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"A CRITICAL REVIEW ON WEAR RESISTANCE OF METAL MATRIX COMPOSITES"

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ABSTRACT

Aluminum metal matrix composites (AMCs) are potential materials for different applications because of their great physical and mechanical properties. The expansion of reinforcements into the metallic composites enhances the solidness, explicit quality, wear, creep and weakness properties contrasted with the regular designing materials. This paper exhibits the review of the impact of expansion on various reinforcements in aluminum composite featuring their benefits and bad marks. Significant issues like agglomerating marvel, fiber-lattice holding and the issues identified with dispersion of particles are talked about in this paper. Impact of various reinforcements on AMCs on the mechanical properties like elasticity, strain, hardness, wear and weariness is likewise talked about in detail. Real uses of various AMCs are likewise featured in this work.

Key Words: *AMCs, Solidness, Creep, Mechanical properties.*

I. Introduction

MMC (Metal matrix composites) are metals reinforced with other metal, ceramic or organic compounds. They are made by dispersing the reinforcements in the metal matrix. Reinforcements are usually done to improve the properties of the base metal like strength, stiffness, conductivity, etc. Aluminium and its alloys have attracted most attention as base metal in metal matrix composites [1]. Aluminium MMCs are widely used in aircraft, aerospace, automobiles and various other fields [2]. The reinforcements should be stable in the given working temperature and non-reactive too. The most commonly used reinforcements are Silicon Carbide (SiC) and Aluminium Oxide (Al2O3). SiC reinforcement increases the tensile strength, hardness, density and wear resistance of Al and its alloys [3]. The particle distribution plays a very vital role in the properties of The Al MMC and is improved by intensive shearing. Al2O3 reinforcement has good compressive strength and wear resistance. Boron Carbide is one of hardest known elements. It has high elastic modulus and fracture toughness. The addition of Boron Carbide (B4C) in Al matrix increases the hardness, but does not improve the wear resistance significantly [4]. Fibres are the important class of reinforcements, as they satisfy the desired conditions and transfer strength to the matrix constituent influencing and enhancing their properties as desired. Zirconia is usually used as a hybrid reinforcement. It increases the wear resistance significantly [5]. In the last decade, the use of fly ash reinforcements has been increased due to their low cost and availability as waste by-product in thermal power plants. It increases the electromagnetic shielding effect of the Al MMC. Based on the stated potential benefits of MMC. This paper examine the various factors like (a) effect of various reinforcement (b) mechanical behaviour like strength, wear ,fatigue behaviour, etc. (c) processing methodology and its effects.(d) application of the speciality AMC were discussed.

