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# Effect of the Reinforcement on the Mechanical Properties of Aluminium Matrix Composite: A Review

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**Abstract**
Aluminium based metal matrix composite are being used for a variety of applications such as military, aerospace, electrical industries and automotive purposes due to their superior physical and mechanical properties. The addition of reinforcements into the metallic matrix improves the stiffness, specific strength, wear resistance, creep and fatigue properties compared to the conventional engineering materials. This paper presents the synopsis of the effect of different reinforcement materials in the aluminium alloy and highlights their merits and demerits. Major issues like reinforcement-matrix bonding, agglomerating phenomenon, and the problems related to distribution of particles are discussed in this paper. Effect of different reinforcement on AMCs on the mechanical properties like tensile strength, strain, hardness, wear and fatigue is also discussed in detail.

**Keywords:** Aluminium matrix composites (AMC), Reinforcement, Mechanical properties.

## INTRODUCTION

Metal matrix composites (MMCs) reinforced with ceramic particles and whiskers are very promising materials for structural applications due to their excellent combination of properties. In MMCs, the properties of metallic alloys (ductility and toughness) and the ceramic reinforcements (high strength and high modulus) combine together and form a superior profile of characteristics [1–2]. In MMCs, aluminium-matrix composites reinforced with discontinuous reinforcements are particularly attractive because they not only give the best combination of strength, ductility and toughness, but also can be processed by conventional means such as forging, rolling, extrusion and subsequently machining. Therefore, aluminium-matrix composites have been used in aircraft, automobile and other transport vehicles successfully such as engine piston, brake drums and electronic packaging and so forth, and further application is expected with development of low-cost processing methods [3].

The types of reinforcement play a vital role in the mechanical reliability of the MMCs. The reinforcements should be non-reactive and stable in the given working temperature. The most commonly used reinforcements are Silicon Carbide (SiC) and Aluminium Oxide ($Al_2O_3$). SiC reinforcement increases the tensile strength, hardness, density and wear resistance of Al and its alloys [4] while the $Al_2O_3$ reinforcement possesses good compressive strength and wear resistance. Boron Carbide ($B_4C$) is one of the hardest known elements which have high elastic modulus and fracture toughness. However, the addition of $B_4C$ in Al matrix increases the hardness, but does not improve the wear resistance significantly [5]. Zircon is usually used as hybrid reinforcement. It improves the wear resistance significantly [6]. 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. The electromagnetic shielding effect of the Al-MMC has been improved significantly by using fly ash reinforcements. Based on the stated potential benefits of MMCs, this paper discusses the effect of different types of reinforcement materials on the mechanical behaviour of the Aluminium based MMCs.

## SILICON CARBIDE REINFORCED AMC

The mechanical properties of SiC reinforced AMCs have been studied extensively. The studies found that with the increase in reinforcement ratio, tensile strength, hardness and density of AMC material increased, but impact toughness decreased [7, 8]. The factors affecting the impact behaviour of SiC reinforced AMCs are particle clustering, particle cracking and weak matrix-reinforcement bonding [9]. The temperature dependency on the impact behaviour of Al-MMC materials have also been investigated but the results found insignificant. The performance of stir cast $Al_2O_3$ and SiC reinforced AMCs have been studied. The results showed that the composite materials exhibit improved physical and mechanical properties, such as high hardness, low coefficient of thermal expansion, high tensile strength and high impact strength. The SiC particle reinforced AMCs exhibited lower wear rate compared to $Al_2O_3$ particle reinforced AMCs [10]. The wear behaviour of A356/25 SiC AMC has been compared with grey cast iron and found that the wear resistance of the composite is higher than the conventional grey cast iron and it is a very suitable material for brake drum [11]. The effects of particle clustering on the flow behaviour of SiC particle reinforced AMCs have been investigated [12]. 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 higher percentage of particles was fractured in the clustering region as compared to the particle random distribution region. The influence of stirring speed and stirring time on distribution of particles in SiC reinforced AMC has been studied by Prabhu et al. [13] during their investigation of stir-casting technique. The analysis revealed