirring the matrix material to a predetermined level reinforcement was added to the matrix material. To avoid the thermal distortion of final product pre heating of reinforcement was done. The production cost of preparing composite material by stir casting is less when compared to other competitive methods available and it noted that it is one third or one half of the other methods. it is estimated that the cost will fall about one tenth [9].

A portion of the vital parameters that need consideration during stir casting are:

a. The trouble of accomplishing a uniform circulation of the reinforcement phase.

b. Wettability among two primary substances (reinforcement and matrix phase).

c. Porosity in the cast metal matrix composites.
d Chemical reaction in between matrix and reinforcement materials [10].

III LITERATURE REVIEW

Dr. Jameel Habeeb Ghazi et al., cut the Al alloy into small pieces for the purpose of weighing and calculating weight fraction of silicon carbide by 5 percentage, and then the weighed pieces were placed in crucible inside electric furnace at fixed temperature at (750 ºC) to ensure full melting of ingot, then the Silicon carbide ceramic particles enveloped by aluminum foils were added to the molten material after pre-heating to 250 ºC in order to remove moisture, to avoid thermal mismatch and to improving the dispersion of particles within the melt. A small amount of Magnesium was added to ensure good wettability of particles with molten metal. The electric mixer enters in crucible furnace which spun rapidly at a speed of 900 rpm to improve homogenizing molten material for 3-5 min, and then the molten material is poured into the pre-heated metallic mold. The authors concluded that the hardness, ultimate tensile strength and yield strength of composites increased with increased addition of reinforcements in the composites up to 20 weight percentage. The impact energy decreased with increase in addition of reinforcement. There was uniform distribution of particulates as found from the microstructural study. The specific reason for this to happen was the addition of reinforcement covered by aluminum foils and also the addition of magnesium in the molten metal [11].

J. Hashim et al., wrote that the stirring speed should not be too high and has to be continuous for few minutes till the melt is poured into the mold by bottom pouring technique. Bottom pouring avoids impurities on the surface of melt being cast into mold. The thoroughness of stirring is dependent on shape of agitator, speed of stirrer and also the placement with reference to the bottom and the side walls of the crucible. The authors also say that the vortex creation during melting will entrap gas and hence the reinforcement particles have to be introduced by injection with the assistance of a carrier gas which is inert thus helping reduce defects in composites. The wettability can be improved by some known methods such as coating the particulates, addition of alloying elements in the melt, irradiation of melt and treatment of particulates [12]

Ramesh et al. (2009) developed Al6061/graphite particulate composites, and reported that the addition of graphite particles results increase in hardness and ultimate tensile strength and decrease in the ductility. [13]

Sozhamannan et al. (2012) fabricated Al-SiC composites by stir casting process, and reported that SiC particles uniformly distributed at the processing temperature in the range of 750°C and 800°C[14]

Rabindra Behera et al. (2011) performed investigations on Al-SiC composite, and reported that percentage of deformation decreases on increasing the weight percentage of SiC. They also reported that the hardness is high at the middle section of the casting [15]

Pardeep Sharma et al., charged 1000 grams of aluminum alloy in an electric furnace with graphite crucible where the temperature was 900 ºC. A mechanical stirrer was used to form fine vortex. The Si3N4 particulates were preheated in order to oxidize the surface of the reinforcement and were fed into the melt at a uniform feed rate. An inert atmosphere was maintained using argon gas and the mixture was stirred. The inert gas was supplied till the melt was poured into the preheated mold. The authors concluded that the density of composite increased from 2.69 to 2.75 g/cm3 after finding out the presence of Si3N4 particulates using SEM images and XRD analysis [16].

Tjong et al. (2003) identified that the presence of in-situ TiB2 particles improves dimensional stability of Al during thermal cycling. Keshavanurthy et al. (2013) fabricated Al7075-TiB2 MMC and investigated that the hardness, tensile strength and yield strength were improved when compared to the matrix material [17]

Dinaharan et al. (2011) fabricated AA6061 metal matrix composites reinforced with zirconium boride (ZrB2) particles by the in situ reaction of K2ZrF6 and KBF4 salts with molten aluminium and reported that the incorporation of ZrB2 reinforcement improved mechanical properties [18].

