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# DEVELOPMENT IN MACHINING OF ALUMINIUM MATRIX COMPOSITES WITH ELECTRICAL DISCHARGE MACHINING: A REVIEW

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## ABSTRACT

*Aluminium based Metal matrix composites (AMMCs) has wide applications in the area of aircraft, automobile, aerospace, railways and sports equipments manufacturing industry. AMMCs are significantly used due to their important mechanical property like light weight and higher strength. This paper focuses on the effect of various types of reinforcements in Aluminium alloy and different processing techniques of AMMCs. The properties like compressive strength, wear, hardness, tensile strength are also discussed for different types of reinforcement. The imperfections related with the casting of AMMCs like as agglomerating, presence of cracks and voids in the structure, poor wettability and cost related issues are also discussed in this paper. Moreover, the machinability of Aluminium based Metal matrix composites on EDM are discussed for various types of electrical and non electrical parameters.*

***Keywords:****Composites, Metal Matrix Composites, AMMCs, EDM, Material removal rate, Electrode wear rate and Surface Roughness*

## Introduction

Nowadays metal matrix composites demand is increasing very widely due to there various mechanical properties. The selection of reinforcement material and the process to be required for making MMCs should be proper so that, it achieve better performances in various fields. Reinforcementparticles having abrasive nature which makes difficulties in machining of the MMCs by the traditional machining process. EDM is widely used for effective machining of the metal matrix composites. It has ability to produce complicated contour shapes with the high accuracy. EDM (Electrical DischargeMachining) is a machiningprocess under which the material removal takes place by the erosive accomplishment of electrical discharge. The electron and ions get accelerated and producing the discharge channel that becomes conductive. Therefore, various material gets melt and get abraded

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due to maximum rise in the temperature that leads to a removing of materials. Such description can be moreover understood by the Figure 1.

For enhancing the thermo-mechanical properties, fibres (short and continous) are added in order to improve the performance of lightweight metal. There are various reinforcement particles like $B_4C$, silicon carbide and alumina, $Si_3N_4$, TiC, $TiO_2$, $TiB_2$ and some of the hard metals like tungsten and titanium. AMCs are made by reinforcing the aluminium matrix with the various reinforced particles. It enhances the properties of the parent metal.

**Fabrication techniques of Aluminium metal matrix composites (AMMC): -**

**Onat*et al.*** [2] create the MMCs i.ealuminium composite by merging the Al-4.5Cu, 3Mg matrix alloy and reinforcement of 5, 10 and 15 vol.% silicon carbide particles by the squeeze casting technique. The process of manufacturing was performed in the heated furnace. The molten metal matrix alloy and intermixing of reinforced particles carried out in the crucible, which is made up of graphite. At the constant pressure of 100MPa casting operations were carried out. The set up of squeeze casting is shown in Figure 2. **Kathirresan M et al**. [3] by means of vortex process and the technique named pressure die casting used for merging Aluminum alloy and SiC particles. The molten temperature used was 850°C and blending (agitate) carried out for 45 minutes at the amount of 200 rpm. SiC particles were firstly preheated to 200°C and then after instigating into the swirl created in the molten alloy.

**Chaudhary et al.** [4]developed Al–2Mg–11$TiO_2$ composite with the traditional vortex method. Through adding magnesium to the aluminium matrix the wetability of dispersoid titanium dioxide get improved. The cold worked composite was found higher ultimate tensile strength as compared to the hot worked composites and also it has the greater hardness then the parent material. **L.Poovazhagan et al.** [5] carried out ultrasonic assisted cavitation supported casting arrangement for the processing of composite. The stirrer rotates at 600 rpm for 2 minutes for obtaining a homogeneous mixture of metal matrix composites. The stirrer rotates about 15 minutes while adding the reinforcement particles and after that it get removed out and ultrasonic probe dipped in moten material at a depth of 30 mm and around 30 minutes ultransonic waves were generated on it as shown in Figure.3.

**Research works in Aluminium Metal Matrix Composites: -**

**1-BORON CARBIDE REINFORCED AMC**

**Cun-zhu et al.** [6] contrived the mechanical properties and the microstructure of a $B_4C_p$/2024Al composite serve by the SEM, TEM and OM study. For preparing the composite i.e reinforcing boron carbide particles into AMC, they used a hot extrusion machinery. They concluded that, it leads to an improvement in the mechanical properties and also the B4C particles gets uniformly distributed into the alloy matrix and provide better structural properties. **Ahamed et al.** [7] explore the consequences of electrical parameters namely pulse on time, current also the parameters like a flushing pressure on SR as well as MRR during machining hybrid composite of aluminium silicon carbide with $B_4C$ and glass particles MMCs on the EDM process. They concluded that by altering the process parameter it can be possible to minimize the obstracle due to ceramic particle in machining process to obtain higher MRR at lower SR of the both composite samples.

## 2-TITANIUM CARBIDE REINFORCED AMC

**Michael Rajan et al**. [8] developed Aluminium alloy AA7075 reinforced with the tungsten carbide particles by the In-Situ technique. They observe the mechanical properties and microstructure of the AMMCs and concluded that the mechanical properties were enhanced as there is an increase in the reinforcement and also there is no any inter metallic compound formed in between the interface of the composites which provide better structural properties. **Thangarasu et al.** [9] evaluate the properties of AA6082/TiC composites. Processing of composite sample is carried out by a Stir casting technique. They establish that micro hardness of the composite increases upto 156 HV from 97 HV due to the addition of the TiC as well as the tensile strength increased from 223 to 265 MPa. **Gopalakrishnan and Murugan** [10] investigated the characterization of the AA 6061 matrix titanium carbide particulate reinforced composite manufactured by the stir casting method. As the increasing of the TiC in the composites, the specific strength was improved as well as maintaining the percentage of elongation. But the wear rate increased marginally with increased TiC addition.

