Chapter 56
EDM Process Parameters Optimization for Al–TiO2 Nano Composite

Arvind Kumar Dixit
Banaras Hindu University, India

Richa Awasthi
National Institute of Foundry and Forge Technology, India

ABSTRACT

Titanium aluminide reinforced aluminium based metal matrix nano composite was prepared by stir casting route. Experiments were conducted with Cu electrode using L9 orthogonal array based on the Taguchi method. Discharge current (Lv), Pulse on time (Ton) and Flushing pressure (FP) are selected to calculate Metal removal rate (MRR), Tool wear rate (TWR) and Surface roughness (SR) based on Taguchi's parameter design. Moreover, the signal-to-noise ratios associated with the observed values in the experiments were determined using MINITAB software for MRR, TWR and SR. PCR – TOPSIS method is used to optimize Taguchi's multi response. Optimum parameter setting is found at Discharge current (Lv) 10 A, Pulse on time (Ton) 150 μs and Flushing pressure (FP) 1 kg/cm2.

1. INTRODUCTION

A composite material is composed of a discrete constituent that is called reinforcement, distributed in a continuous phase (the matrix) and which derives its distinguishing characteristics from the properties of its constituents, from the geometry and architecture of the constituents as well as from the properties of the boundaries (interfaces) between different constituents (Velmurugan, Subramanian, Thirugnanam, & Ananadavel, 2011). Aluminium based metal matrix composites (MMCs) have been extensively studied as an attractive choice for automotive, aerospace and military applications due to their light-weight, high strength, stiffness and resistance to high temperature as light weight high strength material is the need of technologically advanced industries (Gopalkannan & Senthilvenan, 2013; Roy, Basu, & Mallick, 2005).

DOI: 10.4018/978-1-5225-1798-6.ch056

Nano-composites have gained much interest recently. The properties of nano composite materials depend on both: the properties of their individual parents and on their morphology and interfacial characteristics. By optimized fabrication procedure and controlled nano-sized second phase dispersion, thermal stability and mechanical properties such as adhesion resistance, flexural strength, toughness & hardness can be enhanced, which can result into improved nano-dispersion (Baksi, Basak, & Biswas, n.d.; Hay & Shaw, 2000). Metal matrix composites (MMCs) contain a certain amount of secondary hard and abrasive reinforcements due to which they have high strength, hardness and stiffness. So that machining of MMCs using conventional tool materials is very difficult and severe tool wear occurs (Karthikeyan, Narayanan, & Naagarazan, 1999). High tool wear have been reported during conventional machining of Al MMC (Mortensen & Llorca, 2010). Nano composites also have higher strength, toughness and hardness so an alternative to effectively machine this material is to go for non-traditional machining techniques. EDM is one of the machining processes, which is widely used to produce intricate shapes on any conducting metal and alloy irrespective of their hardness and toughness. EDM is a process whereby a desired shape is obtained using electrical discharges. Material is removed from the workpiece by a series of rapidly recurring discharges between two electrodes, separated by an insulating dielectric liquid and subjected to an electric voltage (Srivastava & Pandey, 2013). S. Assarzadeh et al (Assarzadeh & Ghoreishi, 2013) had selected four independent input parameters, viz., discharge current (A: Amp), pulse-on time (B: μs), duty cycle (C:%), and gap voltage (D: Volt) were selected to assess the EDM process performance of tungsten carbide-cobalt composite (Iso grade: K10) in terms of material removal rate (MRR: mm^3/min), tool wear rate (TWR: mm^3/min), and average surface roughness (Ra: μm) using response surface methodology and ANOVA result was found that MRR increases steadily by increasing both discharge current and duty cycle and TWR can be lowered by applying small, current levels with long pulse durations. P. Narender Singh et al. (Narender, Raghukandan, & Pai, 2004) studied the effect of the parameters viz., current (*C*), pulse on-time (*P*) and flushing pressure (*F*) on the responses viz. metal removal rate (MRR), tool wear rate (TWR), taper (T), radial overcut (ROC), and surface roughness (SR) on electric discharge machining (EDM) of Al–10%SiCP as cast metal matrix composites using orthogonal array (OA) with Grey relational analysis. The experimental result for the optimal setting showed that there was considerable improvement in the process. S. Gopalakannan et al. (Gopalkannan & Senthilvenan, 2013) employed EDM to machine MMNC with copper electrode by adopting face centered central composite design of response surface methodology. Ponappa et al. (Ponappa, Aravindan, Rao, Ramkumar, & Gupta, n.d.) studied the effect of EDM microwave- sintered Mg nano composites (reinforced with 0.8 and 1.2% of nano alumina). Experiments were conducted using taguchi methodology to ascertain the effects of edm process parameter. Research work has been done by taking various parameters in account and with different electrode materials. Most of the work is focused on machining hard to machine materials and various alloys. EDM machining characteristics of various composites have also been studied. Nano composites have wide range of applications but less research has been carried out on nano composites. Machining characteristics of Al – TiO_2 nano composite has not been studied till now.

Present work aims to study the effect of Discharge current (Lv), Pulse on time (Ton) and Flushing Pressure (FP) on metal removal rate (MRR), tool wear rate (TWR) and surface roughness (SR), to determine optimum parameter setting for MRR, TWR and SR and to find optimum parameter setting that optimizes MRR, TWR and SR simultaneously.