Debdos rai et al. (2006) fabricated Al-Fe-Aluminide MMC by in-situ and reported that wear rate was decreased by adding the reinforcement. [19]

Das et al. (2010) studied hardness and forgeability characteristics of Aluminium reinforced composites with 5, 10, 15 and 20 Wt% of SiC, and reported that hardness increases with the increase of weight % of SiC in the metal matrix composite. Forgeability of metal matrix composite decreases with an increase in weight % of SiC .[20]

Birol (2008) made in-situ Al-TiC composite and investigated that TiC reinforcement particles are created in a large number by the increase in melt temperatures by the addition of halide salt and graphite powder. [21]

Yucel Birol (2008) reported that salts generated while the formation of Al3Ti particles will clean the surface oxides of the aluminium powders, and Al3Ti particles are gradually replaced by a fine dispersion of TiC particles as soon and as long as solute Ti is made available via the solutionizing of Al3Ti particles over a range of temperatures starting at 8000C.[22]

LE Yong Kang et al. (2006) manufactured Al-TiB2 MMC by metallothermic reduction of hexafluorotitanate (K2TiF6), tetrafluoroborate (KBF4) in the liquid aluminium alloy[23]

El Gallab et al. (1998) did machining investigations on Al-SiC MMC, and reported that tool wear is minimized by increasing the feed which leads to a reduction in contact between the tool and the abrading SiC particles. Increase in the cutting speed increases the flank abrasion wear [24]

Mahamani et al. (2011) developed Al-5Cu- TiB2 in-situ MMC's, and reported that tool wear and surface roughness increased by the increase in the amount of TiB2 reinforcement ratio. The cutting force decreased with the increase in TiB2 reinforcement ratio [25]

Seyed Abdolkarim Sajjadi et al. (2011) performed Taguchi design to study the effects of Sn/Gr lubricants on the cold extrudability of Fe-TiC nano composites, and investigated that milling time is most useful parameter to get the quality extrusion product. Increase in milling time, decreases the degree of crystallinity unlike surface energy of particles. [26]

Mahamani et al. (2012) applied grey relational analysis for minimizing the surface roughness, tool wear and cutting force in turning of Al-6061-6% TiB2 in-situ metal matrix composite, from the investigations they reported that optimum levels of turning parameters are cutting speed of 125 m/min, feed of 0.05 mm/rev and depth of cut of 1 mm [27]

Ravendra Singh et al. (2012) used grey relational analysis in optimization of control parameters for the betterment of mechanical and wear properties of carburized mild steel, and they reported that A3 (960 oC Carburization Temperature), B3 (4 hours Carburization Sock Time), C2 (260 oC Tempering Temperature), D3 (1.5 hours Tempering Sock Time) is an optimal process parameters combination for the carburization process [28].

Suman Kalyan Das et al. (2011) applied grey relational analysis for to minimize the double layer capacitance and maximize the charge transfer resistance of electroless Ni-B coatings. From the investigations, they reported that highest level of the annealing temperature, the highest level of nickel source concentration, the highest level of bath temperature and middle level of reducing agent concentration gives the optimum results [29]

Chauhan et al. (2010) used Taguchi's design of experiments method for to investigate the dry sliding wear and coefficient of friction of the polymer matrix composites reinforced with fly ash. From the investigations, it was reported that 10 Wt%-20 Wt% of fly ash has the highest physical and statistical significance on the responses. [30]

CONCLUSIONS

The stir casting method generally involves the heating of the matrix material to a melting temperature in a crucible which is chemically inert to the materials that are going to be charged into it. The crucible can be of various types and the most basic type being the coke fired. The furnace generally being used is the electric resistance furnace. The particulates are preheated in order to improve its mixing with the matrix material also to avoid thermal mis-match. The melt may or may not be stirred prior to mixing the particulates. The temperature of the crucible depends on the alloy material being melted.

Stir casting composites are having poor surface finish than sqeeze casting. with this review it is found that no work has been carried out on Al 7075 TiB2 and TiC metal matrix composites by using sqeeze casting method.

IV.FUTURE SCOPE

This review allows me to proceed fabricate Al 7075, TiB2 and Tic metal matrix composites by sqeeze casting method. also Perform the Mechanical characterization, SEM. EDX and XRD, Experimental investigation of processing parameters in turning of the same metal matrix composites

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Citation: J.V.Mohanachari et al. (2018). A Review on Fabrication and Mechanical Characterization of Aluminium Metal Matrix Composites, J. of Advancement in Engineering and Technology, V6I4.03. DOI: 10.5281/zenodo.1306312