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Effect of Different Reinforcement on Aluminum Metal Matrix Composites – A Review

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Abstract:

Modern materials provide a wide range of design and content quality requirements. The characteristics of products are continually enhanced with the advancement of technology to reach safety standards. Many researchers are always involved in demanding new content with the necessity of high strength, lightweight, cost-effective etc. Aluminum-based metal matrix composites (MMCs) have observed conformity with consumer standards due to such criteria. Metal matrix composites based on aluminum (MMCs) applies to aluminum composites strengthened by fibers. Compared to conventional material, reinforcing tolerance in the matrix increases the mechanical properties. Due to ductility, good conductivity, light weight and high weight-to-weight ratio, aluminum based metal matrix composites (MMCs) are mostly used in the aircraft and automotive industries. In this paper, the effect on mechanical properties of different reinforcements on AMCs was discussed in detail.

Keywords: *MMC's, Aluminum Metal Matrix Composites, Novel Applications, Mechanical Properties*

INTRODUCTION:

MMC (Metal Matrix Composites) are products that are combined with other pounds of metal, ceramic or organic. These are rendered through the dispersal of the metal matrix reinforcements. Reinforcements are typically made to improve the base metal's properties such as energy, rigidity, conductivity, etc. For product matrix composites, aluminum and its alloys have received the most interest as base metal [1]. Aluminum MMCs are commonly used in construction, aerospace, industrial and other fields [2]. In the specified working temperature, the replacements should be robust and also non-reactive. Silicon Carbide (SiC) and Aluminum Oxide (Al 2) are the most widely used additives. SiC reinforcement improves the resilience of Al and its alloys to tensile stress, stiffness, density and wear [3]. The movement of particles plays a very important role in the Al MMC processes and is increased by intense shearing. Reinforcement Al_2O_3 has good resistance to strain and tear. One of the hardest recognized elements is boron carbide. It has a high elastic frame and hardness to fracturing. Adding Boron Car-bide (B4C) to the Al matrix improves hardness, but does not significantly improve wear resistance [4]. Fibers are the essential type of reinforcements because they satisfy the necessary requirements and transfer energy to the affecting and improving the required properties of the matrix constituent. Zircon is commonly used as a stabilization of the mixture. This significantly increases wear resistance [5]. Due to their low cost and availability as waste by-product in thermal power plants, the use of fly ash reinforcements has been growing over the last decade. This produces the Al MMC's electromagnetic shielding power. Based on MMC's reported potential benefits, this paper discusses the different factors such As (a) consequence of different feedback (b) mechanical activities such as strength, tear, fatigue behaviour, etc. (c) technique of processing and its results.

1. SILICON CARBIDE REINFORCED AMC :

Tamer Ozbenet al. [6] The mechanical and machinability properties of Al-MMC reinforced SiC particle is studied. Improved tensile power, stiffness and durability of Al MMC content, however reduced impact resilience with the rise in the reinforcing ratio. The impact activity of Al and SiC particles reinforced with AMC under different temperature conditions was examined by Sedat Ozdenet al. [7]. Clustering of components, crystal splitting and poor matrix-reinforcement coupling impacted the effect actions of composites. The effect activity of all components was not significantly affected by the test temperature. Srivatsan et al. [8] A high-cycle fatigue study was conducted and the failure activity of 7034/SiC/15p-UA and 7034/SiC/15p-PAmetal composites was studied. The modulus, power and ductility of the two composite microstructures deteriorated with a temperature drop in. For the under-age microstructure, the deterioration of cyclic fatigue life was more severe than the peak-age microstructure. Changing the load ratio often resulted in increased fatigue intensity for a specified aging state. Maik Thunemann et al. [9] based on preceramic-polymer-bonded SiC results, the properties of AMMC were studied. Used as a binder, polymethylsiloxane (PMS). The preforms were given sufficient toughness by a polymer content of 1.25 wt. maximum to allow composite production. It is thus shown that the PMS- derived binder gives the SiC preforms the required intensity without compromising the mechanical properties of the resulting Al / SiC composites. Sujan et al. [10] analyzed the efficiency of Al_2O_3 stir cast and composite material for SiC reinforced metal matrix. The test shows that the composite materials display enhanced physical and mechanical properties, such as low thermal expansion coefficient as low as 4.6x10-6/ ° C, good ultimate tensile strength up to 23.68%, high impact resistance and 2O3 hardness. The composite materials can be used in vehicle parts as future lightweight materials. Experimentally, it is observed that the composite displayed a lower wear rate compared to Al_2O_3 composites with the introduction of Al-SiC reinforcement particles. Zhang Peng et. al. [11] the results of particle clustering on SiC particle flow activity improved Al MMCs. The results revealed that the particle clustering during the tensile deformation has greater effects on the matrix's mechanical reaction than the elastic response and is also greatly affected by the plastic deformation. The microstructure of particle clustering will undergo a higher percentage of particle fracturing than the random distribution of particles. Rahman and Rashed [12] studied the mechanical behavior of silicon carbide reinforced AMC. Results reveal that with adding SiC reinforcements in Al matrix increases tensile strength and hardness. According to Singh et. al. [13] by adding SiC in AMC exhibit higher density than pure AL matrix along with enhanced mechanical properties.

