REVIEW PAPER ON PROCESSING OF METAL MATRIX COMPOSITES & ITS PROPERTIES.

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Abstract: Several technical challenges exist with casting technology yet it can be used to overcome this problem. Achieving a uniform distribution of reinforcement within the matrix is one such challenge, which affects directly on the properties and quality of composite material .In the present study a modest attempt would be made to develop Aluminium based silicon carbide particulate MMCs with an objective to develop a conventional low cost method of producing MMCs and to obtain homogenous dispersion of ceramic material. To achieve these objectives two step-mixing method of stir casting technique has been proposed and subsequent property analysis has been made. Aluminium (98.41%) and SiC (320-grit) has been chosen as matrix and reinforcement material respectively. Aluminum alloys are widely used in aerospace and automobile industries due to their low density and good mechanical properties, better corrosion resistance and wear, low thermal coefficient of expansion as compared to conventional metals and alloys. The excellent mechanical properties of these materials and relatively low production cost make them a very attractive candidate for a variety of applications both from scientific and technological viewpoints. The aim involved in designing aluminum based metal matrix composite materials is to combine the desirable attributes of metals and Ceramics.

I. INTRODUCTION

From the last few years in industrial applications, the important parameters in material selection is specific strength, weight and cost. Before going study about the paper we must know the difference between the composite and MMC. The composite defined as the made of several part or element but only combined different material not a non-metal whereas the non-metal is mixed with material this called MMC. Clearly we had seen the review paper. the main mixed material most probably like aluminum alloy, silicon carbide, fly ash, graphite, boron carbide, fly ash chemosphere, silicon nitride, silicon carbide, etc, in this material we fabricated by using different method with respected to the grain size the generally we go for the stir and GPIT technique were check the material distribution by using SEM analyzed with FEA model. Finally we are going to study about the properties.

A more restrictive definition is used by industries and materials scientists: a composite is a material that consists of constituents produced via a physical combination of pre-existing ingredient materials to obtain a new material with unique properties when compared to the monolithic material properties. This definition distinguishes a composite from other multiphase materials which are produced by bulk processes where one or more phases result from phase transformation ("in-situ" composites).

Classification of the composite materials with metal matrix

Metal matrix composites can be classified in various ways. One classification is the consideration of type and contribution of reinforcement components in particle-, layer-, fiber- and penetration composite materials. Fiber composite materials can be further classified into continuous fiber composite materials (multi- and monofilament) and short fibers or, rather, whisker composite materials

The terms matrix and reinforcement are often used. The matrix is a percolating “soft” phase (with in general excellent ductility, formability and thermal conductivity) in which are embedded the “hard” reinforcements (high stiffness and low thermal expansion). The reinforcements can be continuous or discontinuous, orientated or disorientated. The composites are classified by: (1) their matrix (polymer, ceramic, metal), (2) their reinforcement, which includes the chemical nature (oxides, carbides, and nitrides), shape (continuous fibers, short fibers, whiskers, particulates) and orientation, (3) their processing routes.

Aluminum Matrix Composites (AMCs)

Aluminum is the most popular matrix for the metal matrix composites (MMCs). The Al alloys are quite attractive due to their low density, their capability to be strengthened by precipitation, their good corrosion resistance, high thermal and electrical conductivity, and their high damping capacity. Aluminum matrix composites (AMCs) have been widely studied since the 1920s and are now used in sporting goods, electronic packaging, amours and automotive industries. They offer a large variety of mechanical properties depending on the chemical composition of the Al-matrix. They are usually reinforced by Al_2O_3, SiC, C but SiO_2, B, BN, B_4C, AlN may also be considered. The aluminum matrices are in general Al-Si, Al-Cu, 2xxx or 6xxx alloys. As proposed by the American Aluminum Association the AMCs should be designated by their constituents: accepted designation of the matrix / abbreviation of the reinforcement’s designation / arrangement and volume fraction in % with symbol of type (shape) of reinforcement. For example, an aluminum alloy AA6061 reinforced by particulates of alumina, 22 % volume fraction, is designated as "AA6061/Al2O3/22p".

In the 1980s, transportation industries began to develop discontinuously reinforced AMCs. They are very attractive for their isotropic mechanical properties (higher than their unreinforced alloys) and their low costs (cheap processing routes and low prices of some of the discontinuous reinforcement such as SiC particles or Al_2O_3 short fibers). Among the various and numerous applications [10, 11], a few arbitrary examples, are given in Fig. brake rotors for high speed train automotive braking systems automotive pushrods cors for HV electrical wires etc.

