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A Review on Investigation of Copper Matrix Composite by using Stir casting Method

KEYWORDS: Stir casting process, Cu Matrix composite, Reinforcement.

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ABSTRACT The "composite material" is composed of a discrete reinforcement & distributed in a continuous phase of matrix, In Copper matrix composite (CMC) one constitutes is Cu which forms network i.e. matrix phase and another constitute serve as reinforcement which is generally ceramic or non metallic hard material. The basic reason of metals reinforced with hard ceramic particles or fibers are improved properties than its original material like strength, stiffness etc. Stir casting process is mainly used for manufacturing of particulate reinforced metal matrix composite (PMMC). Manufacturing of Cu alloy based casting composite by stir casting is one of the most economical method of processing MMC. Properties of these materials depend upon many processing parameters and selection of matrix and reinforcements. This paper presents an overview of stir casting process, process parameter, & preparation of CMC material by using Cu as matrix form and TiB2 as reinforcement.

I. INTRODUCTION:

Now days with the modern development need of developments of advanced engineering materials for various engineering applications goes on increasing. To meet such demands metal matrix composite is one of reliable source. Composite material is one of the reliable solutions for such requirement. In composites, materials are combined in such a way as to enable us to make better use of their parent material while minimizing to some extent the effects of their deficiencies. The simple term 'composites' gives indication of the combinations of two or more material in order to improve the properties. In the past few years, materials development has shifted from monolithic to composite materials for adjusting to the global need for reduced weight, low cost, quality, and high performance in structural materials. Driving force for the utilization of AMCs in areas of aerospace and automotive industries include performance, economic and environmental benefits.

In CMC one of the constituent is Cu, which forms percolating network and is termed as matrix phase. The other ceramic such as TiB2 mostly. These advantages can be used to achieve better properties. [1]

There is a variety of manufacturing processes available for discontinuous metal matrix composites; stir casting is generally accepted as a particularly promising route, currently practiced commercially.



Fig.1: Composite Material

In general stir casting of MMCs involves producing a melt of the selected matrix material, followed by introducing reinforcement material into the melt, obtaining a suitable dispersion through stirring. Its advantages lie in its simplicity, flexibility and applicability to large quantity production, (Hashim et al., 1999). It is also attractive because, in principle this method suitable for engineering application in terms of production capacity and cost efficiency (Zhou et al., 1997).

II. PROCESSING OF CMC

Stir Caster Design[2]:

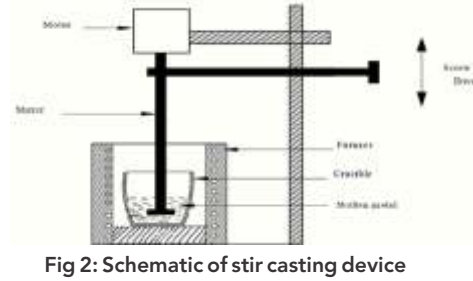
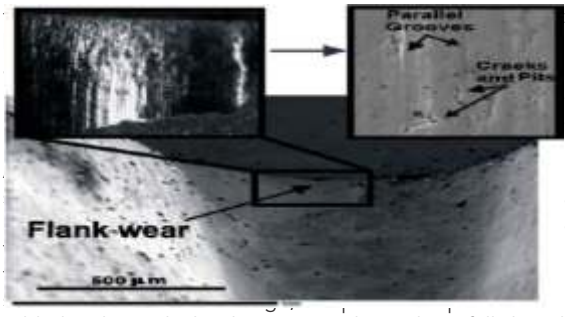


Fig 2: Schematic of stir casting device

A mechanical stir caster/rheometer as illustrated in Fig. 2, was designed and built to produce the various cast morphologies. The semi-solid alloy was sheared in a heated tubular zone between a grooved rotor and a crucible. An independent in-line torque meter was positioned between the stirring rotor and the drive motor to enable rheological measurements. The caster furnace was heated by means of four resistance heating elements. One element around the wide reservoir at the top of the crucible and three along the lower narrow section were used to control the temperature in the semi-solid range of the alloy. This configuration enabled a maximum temperature of 1100 °C and control of the temperature gradient within the narrow section of the crucible, where the shearing occurred. A linear drive provided lift to the rotor, enabling evacuation of the stir caster after the desired period of shear. During shear, with the rotor in the lower position, the device also acted as a rheometer.

