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Effect of Turning Parameters on Tool Wear, Surface Roughness and Metal Removal Rate of Alumina Reinforced Aluminum Composite

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Abstract

Now a day's demand of light materials is increasing continuously and MMC of aluminum playing a vital role to fulfill these demands due to their light weight, high strength and appreciable hardness etc. This study deals with the manufacturing of Aluminum based MMC of Alumina. Three samples were manufactured by sand casting with 2%, 4% and 6% of alumina by weight and mechanical properties like tensile Strength and Hardness were tested. Investigation reveals that mechanical properties enhanced in appreciable fashion as compared to pure aluminum. Turning on MMCs were carried out using uncoated carbide tool and coated tool. Turning test were performed at various speed, feed rate, depth of cut and percentage of alumina inclusion in MMCs. Furthermore tool wear, surface roughness and metal removal rate were investigated. Purpose of the study is to observe and understand the behavior of the turning parameters of composite materials under various operating conditions.

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Keywords: Metal Matrix Composite; Alumina; Tool Wear; MRR.; Hardness;

Nomenclature

MMC	Metal Matrix Composite
MRR	Metal Removal Rate
SEM	Scanning Electron Microscope

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1. Introduction

Metal matrix compositions (MMC) have become leading materials and particles reinforced aluminum MMCs has received Considerable attention due to their excellent mechanical properties. Metal matrix composite (MMC) are widely used composite materials in aerospace, automotive, electronics and medical industries. They have outstanding mechanical properties like high strength, low weight, low ductility, high wear resistance, high thermal conductivity and low thermal expansion. These desired properties are mainly manipulated by matrix, the reinforcement element and the interface. Aluminum-based Al_2O_3 particle reinforced MMC material have become useful engineering materials due to their properties such as low weight, heat-resistant, wear-resistant and low cost. These are found in various engineering applications such as cylinder block liners, vehicle drive shafts, automotive pistons, bicycle frames etc. These materials are known as the difficult-to-machine materials because of the hardness and abrasive nature of reinforcement element like alumina (Al_2O_3) particle [1].The addition of Al_2O_3 will not only strengthen the microstructure but also channel deformation at the tip of a crack into the matrix regions between the fibers, thereby constraining the plastic deformation in the matrix leading to reduction of fatigue ductility [2,3]. Selection of manufacturing method for MMC of Aluminum depends upon the type of reinforcement required. Methods like casting and powder metallurgy can be used to manufacture MMC of aluminum amongst them casting is most acceptable because it results in homogeneous mixing of particles with base metal and made a strong bond of foreign particles with the base metal. Due to the proper mixing of metal and ceramic particles, MMC not only combine properties of metallic base like ductility but also the ceramic reinforcement like high hardness and tensile strength which leads to a high strength in tension and shear [4]. MMCs are harder due to the presence of ceramic particles however the carbide tools are widely used commercially for cutting operations but tool wear is very high due to the reinforcement of particles like Al_2O_3 and SiC [5].Reinforced particles are harder as compared to cemented carbide tool cutting tool so cutting tools harder than these particles needed to machine MMCs. Some carbide tools are available to machine MMCs with particles like Al_2O_3 and SiC even tool wear is much rapid during the cutting of reinforced material [6-8].Tools like Polycrystalline diamond, cubic boron nitride and tungsten carbide are suggested for cutting operations for better surface finish [9-10].As these cutting tools are very expensive so selection of cutting tool is plays a vital role along with the cutting parameters, carbide tools can be used for cutting operations. Tool wear, MRR and surface roughness are not only depends upon the cutting tool but also on feed rate, depth of cut, speed and concentration of reinforcement of ceramic particles in MMCs [11-12].

When SiC based MMCs of Aluminum were tested for cutting operation, surface finish directly depends upon cutting speed i..e as cutting speed increased better surface finish achieved [13]. Surface finish of MMCs with reinforcement increases as compared to material without particulates due to the presence of peaks and valleys of ceramic particles [14]. Surface roughness of MMCs are increase with depth of cut and cutting speed also with the concentrations of reinforcement during the machining even effect of feed rate is much higher on surface roughness [15-16].

The cutting parameters like speed, feed rate, and depth of cut made an impact during the turning of MMCs for various levels of reinforcement ceramic particles.

2. Experimental Detail

To prepare MMCs, Al 2024 alloy is used as base metal and α- Al_2O_3 is used as reinforcement material. Alumina was reinforced with the aluminum 2%, 4% and 6% by weight to manufacture MMCs.

2.1. Manufacturing of MMCs

Manufacturing of MMCs done by sand casting, aluminium were act as base metal while alumina were reinforced with base metal, inclusion of alumina were 2,4 and 6 percentage by the weight of aluminium. During the manufacturing of the MMCs first aluminium were melted after melting of the base metal alumina were poured in to the molten aluminium while keeping continuous steering of solution. The dimensions of workspiece are 45 mm in diameter and 300 mm in length.