Study of the Metal-Matrix Composite materials for Wear based Application-A review

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Abstract: Since a single material can't meet the requirements of engineering environments that is why the need for composites materials with unique properties is growing every year. So the metal matrix composite came into use because of the high wear resistance and mechanical properties of metal matrix composites, they are widely used in the field such as aerospace, automotive, aircraft, defense, sports and appliance industries. Metal matrix composites (MMCs), like most composite materials, provide significantly enhanced properties over conventional monotonic materials, such as higher weight savings, strength and stiffness. Metal-Matrix composites play a vital role in industrial metallurgical processes because of the tremendous development of the present engineering sectors. The metal-matrix composite has a great advantageous properties and reasonable costing increases the performance of the machineries and it also much more profitable technology than powder metallurgical processes. Metal-matrix composites can mainly prepared by metallic materials, ceramic materials and non-metallic materials.

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Introduction

Metal composites combine ductility and toughness of the matrix materials and also it will increase the hardness, wear resistance etc. of the reinforcements. Development of MMC materials consists of combinations of desirable attributes of metals and ceramics. The addition of high strength, high modulus refractory particles to a ductile metal matrix produce a material whose mechanical properties are intermediate between the matrix alloy and ceramic reinforcement. In this paper we have studied a review of the wear application of the metal matrix composites.

Amir Hussain Idrisi in 2014 presented Development and testing of Al5083 alloy reinforced by SiC particles in such a way that Composites are materials in which the desirable properties of separate materials are combined by mechanically binding them together. They have superior properties from individual materials and their respective alloys as well. Development of metal matrix composite materials consists of combination of desirable attributes of metals and ceramics. The addition of high strength, high modulus refractory particles to a ductile metal matrix produce a material whose mechanical properties are intermediate between the matrix alloy and the ceramic reinforcement. In the past, various studies have been carried out on metal matrix composites. Metal matrix composite (MMC) consists of combination of desirable attributes of metals as matrix and ceramics as reinforcement. Work on MMCs began in the 1950s since then researchers tried numerous combinations of matrices and reinforcements. This led to the development of product for aerospace, but resultant commercial applications were limited. The introduction of ceramic whiskers as reinforcement and the development of in-situ eutectics in the 1960s aided high temperature applications in aircraft engines. In the late 1970s the automobile industries started to take MMCs seriously. In the last 20 years, MMCs evolved from laboratories to a class of materials with numerous applications and commercial markets.

Pradeep K et al in October 1993, shows that Metal-matrix composites (MMCs) are engineered combinations of two or more materials (one of which is a metal) where tailored properties are achieved by systematic combinations of different constituents. Conventional monolithic materials have limitations in respect to achievable combinations of strength, stiffness and density .Engineered MMCs consisting of continuous or discontinuous fibres, whiskers, or particles in a metal achieve combinations of very high specific strength and specific modulus. Furthermore, systematic design and synthesis procedures allow unique combinations of engineering properties in composites like high elevated temperature strength, fatigue strength, damping property, electrical and thermal conductivities, friction coefficient, wear resistance and expansion coefficient. Structurally, MMCs consist of continuous or discontinuous fibres, whiskers, or particles in an alloy matrix which reinforce the matrix or provide it with requisite properties not achievable in monolithic alloys. In a broader sense, cast composites, where the volume and shape of phase is governed by phase diagrams, for example, cast iron and aluminium-silicon alloys, have been produced by foundries for a long time. The modern composites differ in the sense that any selected volume, shape and size.

Sahin (2003) has developed a setup for manufacturing MMCs. The setup has a bottom tapping facility. He has evaluated three methods for mixing of the reinforcement and has achieved full and homogenous distribution of the particles in the matrix alloy. However, the setup does not have the facility to change the positioan of the impeller in the melt. If investigated, this could further enhance the quality of the MMCs produced. The pouring molten mixture is tapped from the bottom