Some industrial AMCs applications: brake rotors for high speed train automotive braking systems automotive pushrods cors for HV electrical wires.

II. SUMMARY

Processing of MMCS

Accordingly to the temperature of the metallic matrix during processing the fabrication of MMCs can be classified into three categories: (a) Liquid phase processes, (b) solid state processes, and (c) Two phase (solid-liquid) processes

Stir Casting Process -Stir Casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring. The liquid composite material is then cast by conventional casting methods and may also be processed by conventional Metal forming technologies.

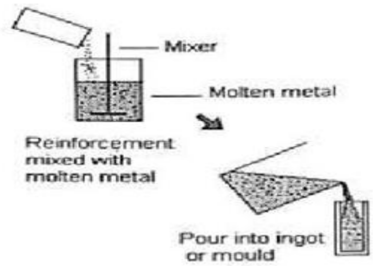

Fig-A: Stir Casting

Fabrication of the AMCs

There are many processes viable to fabricate AMCs; they can be classified in: solid-state, liquid-state and deposition processes. In solid-state processes, the most spread method is powder metallurgy PM; it is usually used for high melting point matrices and avoids segregation effects and brittle reaction product formation prone to occur in liquid state processes. This method permits to obtain discontinuously particle reinforced AMCs with the highest mechanical properties. These AMCs are used for military applications but remain limited for large scale productions. In liquid-state processes, one can distinguish the infiltration processes where the reinforcements form a perform which is infiltrated by the alloy melt (1) with pressure applied by a piston or by an inert gas (gas pressure infiltration GPI) and (2) without pressure. In the last case, one can distinguish (a) the reactive infiltration processes using the wetting between reinforcement and melt obtained by reactive atmosphere, elevated temperature, alloy modification or reinforcement coating (reactive infiltration) and (b) the dispersion processes, such as stir-casting, where the reinforcements are particles stirred into the liquid alloy. Process parameters and alloys are to be adjusted to avoid reaction with particles. In deposition processes, droplets of molten metal are sprayed together with the reinforcing phase and collected on a substrate where the metal solidification is completed. This technique has the main advantage that the matrix microstructure exhibits very fine grain sizes and low segregation, but has several drawbacks: the technique can only be used with discontinuous reinforcements, the costs are high, and the products are limited to the simple shapes that by obtained by extrusion, rolling or forging

Comparison between MMC & AMMC:

The main concept of composite is that it contains matrix materials. In composite material the reinforcements can be fibers, particulates or whiskers, and the matrix materials can be metals, plastics, or ceramics. The reinforcements can be made from polymers, ceramics and metals. [1].

Some automotive companies using MMC for disc brakes also. Honda Company used AMMC for cylinder liners in some of their engines like F20C, F22C and H22A. In recent years considerable development has occurred in nonferrous composites and attention is now being given to make iron based composites. The paper [2] reviews the ongoing research and interaction between iron based materials and reinforcements including wetting and spreading of iron melts on ceramic materials. The paper provides insight into the evolution of the processes that are used to manufacture iron based composites, and the applications that benefit from their unique characteristics. In order for ferrous based composite materials to find applications in production environments, consistent and controlled mechanical and physical characteristics are required. Ultimately, industry standards need to be written defining the material design parameters. Over the past thirty years Metal Matrix Composites (MMCs) have [3] emerged as an important class of material within the engineering industry. At present, MMCs offer attractive performance or weight-saving alternatives for a wide range of applications within the sport industry, from Formula 1 racing components to golf club shafts. This paper briefly reviews the advantages of MMCs, and presents a study of the effects of additional treatments (heat and surface) which produce beneficial characteristics in monolithic and alloy materials, but whose effects become more complex when applied to composites. The material used for this study was 2124 Al alloy matrix, reinforced with particulate silicon carbide having a mean particle size of around 3 µm treatment. The influence of machining parameters [4] such as cutting forces and surface roughness on the machinability of LM6/ SiCp metal matrix composites at different weight fraction of SiCp discussed in this paper. It is observed that the depth of cut and the cutting speed at constant feed rate affects the surface roughness and the cutting forces during dry turning operation of cast MMCs. It is also observed that higher weight percentage of SiCp reinforcement imparts a higher surface roughness and needs high cutting forces. This experimental analysis and test results on the machinability of Al/SiC-MMC will provide essential guidelines to the manufacturers. A detailed study [5] on the processing of Al-metal matrix composites cites with the reinforcement of different particulates such as SiC, TiN and TiO_2 was carried out. The results of the present studies show that the Al based composites prepared through various techniques exhibits excellent mechanical, physical and tribological properties and could emerge as promising materials for defense, aerospace and other engineering applications. With concern [6] increasing over environmental issues, reduction in automobile weight has become more important and has been proved to be effective for improving fuel efficiency. Metal Matrix Composites (MMC) are expected to be useful to cope with these problems. The authors have developed a new aluminium engine block which has the cylinder bore surface structure reinforced with short hybrid fibers of alumina and carbon. The development of aluminum metal matrix composites (Al-MMC) brake rotor and pad was discussed [7].The improvement in fuel consumption rate requires a reduction in vehicle weight. In this study, we developed aluminum metal matrix composites brake rotor and pads, which have equivalent braking effects and wear resistance to those of the conventional cast iron rotor, by optimization of the quantities and the particle diameter ratio of hard particles used for the rotor and the pad. Metal matrix composites [8] offer considerable potential for widespread application in most aerospace fields. The potential for the use of these materials in civil aircraft is largely dependent on costs and currently these are too high. However, by the use of appropriate design and manufacturing technology this intrinsic high cost can be overcome to unlock their potential.