## 3-SILICON CARBIDE REINFORCED AMC

**Tamer Ozben et al.** [11] estimated the machinability and the mechanical property of a silicon carbide particles reinforced AMC. They establish a relationship that as increasing weight percentage of silicon carbide reinforcement the hardness and density as well as the tensile strength, of the composites get also increased whereas the impact toughness get decreased. **Yanming and Zhou** [12] studied about tool wear and also the procedure for machining of SiC reinforcement with AMC. They observed from the experimental results that the particle size and the volume fraction of SiC are the important factors in affecting the life of tool. They established that abrasive wear was now located on the edge flank of tool in traditional tools and as machining of the composite materials carried out the life of tool was decreased due to the inelastic failure.

## 4-ALUMINIUM OXIDE REINFORCED AMC

**Altinkok and Koker** [13] estimated deflection strength and solidification performance of the processed $Al_2O_3$/SiC particulate reinforced AMCs and selected the processing method as stir casting process. After investigating the results where mechanical forces were carried on the composite sample that the large particles consisted lower deflection and inflexibility conflict whereas decreasing particle size presenting the higher hardness resistance and deflection. **Owolabi et al.** [14] studied the part of Alumina particulate reinforcement on the method of adiabatic reheating to strain location in Aluminum 6061 $T_6$ alloy below the higher velocity. On increasing the volume segment of reinforcement, stiffness and strength of composite get improved.

## 5-ZIRCON REINFORCED AMC

**Kaur and Pandey** [15] contrived the zircon sand reinforced Al–Si alloy composite with the technique named spray deposition technique. By the assistance of optical and scanning electron microscope study they recognized that there was a better attachment between the matrix alloy and Zircon sand particles. The stiffness of the composites increased as on increasing the weight percentage of Zircon sand particle in the LM13 alloy. **Sucitharan et al.** [16] studied the wear performance of Al 6063 and Zircon sand composite equipped with the help of stir casting technique. They engaged Pin on disk technique for testing the attire performance of equipped composite sample with the variation of a weight fraction. They projected that on the basis of testing result, the wear resistance capability had been enlarged as the proportion of Zircon sand enlarged in the composite.

## CONCLUSION

From the above study regarding different reinforcement particles applied inside AMCs, following points are concluded:-

(a) Related to unreinforced Aluminium alloy, Aluminium MMCs have better stiffness to density ratios, greater strength to density ratios, greater weariness conflict , enhanced elevated temperature and lesser factors of thermal expansions.

(b) The SiC reinforced Aluminium created MMCs have better attire resistance than the $Al_2O_3$ reinforced AMCs.

(c) The Al created MMCs are hard to machining in conventional machine due to there abrasive behavior of reinforcements as compared with non conventional processes.

(d) EDM and WEDM process are much active and economical for machining of the AMCs compared to the other non-traditional machining process.

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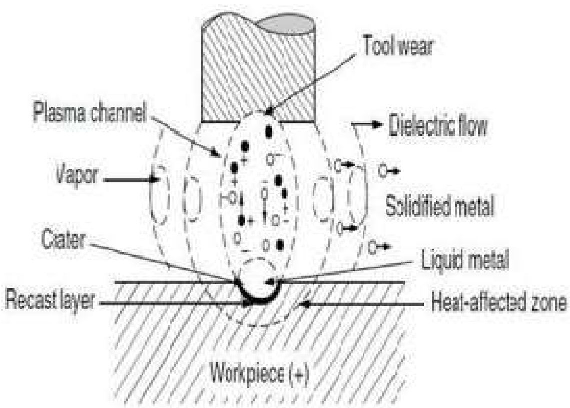


*Figure 1: Spark description of EDM process [1]*

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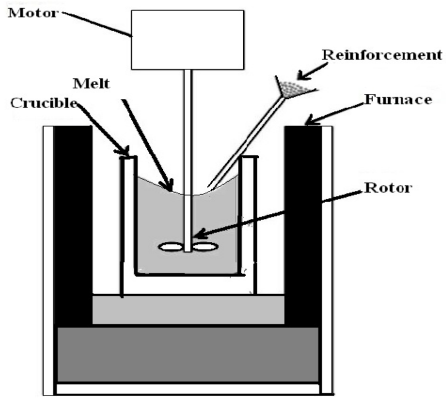


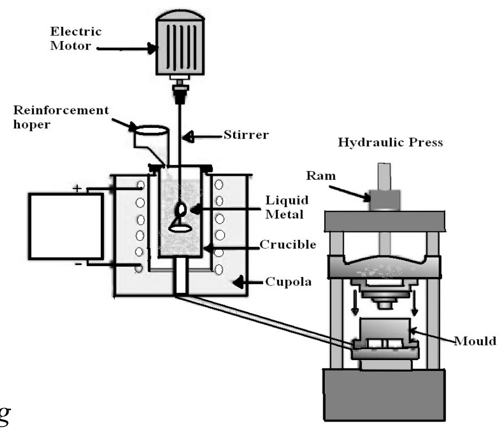


*Figure 2: Set Up of Stir Casting*

*Figure 3: Stir Casting Setup using Squeeze Casting attachment*