REVIEW ON MECHANICAL PROPERTIES OF NON-ASBESTOS COMPOSITE MATERIAL USED IN BRAKE PAD MANUFACTURED BY DIFFERENT METHODS

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ABSTRACT
Metallic matrix composites are combinations of two or more different metals inter metallic compounds or second phases in which dispersed phases are embedded within the metallic matrix. They are produced by controlling the morphologies of the constituents to achieve optimum combination of properties. Properties of the composites depend on the properties of the constituent phases, their relative amount, and dispersed phase geometry including particle size, shape and orientation in the matrix. In this paper, The mechanical properties, behaviour and micro structural evolution of aluminium metal matrix metallic composites fabricated under various process conditions were investigated to understand their process-structure–property relations by optimization process. Addition of silicon carbide to aluminum has shown an increase in its mechanical properties.
KEY WORDS: Metal Matrix Composites MMC's, Silicon Carbide SiC

INTRODUCTION
Aluminium-based Metal Matrix Composites (MMCs) have received increasing attention in recent decades as engineering materials. The introduction of a ceramic material into a metal matrix produces a composite material that results in an attractive combination of physical and mechanical properties which cannot be obtained with monolithic alloys [4]. The various reinforcements that have been tried out to develop aluminium matrix composites(AMCs) are graphite, silicon carbide, titanium carbide, tungsten, boron, Al203, fly ash, Zr, TiB2. Addition of hard reinforcements such as silicon carbide, alumina, and titanium carbide improves hardness, strength and wear resistance of the composites [1, 2-4].
AMCs can be manufactured by liquid state processing (stir casting, infiltration, squeeze casting etc.), semisolid processing and powder metallurgical route. Usually non-metallic and ceramic particles like silicon carbide (SiC), alumina (Al2O3), boron carbide (B4C), graphite etc. are used as reinforcements in AMCs. When loads are applied externally to the composites, metal matrix transmits loads to reinforcements and then loads are carried by dispersed reinforcements bonded with the matrix. Strong interface bond between reinforcements and matrix is required to obtain high strength of composites. Interface bond is formed by reaction or mutual dissolution during casting. Therefore, good wetting of the reinforcements is necessary during casting. Following table shows different fabrication technique of non-asbestos material

Table 1.1 Comparison of metal matrix composites fabrication techniques
Liquid state fabrication route

Sr.No	MMC fabrication route	Inference	Applications	Cost Aspects
1	Stir casting	Depends on material properties and process parameters. Suitable for particulate reinforcement in AMC.	Applicable to large quantity production. Commercial method of producing aluminium based composites.	Least expensive
2	Squeeze casting	Pertinent applicable to any type of reinforcement and suitable for mass production.	Used in automotive industry and aeronautical industry for producing different components like pistons, connecting rods, rocker arms, cylinder heads, front steering knuckle, cylindrical components etc	Moderate
3	Compo casting (or) Rheocasting	Apt for discontinuous fibres, particularly suitable for particulate reinforcement. Lower porosity is observed.	Used in automotive, aerospace industry , manufacturing industry.	Least expensive

4	Liquid metal infiltration	Filament type reinforcement normally used.	Production of tubes, rods, structural shapes and structural beams.	Moderate/ Expensive
5	Spray casting	Particulate reinforcement used and used to produce full density materials	Cutting and grinding tools, electrical brushes and contacts.	Moderate
6	In-situ (reactive) processing	Good reinforcement/ matrix compatibility, homogeneous distribution of the reinforcing particles.	Automotive applications.	Expensive
7	Ultrasonic assisted casting	Nearly uniform distribution and good dispersion.	Mass production and net shape fabrication of complex structural components.	Expensive

SOLID STATE FABRICATION ROUTE

Sr.No	MMC fabrication route	Inference	Applications	Cost Aspects
1	Powder Metallurgy (PM route)	Both matrix and reinforcements used in powder form. Best for particulate reinforcement.	Production of small objects (especially round), bolts, pistons, valves, high-strength and heat-resistant materials. Vast applications in automotive, aircraft, defense, sports and appliance industries.	Moderate
2	Diffusion bonding	Handles foils or sheets of matrix and filaments of reinforcing element.	Manufacture sheets, blades, vane, shafts, structural components.	Expensive
3	Vapour deposition techniques	PVD coatings are sometimes harder and more corrosion resistant than coatings applied by the electroplating process.	Aerospace, Automotive, Surgical/Medical Dies and moulds for all manner of material processing. Cutting tools, Firearms Optics Watches, Thin films (window tint, food packaging, etc.)	Moderate
4	Friction Stir Process	Used as surface modification process. Increase in micro hardness of the surface, significant improvement in wear resistance.	In Automotive and Aerospace applications.	Moderate/ Expensive

LITERATURE REVIEW

Md. Habibur Rahmana, H. M. Mamun Al Rashed studied about the microstructures, mechanical properties and wear characteristics of as cast silicon carbide (SiC) reinforced aluminium matrix composites (AMCs). AMCs of varying SiC content (0, 5, 10 and 20 wt. %) were prepared by stir casting process.The results showed that introducing SiC reinforcements in aluminium (Al) matrix increased hardness and tensile strength and 20 wt. % SiC reinforced AMC showed maximum hardness and tensile strength. Himanshu Kala, K.K.S Mer, Sandeep Kumar(2014) reviewed metal matrix composite by stir cast aluminium based leads to the following conclusions. Stir casting method can be successfully used to manufacture metal matrix composite with desired properties, Reinforcing Aluminium and its alloys with ceramics particles has shown an appreciable increase in its mechanical properties. The melt, with the reinforced particulates, is poured into the dried, coated, cylindrical permanent sand mould.