Alumina as reinforcement

Aluminum oxide, commonly referred to as alumina, possesses strong ionic inter atomic bonding giving rise to its desirable material characteristics. It can exist in several crystalline phases which all revert to the most stable hexagonal alpha phase at elevated temperatures. Its high hardness, excellent dielectric properties, refractoriness and good thermal properties make it the material of choice for a wide range of applications.

Performance characteristics of Al/SiC-MMCs:

Hardness

The Brinell hardness test shall be carried out over Brinell hardness tester. Six samples of Al/Sic-MMC's for different sizes and weight fraction of SiC particles shall be prepared. After test and hardness value on dial, the Brinell hardness values with reference to scale HRB shall be taken for different samples

Impact Strength

Impact Test to be carried out over Charpy Impact Testing Machine and results to be recorded. According to size and weight fraction of SiC particles Twelve Specimens Al/Sic-MMC's of Square cross-section of size (10X10X55) with single V-notches are planned. The size of V-notches is 45^o and 2mm depth.

Fig-B: Charpy impact testing machine

Microstructure

Metallographic samples are normally sectioned from the cylindrical cast bars. A 0.5 % HF solution is used to etch the samples wherever required. To see the difference in distribution of SiC particles in the aluminium matrix, microstructure of samples are developed on Inverted type Metallurgical Microscope (Make: Nikon, Range-X50 to X1500). Micrograph of Al/Sic-MMC's samples for different Sizes (2000 mesh, 250 mesh, 320 mesh) and weight fraction (2.5%, 4.5%, 12.5% & 17.5 %) of SiC particles. Optical micrographs show the distribution of SiC particles within the matrix.

III. CONCLUSION

Following direct improvements could be gained

- Impotent of the casting quality by minimizing the entrapped air during the shot sleeve process
- Minimizing set up time during the start of casting process.
- Optimization of the whole casting process by controlling filling with optimal plunger movement
- Shorter lead time during the tool designing process.
- Less scrap and waste production when new design is taken on the use.
- The results confirmed that stir formed Al alloy 6063 with Al_2O_3 reinforced composites is clearly superior to base Al alloy 6063 in the comparison of tensile strength, Impact strength as well as Hardness.
- Dispersion of Al_2O_3 particles in aluminum matrix improves the hardness of the matrix material.
- It is found that elongation tends to decrease with increasing particles wt. percentage, which confirms that alumina addition increases brittleness.
- Aluminum matrix composites have been successfully fabricated by stir casting.
- Technique with fairly uniform distribution of Al_2O_3 particles.
- It appears from this study that UTS and Yield.
- Strength trend starts increases with increase in weight percentage of Al_2O_3 in the matrix.
- The matrix hardening does not influence the stiffness of the alloy and therefore of the discontinuous AMCs, but significantly improves the yielding behavior and tensile properties.
- A fine precipitation homogeneously distributed in the matrix is required to obtain good mechanical properties for the matrix alloy and therefore also for the composite.

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