2. ALUMINIUM OXIDE REINFORCED AMC :

Park et al. [14] investigated the impact of Al_2O_3 on volume fractions of aluminum ranging from 5-30 percent and noticed that the rise in volume fraction of Al_2O_3 reduced the MMC fracture durability. This is due to a decrease in the distance of nucleated micro voids and particles. Park et al. [15] investigated the high cycle fatigue activity of 6061 Al-Mg-Si alloy strengthened Al_2O_3 microspheres with a varying volume fraction ranging from 5% to 30%. We observed that the fatigue resistance of the composite manufactured by the powder metallurgy was better than that of the composite processed by the unreinforced alloy and liquid metallurgy. Tjong et al. [16] Comparison of the properties of the two Al-B_2O_3-TiO_2 aluminum metal matrix and the Al-TiO_2 framework. It was observed that the composites ' reactive hot pressing culminated in the creation of ceramic particles and Al_2O_3 TiB_2 as well as small intermetallic blocks Al3Ti. Al-B-TiO2 had higher Al3Ti content and good tensile strength, but Al-B_2O_3-TiO_2 poor tensile ductility. Had more power of exhaustion than Al-B-TiO_2. Kok [17] Manufactured Al_2O_3 strengthened material 2024 Alloy composites by vortex system and examined their mechanical properties and found optimum production process conditions at a temperature of 700 C, preheated mold temperature of 550 ° C, stirring speed of 900 rev / min, particle support rate of 5 g / min, Min stirring time and 6 MPa pressure applied. Kannan and Kishawy [18] performed orthogonal cutting experiments to examine the impact of cutting parameters and particulate properties on the differences in micro-hardness of the machined Al_2O_3 particulate enhanced AMC. We noticed that next to the machined surface layer, the micro-hardness is stronger. Variations of micro- hardness for low volume fraction and coarse particles were larger. Salihi et. al. [19] made aluminum alloy 7075 matrix reinforced with Al_2O_3 particulate. Results revealed that by adding Al_2O_3 reinforcement were significantly enhanced the mechanical properties. Bhatia and Singh [20] developed hybrid AMC by using different type of reinforcement. Results indicate that perfect interface was observed between Alumina and graphite particles.

3. BORON CARBIDE REINFORCED AMC :

Bo Yao et. al. [21] the trimodal aluminum metal matrix composites were examined and the factors influencing their strength. The test results indicate that attributes such as Al_2O_3 nano- scale dispersoids, AlN and Al_4C_3 crystalline and amorphous, large dislocation densities in both NC-Al and CG-Al realms, interfaces between different components, and concentration and distribution of nitrogen contribute to increased strength. Vogt et al. [22] studied three methods:
(1) hot isostatic pressing (HIP) followed by high strain forging (HSRF), (2) HIP followed by quasi-isostatic forging (QIF) in two phases, and (3) QIF in three stages. The test results revealed a higher power of the HIP / HSRF plate with less ductility than the QIF plate, which had identical mechanical properties. The HIP / HSRF plate's in-grown strength and decreased ductility is due to inhibiting dynamic recrystallization during the high strain rate forging phase Mahesh Babu et al. [23] the surface quality characteristics of hybrid aluminum-B4C-SiC metal matrix composites were studied using Taguchi process. The most significant parameter was found to be the feed rate followed by the cutting pace. It was also found that the feed rate has no major effect on the quality of the air. Previtali et al. [4] investigated the impact of conventional investment casting processes on composites of aluminum metal matrix. Comparison was made of SiC and B4C reinforced aluminum alloy and the results revealed that SiC reinforced MMC's wear tolerance is better than that of B_4C reinforced. Murthy and Rao [24] discussed the effect of Boron carbide on AMC. Results revealed that by adding Boron carbide mechanical and tribological properties have been upgraded.