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II. Literature Review

I. SILICON CARBIDE REINFORCED AMC

Tamer Ozbenet al. [6] investigated the mechanical and machinability properties of SiC particle reinforced Al-MMC. With the increase in reinforcement ratio, tensile strength, hardness and density of Al MMC material increased, but impact toughness decreased. Sedat Ozdenet al. [7] investigated the impact behaviour of Al and SiC particle reinforced with AMC under different temperature conditions. The impact behaviour of composites was affected by clustering of particles, particle cracking and weak matrix-reinforcement bonding. The effects of the test temperature on the impact behaviour of all materials were not very significant. Srivatsan et al. [8] conducted a study of the high cycle fatigue and investigated the fracture behaviour of 7034/SiC/15p- UA and 7034/SiC/15p-PAmetalmatrix composites. The modulus, strength and the ductility of the two composite microstructures decreased with an increase in temperature. The degradation in cyclic fatigue life was more pronounced for the under-aged microstructure than the peak-aged microstructure Also, for a given ageing condition, increasing the load ratio resulted in higher fatigue strength. Maik Thunemann et al. [9] studied the properties of performs. Polymethylsiloxane (PMS) was used as a binder. Apolymer content of 1.25 wt.% conferred sufficient stability to the pre forms to enable composite processing. It is thus shown that the PMS derived binder confers the desired strength to the SiC preforms without impairing the mechanical properties of the resulting Al/SiC composites. Sujan et al. [10] studied the performance of stir cast Al2O3 and SiC reinforced metal matrix composite material. The result showed that the composite materials exhibit improved physical and mechanical properties, such as low coefficient of thermal expansion as low as 4.6x10-6/ C, high ultimate tensile strength up to 23.68%, high impact strength and hardness. The composite materials can be applied as potential light weight materials in automobile components. Experimentally it is found that with addition of Al- SiC reinforcement particles, the composite exhibited lower wear rate compared toAl-Al2O3 composites. Zhang Peng et al. [11] studied the Effects of Particle Clustering on the flow behaviour of SiC particle reinforced Al MMCs. The results revealed that during the tensile deformation, the particle clustering has greater effects on the mechanical response of the matrix than the elastic response and also the plastic deformation is affected very much. The particle clustering microstructure will experience higher percentage of particle fracture than particle random distribution. Balasivanandha Prabhuet et al. [12] analysed the influence of stirring speed and stirring time on distribution of particles in SiC AMC. The studywas about high silicon content aluminium alrial, with 10% SiC synthesized using different stirring speeds and stirring times. The analysis revealed that at lower stirring speed and time, the particle clustering was more at some places, by increasing themthe distribution resulted better and also it had its effect on hardness of the composite. Uniform hardness values were achieved at 600 rpm with 10 min stirring. Tzamtzis et al. [13] suggested processing Al/ SiC particulate MMCs under intensive shearing by novel Rheo-process. The current processing methods such as conventional stir casting technique often produce agglomerated particles in the ductile matrix and as a result these composites exhibit extremely low ductility. whereas the Rheo-process significantly improved the distribution of the reinforcement in the matrix by allowing the application of sufficient shear stress (s) on particulate clusters embedded in liquid metal to overcome the average cohesive force or the tensile strength of the cluster. Valencia Garcia et al. [14] suggested an alternate technique of compo forging of Al-Si Metal Matrix Composites reinforced with SiC. This method of preparation increased the mechanical resistance to elongation. This method proves to be more economical as it reduces production stages, as well as time and energy consumption. Narayana Murty et al. [3] 2O3 particulate reinforced metal matrix composites. They proposed from productivity viewpoint that a high strain rate region in which high values of mass and efficiency are present should be selected for bulk working operations and the lower strain rate regions for secondary metal working operations. Palani kumar and Karthikeyan [15] and [16] assessed the factors influencing surface roughness on the machining of Al/SiC particulate composites. The parameters like feed rate, cutting speed, %volume fraction of SiC were optimized to attain minimum surface roughness using response graph, response table, normal probability plot, interaction graphs and analysis of variance (ANOVA) technique. Feed rate is the factor, which has greater influence on surface roughness, followed by cutting speed and %volume fraction of SiC. The recommended machining conditions are low cutting speed with high feed rate and depth of cut for rough and medium turning process.

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II. ALUMINIUM OXIDE REINFORCED AMC