An additional external immersion heating element was needed in the reservoir to provide sufficient molten alloy

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added and mixed. The slurry is again heated to a fully liquid state and mixed thoroughly. This two-step mixing process has been used in the fabrication of Copper.

Among all the well-established metal matrix composite fabrication methods, stir casting is the most economical. For that reason, stir casting is currently the most popular commercial method of producing Copper based composites.

III. PROCESS PARAMATER

For manufacturing of composite material by stir casting knowledge of its operating parameter are very essential. As there is various process parameters if they properly controlled can lead to the improved characteristic in composite material.

(A) Stirring Speed:

Stirring speed is the important process parameter as stirring is necessary to help in promoting wettability i.e. bonding between matrix & reinforcement. Stirring speed will directly control the flow pattern of the molten metal. Parallel flow will not promote good reinforcement mixing with the matrix. Hence flow pattern should be controlled turbulence flow. Pattern of flow from inward to outward direction is best. In our project we kept speed from 300-600 rpm. [3]

(B) Stirring Temperature:

It is an important process parameter. It is related to the melting temperature of matrix i.e. Copper. Cu generally melts at 1085 C. The processing temperature is mainly influence the viscosity of Cu matrix. The change of viscosity influences the particle distribution in the matrix. The viscosity of liquid decreased when increasing processing temperature with increasing holding time stirring time. [3]

(C) Stirring Time:

Stirring promotes uniform distribution of the particles in the liquid and to create perfect interface bond b/w reinforcement and matrix. The stirring time b/w matrix and reinforcement is considered as important factor in the processing of composite. For uniform distribution of reinforcement in matrix in metal flow pattern should from outward to inward.

IV. LITERATURE SURVEY

A literature review surveys scholarly articles, books, dissertations, conference proceedings and other resources which are relevant to a particular issue, area of research, or theory and provides context for a dissertation by identifying past research. I have synthesized various papers' research regarding my project 'INVESTIGATION OF COPPER MATRIX COMPOSITE BY USING STIR CASTING METHOD' as following.

G. G. Sozhamannan, S. Balasivanandha Prabu, V. S. K. Venkatagalapathy [4], were carried out "Effect of Processing Parameters on Metal Matrix Composites: Stir Casting Process". They investigated Conventional stir casting process has been employed for producing discontinuous particle reinforced metal matrix composites for decades. The major problem of this process is to obtain sufficient wetting of particle by liquid metal and to get a homogenous dispersion of the ceramic particles.

P. Yih, D. D. L. Chung [5], were carried out "Titanium Diboride Copper Matrix Composite". They investigated that Composite has lower electrical resistivity, higher thermal conductivity, higher compressive yield strength, greater hardness, greater abrasive wear resistance, lower porosity.

S. Suresh, N. Shenbaga Vinayaga Moorthi, S. Suresh, N. Shenbaga Vinayaga Moorthi, S.C. Vettivel, N. Selvakumar [6] , were carried out "Process development in stir casting and investigation on microstructures and wear behavior of TiB2 on Al6061 MMC". The unique characteristics of the composite materials for the specific requirements makes these materials more popular in a variety of applications such as aerospace, automotive (pistons, cylinder liners, bearings), and structural components, resulting in savings of material and energy. Experiments were conducted by varying weight fraction of TiB2 (0%, 4%, 8% and 12%), while keeping all other parameters constant.