G. A. Kosnikov et al in 2014 showed that The research and development of metal matrix composites (MMCs) are given a significant consideration practically in all economically developed countries due to the complex of mechanical and service properties that could be obtained in this class of structural materials and that are unattainable in the traditional materials, produced using the traditional technologies. Metal matrix provides a number of advantages if compared to other (polymer, carbon, ceramic) matrices, in particular, higher hardness, strength, electric and heat conductivity, crack resistance, melting temperature, the possibility of the use of the liquid phase technologies. The use of the liquid phase technologies means that in the process of MMCs production at least one of the components is in the liquid phase (casting technologies, liquid forging, laser and plasma spraying, sintering with liquid phase, etc.)Depending on the method of their production, the two types of composites are distinguished: artificial and natural. In artificial composites the strengthening disperse phase is either introduced artificially from the outside or is formed when matrix melt interacts with artificially introduced agents. Natural composites include the alloys, in which the disperse phases are formed under the natural processes of primary , in particular – oriented crystallization. Typical natural composites are graphitized cast irons. The properties of natural composites can also be improved using the technologies typical to artificial composites. However, artificial composites are regarded as the prospective materials with unique properties.Composites, reinforced with fibers or whisker crystals, and layered composites are widely used in industry. The technologies of their production are relatively simple, the scientific bases of their development, analysis and prognostication of their behavior while using the a rticles are oroughly studied.Excluding the production of prepregs , that serve as semi-finished articles for the production of the constructions, the composites of this type and the constructions are produced simultaneously, allowing of considering the specifics of the use of these constructions and purposely orient . These composites obtain a number of useful properties (high specific strength, hardness, wear resistance, fatigue resistance, etc.), at the same time possessing substantial defects (anisotropy of properties, high cost, low maintenance workability , etc.), that result in a narrower range of their application, specific technology and engineering properties taken into consideration

Ashok Kr. Mishra et al in 2012 presented the research has shifted from monolithic materials to in composite materials to meet the global demand for light weight, high performance, environmental friendly, wear and corrosion resistantmaterials. Metal Matrix Composites (MMCs) are suitable for applications requiring combined strength,thermal conductivity, damping properties and low coefficient of thermal expansion with lower density.These properties of MMCs enhance their usage in automotive and tribological applications. In the field of automobile, MMCs are used for pistons, brake drum and cylinder block because of better corrosionresistance and wear resistance. Fabrication of MMCs has several challenges like porosity formation, poorwet ability and improper distribution of reinforcement. The tribological properties are considered to be one of the major factors controlling the performance. Fabrication of MMCs has several challenges like porosity formation, poor wet ability and improper distribution of reinforcement. Achieving uniform distribution of reinforcement is the foremost important work. It was found that there existed a strong dependence on the kind of reinforcement and its volume fraction. The results revealed that particulate reinforcement is most beneficial for improving the wear resistance of MMCs.

Sanna Ala-Kleme et al in 2006 presented that Metal matrix composites (MMC) consist of the metal matrix and reinforce-ment (typically 10–40 vol%). The reinforcement materials are usually ceramics (e.g. TiC, WC, NbC and $Al2O3$). The composite materials offer such property combinations and performance profiles, which are not available in any con-ventional engineering materials [1,2]. The properties of metal matrix composites depend on the shape, size, pro-perties, volume fraction and distribution of the reinforcement material, properties of the matrix materials and compatibility of the matrix and reinforcement. Material properties also depend on the manufacturing method and on the heat treatment. The matrix–reinforcement interface has a strong influence on the mechanical properties of hard phase containing material. The properties of the interface depend on physical and chemical properties of the matrix and hard particles, and on the reaction between these materials during consolidation and subsequent heat treatment [2,3]. It has been reported that reaction layers, which are relatively thick (around 1 μ m), weaken mechanical properties of the composites, while the layers thinner than 0.1 μm might be beneficial [1]. Lou et al. [2] have investigated interactions between the tungsten carbide and the metal matrix. They have reported that the matrix alloys were intruded easily into WC particles and reacted with WC during anufacturing, because there was a great amount of primary microporosity in WC particles. The hardness of the reinforcement should be higher than that of the abrasive for obtaining good abrasion resistance. Also the matrix hardness should be as high as possible. In addition, the interparticle spacing should be smaller than the abrasive size and the reinforcement particle size should be bigger than the abrasive size [4,5]. The distribution of the reinfo rcement in the matrix depends also on the powder grains size. Relatively fine reinforcement would tend to surround the matrix powder grains like satellites, forming a brittle net-like tructure [3]. The net-like structure may improve the abrasion resistance of the composites, because it reduces interparticle spacing [1]. The abrasion wear resistance of the composites increases with the reinforcement volume fraction if the damage in the reinforcements, cracking or pull-out of the matrix, is negligible.

Conclusion

Here I have reviewed an article based on metal matrix composite by different authors and concluded that matrix composite came into use because of the high wear resistance and mechanical properties of metal matrix composites, they are widely used in the field such as aerospace, automotive, aircraft, defense, sports and appliance industries.

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