Park et al. [19] investigated the effect of Al2O3 in Aluminium for volume fractions varying from5-30% and found that the increase in volume fraction of Al2O3 decreased the fracture toughness of the MMC. This is due to decrease in inter-particle spacing between nucleated micro voids. Park et al. [20] investigated the high cycle fatigue behaviour of 6061 Al-Mg-Si alloy reinforced Al2O3 microspheres with the varying volume fraction ranging between 5%and 30%. They found that the fatigue strength of the powder metallurgy processed composite was higher than that of the unreinforced alloy and liquid metallurgy processed composite. Tjong et al. [21] compared the properties of two aluminium metal matrix 2O3 2 2 system. It was found that the reactive hot pressing of the composites resulted in the formation of ceramic Al2O3 and TiB2 particulates as well as coarse intermetallicAl3 2 had higherAl3Ti content and showed high tensile strength, but low 2O3 2 had more fatigue 2. Kok [22] fabricated the Al2O3 particle reinforced 2024 Al alloy composites by vortex method and studied their mechanical properties and found the optimum conditions of the production process with a pouring temperature of 700 C, pre heated mould temperature of 550 C, stirring speed of 900 rev/min, particle addition rate of 5 g/ min, stirring time of min and with a applied pressure of 6MPa. The wettability and the bonding between Al alloy/Al2O3 particles were improved by applied pressure but porosity will be decreased by this pressure. Abhishek Kumar et al. [23] experimentally investigated the characterization ofA359/Al2O3MMC using electromagnetic stir casting method. They found that the hardness and tensile strength of MMC increases and electromagnetic stirring action produces MMC with smaller grain size and good particulate matrix interface bonding. Abouelmagd [24] studied the hot deformation and wear resistance of powder metallurgy aluminium metal matrix composites. It was found that the addition ofAl2O3 andAl4C3 increases the hardness and compressive strength. The addition ofAl4C3 improved the wear resistance of the MMC. Kannan and Kishawy [25] conducted orthogonal cutting tests to study the effect of cutting parameters and particulate properties on the micro-hardness variations on the machined Al2O3 particulate reinforced AMC. They found that the micro- hardness is higher near the machined surface layer. Micro-hardness variations were higher for low volume fraction and coarse particles.

III. FLY ASH REINFORCED AMC

Fly ash particles are potential discontinuous dispersoids used in metal matrix composites due to their low cost and low density reinforcement which are available in large quantities as a waste by product in thermal power plants. The major constituents of fly ash are SiO2,Al2O3, Fe2O3, and CaO. Rajan et al. [41] compared the effect of the three different stir casting methods on the properties of fly ash particles reinforcedAl-7Si-0.35Mg alloy. The three stir casting methods are liquid metal stir casting, compo casting, modified compo casting followed by squeeze casting. The compression strength of the composite processed by modified compo casting cum squeeze casting is improved compared to the matrix alloy. However, the tensile strength was found to be reduced. The modified compo casting cum squeeze casting process has resulted in a well dispersed and porosity free fly ash particle dispersed composite. Zuoyong Dou et al. [42] studied the electromagnetic interference shielding effectiveness prop composite have effective shielding property in the addition of fly ash particulate decreases the tensile strength of the composites. Ramachandra and Radhakrishna [43] experimentally found that the wear resistance of Al MMC increases with the increase in flyash content, but decreases with increase in normal load and sliding velocity, and also observed that the corrosion resistance decreases with the increase in fly ash content.

III. SUMMARY

Several confronts must be surmounted in order to strengthen the engineering usage of AMCs such as processing methodology, influence of reinforcement, effect of reinforcement on the mechanical properties and its corresponding applications. The major conclusions derived from the prior works carried out can be summarised as below: SiC reinforced Al MMCs have higher wear resistance thanAl2O3 reinforced MMCs. SiC reinforced Al MMCs are suitable materials for brake drums as they have high wear resistance but cannot be used in brake linings as it will damage the brake drum.

It has been found that the increase in volume fraction of Al2O3 decreases the fracture toughness of the Al MMC. The optimum conditions for fabricatingAl2O3 reinforced Al MMC as pouring temperature-700 C, preheated mould temperature-550 C, the stirring speed-900 rev/min, particle addition rate-5g/min, the stirring time - 5min and the

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applied pressure was 6 MPa. The wear resistance of SiC reinforced Al MMC is higher than B4C reinforced MMC. Al MMCs reinforced with diamond fiber exhibit high thermal conductivity and a low thermal expansion co-efficient. The wear resistance and compressive strength of Al MMCs increase with the addition of Zircon sand reinforcement. The addition of fly ash reinforcement in Al increases the wear resistance but decreases the corrosion resistance.

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