Shubham Mathur, Alok Barnawal [7] were carried out "Effect of Process Parameter of Stir Casting on Metal Matrix Composites". In the present study a modest attempt has been made to develop aluminum based silicon carbide particulate Metal Matrix Composites(MMC) with an objective to develop a conventional low cost method of producing MMCs and to obtain homogenous dispersion of ceramic material. Desired improvements in properties including specific strength, hardness and impact can be achieved by intelligently selecting the reinforcement materials, their size, and shape and volume fraction. It has been observed that melting and pouring conditions have directly or indirectly effect on mechanical properties of cast materials as hardness, percentage elongation, percentage reduction in diameter, toughness and so on. The knowledge of melting temperature of metals and alloys is necessary to estimate their corresponding pouring temperature.

H. Sun Ph.D., J. E. Orth Ph.D., H. G. Wheat Ph.D. [8] were carried out " Corrosion Behavior of Copper based Metal Matrix Composite". They investigated that The developmental composites were reinforced with graphite in either particulate or fiber form. Graphite content and the presence of dissolved oxygen affected corrosion severity, and all of the developmental composites exhibited uniform corrosion and some localized galvanic corrosion at the reinforcement-copper interface during polarization. Other types of corrosion damage were also observed in the noncommercial materials.

Riccardo Casati and Maurizio Vedani [9] were carried out "Metal Matrix Composites Reinforced by Nano-Particles". Metal matrix composites reinforced by nano-particles are very promising materials, suitable for a large number of applications. These composites consist of a metal matrix filled with nano-particles featuring physical and mechanical properties very different from those of the matrix. The nano-particles can improve the base material in terms of wear resistance, damping properties and mechanical strength. Moreover, the strengthening mechanisms responsible for the improvement of mechanical properties of nano-reinforced metal matrix composites have been reviewed and the main potential applications of this new class of materials are envisaged.

Nur Hawadah, Mohd Subhi, Zuhailawati, Hussain Radzali, Othman [10] were carried out "Fabrication of titanium carbide reinforced copper matrix composite by in-situ

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processing". Composite materials with copper matrix and ceramic particle reinforcements provide an alternative material for scope for producing relatively high thermal conductivity, electrical conductivity and hardness properties. Most of the work on copper-based composites has involved TiC reinforcement, which is introduced in the copper matrix through a powder metallurgy (P/M) route.

Yongzhong Zhan, Guoding Zhang [11] carried out " Friction and Wear Behavior of Copper Matrix Composites reinforced with SiC and Graphite Particles". The results indicate that a graphite-rich mechanically mixed layer (MML) formed on the tribo-surface was responsible for the good tribological properties of the hybrid composites at low normal loads. When graphite content was high enough for delamination wear to take place at high load, wear resistance deteriorated. A continuous supply of graphite to the tribo-surface is an important precondition for the formation of a graphite-rich MML and the benefit of its anti-friction properties for the copper hybrid composites.

S. Naher, D. Brabazon, L. Looney [12] were carried out "Simulation of the stir casting process". Non-homogeneous particle distribution is one of the greatest problems in casting metal matrix composites (MMCs). To optimize some of the parameters for uniform particle distribution for batch compocasting the present simulation studies were conducted. The simulation involves visualisation experiments. In the visualization experiments liquid and semisolid metal are replaced by other fluids with similar characteristics.

K. Sekar, Allesu K. and M.A. Joseph [13] were carried out "Design of a stir casting machine". Non-homogeneous particle distribution is one of the greatest problems in casting of metal matrix composites (MMC's), because of ceramic materials have different density, melting point and boiling point. But other light materials like Aluminium, copper and magnesium etc, have less density of melting point and boiling point, so ceramic particle mixing is very difficult to light materials. In this machine the nano particle pre heater attached in the top of the furnace, because of red hot condition with constant temperature of nano particle injected by push rod into the molten metal. The stirrer rod designed by variation of speed (0-2000rpm) for mixing purpose.

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