Springer

KSME

Journal of Mechanical Science and Technology 30 (1) (2016) 89~95
www.springerlink.com/content/1738-494x(Print)/1976-3824(Online)
DOI 10.1007/s12206-015-1210-y

Effect of high speed turning operation on surface roughness of hybrid metal matrix (Al-SiC_p-fly ash) composite †

E. Baburaj[1,*], K. M. Mohana Sundaram[2] and P. Senthil[3]

[1]*Department of Mechanical Engineering, Karpagam College of Engineering, Coimbatore-641032, India*
[2]*Jansons Institute of Technology, Coimbatore-641659, India*
[3]*Department of Mechanical Engineering, Karpagam University, Coimbatore-641021, India*

(Manuscript Received October 4, 2014; Revised June 30, 2015; Accepted August 16, 2015)

Abstract

This paper explains the effect of turning parameters such as cutting speed, feed rate, depth of cut and cutting tool nose radius on surface roughness of hybrid metal matrix (Al-SiC_p-Fly ash) composite. Experiments have been conducted based on the orthogonal array $L_{16}(4)^5$ and surface roughness was tested on the composites turned by an high speed CNC centre lathe. Analysis of variance (ANOVA) was performed to predict the significant parameters and their contribution towards surface finish of the composite. A mathematical model was developed using non-linear regression analysis. Taguchi method and Genetic algorithm have been employed to optimize the turning parameters for optimum surface roughness of the composite. The optimum turning parametric conditions have been checked with the confirmation experiments. It has been noted that the optimum condition of genetic algorithm exhibited better results than the experimental results based on the orthogonal array and the optimum condition of Taguchi method.

Keywords: Hybrid metal matrix composites; High speed turning; Surface roughness; Taguchi method; Genetic algorithm

1. Introduction

Metal matrix composites (MMC) are widely used in many industries such as aerospace, automotive, electronics and medical industries due to their desirable properties like high strength, low weight, high module, low ductility, high wear resistance, high thermal conductivity and low thermal expansion [1-5]. Aluminum, titanium and magnesium alloys are commonly used as metal matrix and silicon carbide (SiC), aluminium oxide (Al_2O_3) and boron carbide (B_4C) are commonly used as reinforcements during the production of MMCs [6-10].

Machinability of MMCs has received considerable attention because of high tool wear associated with machining. MMCs reinforced with SiC_p particles are extremely difficult to machine (Turning, milling, drilling, grinding, etc) due to their extreme abrasiveness [11-13]. Generally, the presence of hard reinforcement particles makes them extremely difficult to machine as they lead to rapid tool wear. Additionally, the production of good surface finish is essential for many components [14, 15]. Studies on machinability of light metal alloy composites reinforced with Al_2O_3/SiC fibers/particles [16, 17] indicate poor machinability due to abrasive wear of tools [18]. Moreover, quality of the machined surface also deteriorates with tool wear [19-21]. Published literature on the machinability of particulate reinforced MMCs indicates that only Polycrystalline diamond tools (PCD) provide a useful tool life when machining these materials with PCD tool, which is harder than Al_2O_3, SiC, B_4C, etc and also does not have a chemical tendency to react with the work piece material [22-25]. However, due to the extremely high cost of PCD tools, less expensive tools like cemented carbides and ceramics are being used to machine these materials.

Now-a-days, aluminum metal matrix composites have emerged as the forerunner for a variety of general and special applications [26-29] due to their superior specific strength, specific stiffness, high temperature capability, lower coefficient of thermal expansion, better wear resistance, improved dimensional stability and amenability to conventional metal forming techniques [30-33]. The present study has been carried out to investigate the effect of high speed turning parameters like cutting speed, feed rate, depth of cut and tool nose radius on the surface roughness of Al-SiC_p-Fly ash metal matrix composites. Taguchi method and genetic algorithm have been employed to find out the optimum parametric conditions for obtaining optimum surface roughness on the turned composites.

*Corresponding author. Tel.: +91 9486409816, Fax.: +91 4222980022
E-mail address: ebaburaj.kmms@gmail.com
† Recommended by Associate Editor Kyeongsik Woo