METHODOLOGY

3.1 STIR CASTING:

The metal matrix composite used in the present work is prepared by the stir casting method.The metal ingots are cleaned and melted to the desired super heating temperature of 75°C ingraphite crucibles. The super heated molten metal is degassed at a temperature of 780°C. SiC particulates, preheated to around 500°C, are then added to the molten metal and stirred continuously by a mechanical stirrer at 720°C. The stirring time is between 5 and 8 minutes. During stirring, Borax powder was added in small quantities to increase the wettability of SiC particles.

Fig 3.1photograph showing experimental set up for the stir casting

3.2 POWDER METALLURGY:

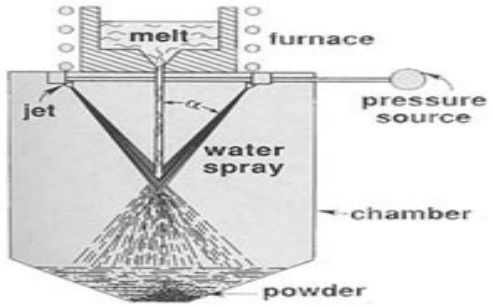

Fig.3.2 Schematic of Powder Metallurgy process

Powder metallurgy is the process of blending fine powdered materials, pressing them into a desired shape (compacted), and then heating the compressed material in a controlled atmosphere to bond the material (sintering). The powder metallurgy process generally consists of four basic steps:

(1) Powder manufacture,
(2) Powder mixing and blending
(3) Compacting,
(4) Sintering.

EXPERIMENTAL PROCEDURE

Test specimens can be prepared by stir casting and powder metallurgy processes as per the above mentioned procedure and standards, same can be tested for mechanical properties like hardness, tensile strength, impact strength as per the ASME Standards.

RESULTS AND DISCUSSIONS

The Purpose of this work is to study about the microstructures, mechanical properties and wear characteristics of as cast silicon carbide (SiC) reinforced aluminum matrix composites (AMCs). AMCs of varying SiC content and other elements were prepared by stir casting process and powder metallurgy. Microstructures, Vickers hardness, tensile strength and performance of the prepared composites can be analyzed.

- The results may show that introducing SiC reinforcements in aluminum (Al) matrix may increases hardness and tensile strength.
- Microstructural observation revealed clustering and non homogeneous distribution of SiC particles in the Al matrix. Porosities were observed in microstructures and increased with increasing wt. % of SiC reinforcements in AMCs
- Stir casting method can be successfully used to manufacture metal matrix composite with desired properties.

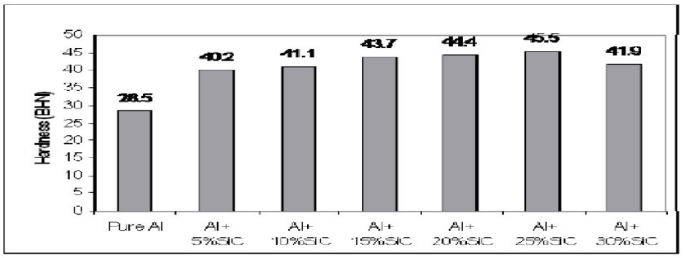

Fig . Comparative bar chart (Hardness)

- The results of study may suggest that with increase in composition of SiC, an increase in hardness, strength and stiffness have been observed. From weight fraction of SiC (5%, 10%, 15%, 20%, 25%, and 30%), The best results may obtained at 25% weight fraction of 320 grit size SiC particles ,Maximum Hardness = 45.5 BHN & Maximum Strength = 36 N-m
- The decrease of impact strength after 25wt. % SiC reinforced AMC may be due to the effect of segregation of SiC particles in tensile test specimens.
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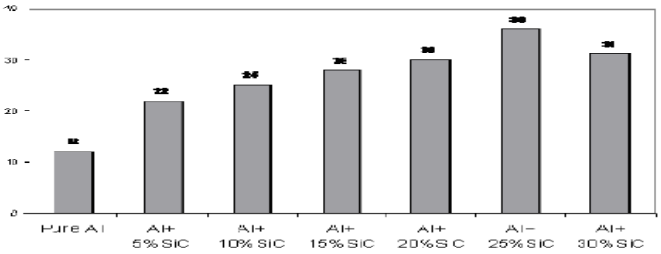

Fig. Comparative bar chart (Strength)

CONCLUSION

- In most of experimental work stir casting technique is used to manufacture the composite. Much work is carried on dissimilar series of Al alloy with various percentage of reinforcement of SiC particles
- According to the literature review, precise control of the Al–SiC interface is the first key parameter to achieve improved mechanical properties. Hardness of Al-SiC is much better than the aluminum metal. In case of increased silicon carbide content, the hardness, and material toughness are enhanced and highest value is obtained at 20-22% SiC content.
- More uniform distribution of SiC particles can be found if composite is prepared by powder metallurgy than stir casting; however stir casting is more economical. These composites can be used for making power transmitting elements such as gears, which are subjected to continuous loading.

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