4. ZIRCON REINFORCED AMC :

Jenix Rina et al. [25] Compared properties of Al6063 MMC fortified with Zircon Sand and Alumina with four specific volume fractions of Zircon sand and Alumina with separate volume fractions of (0 + 8)%, (2 + 6)%, (4 + 4)%, (6 + 2)% and (8 + 0)%.The composites ' resilience and O_3 tensile strength was higher for (4+ 4) each. The particle dispersion is constant in this mixture, and the pores are less when inter-metallic particles are produced. Comparatively, Sanjeev Das et. al.[5] examined Al-Cu alloy abrasive wear with alumina and Zircon sand particles and found that alloy wear resistance increased significantly after alumina and zircon particles were applied.

Nevertheless, because of its superior coupling of the particle matrix, zircon-reinforced composites displayed greater wear resistance than that of alumina-reinforced composite. Scudino et. al. [26] studied the mechanical properties of Al-based metal matrix composites strengthened by powder metallurgy-produced Zircon-based glass pieces. The test results revealed that pure Al's compressive strength improves by 30% with glass reinforcement amount of 40%. While the pressure fraction of the glassy process rises to 60%, the compressive force increases further by about 25%. Aski and Kurahatti [27] studied the mechanical behavior of Zirconium Silicate based AMC. Results indicate that strength of composites are inversely proportional to the grain size.

7. FLY ASH REINFORCED AMC :

Due to their low cost and low density insulation, fly ash particles are possible discontinuous dispersoids used in metal matrix composites that are available in large amounts as a component by product in thermal power plants. SiO_2, Al_2O_3, Fe_2O_3, and CaO are the major components of fly ash. Rajan et. al. [28] contrasted Al-7Si-0.35Mg alloy validated the impact of the three specific stir casting methods on the properties of fly ash particles. The three forms of swirl casting are casting liquid metal, compocasting, adjusted compocasting, preceded by squeezed casting. Relative to the matrix alloy, the compression strength of the composite produced by adjusted compocasting cum squeeze casting is increased. It was noticed, though, that the tensile strength was that. The improved method of compocasting cum squeeze has resulted in a well scattered and porosity-free matrix of fly ash particles. Findings of Kanth et. al. [29] revealed that incorporation of fly ash particles enhance the hardness and tensile properties.

8. CONCLUSION :

In order to reinforce the engineering use of AMCs such as manufacturing technique, reinforcement control, reinforcement effect on the mechanical properties and their subsequent implementations, many confrontations must be solved. The key findings of the previous works can be summarized as follows: SiC reinforced Al MMCs have better wear tolerance than MMCs reinforced by Al_2O_3. SiC strengthened Al MMCs are ideal brake drum materials as they have good wear resistance but are not appropriate for use in brake linings as it will weaken the brake drum. The rise in volume fraction of Al_2O_3 has been shown to decrease the Al MMC's fracture durability. The optimal conditions for Al_2O_3 manufacturing confirmed Al MMC as pouring temperature-700 ° C, preheated mould temperature-550°C, stirring speed-900 rev/min, particle supplement rate-5g/min, stirring time-5 min and applied pressure-6 MPa. SiC strengthened Al MMC's wear tolerance is stronger than MMC reinforced by B4C. Al MMCs strengthened with diamond fiber display strong thermal conductivity and weak co-efficient of thermal expansion.

With the introduction of Zircon sand reinforcement, the wear resistance and compressive strength of Al MMCs improve. Using fly ash reinforcement in Al improves tolerance to wear but reduces resistance to corrosion.

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