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Multi-objective optimization in WEDM process of graphene – SiC-magnesium composite through hybrid techniques

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ABSTRACT

This paper exhibits a test examination and investigation on the impacts of Wire Electric Discharge Machining (WEDM) parameter on Material removal rate (MRR) and surface roughness (Ra) for the newly developed Magnesium metal matrix composite. Two material parameters (namely reinforcement wt.%, SiC doping %) and three machining parameters (viz. Pulse-On Time (P-ON), Pulse-Off Time (P-OFF), and Wire Feed Rate (WFD)) have been selected to study their effects on the desired output responses (MRR and Ra). The output response variables like MRR and Ra are then analyzed using Taguchi coupled Grey relation analysis. The general belief in any such investigations is that increase in P-ON increases MRR and the same has been revisited through this exhaustive study. Nevertheless, as increased machining time leads to an increase in the manufacturing cost, a trade-off between MRR and Ra, was successfully made by utilizing a Taguchi coupled Grey relation analysis. This gave the best combination of input parameters.

1. Introduction

Nowadays, lightweight materials that includes magnesium, aluminium etc., are emergent in their ultimatum in several fields of applications viz. transport industries, medicine, household equipment owing to its satisfactory possessions such as low density, better strength of weight ratio, high thermal conductivity, high damping capacity, shielding behaviour etc. These appearances construct suitability for consumers in their field where weight reduction target is needed [1–7]. Magnesium alloy has lower density among structural materials. It has also been acclaimed for using them as bio-implant metal due to its lower density and its biocompatibility property. Likewise, transport industries have forfeiting cumulative responsiveness to diminish the greenhouse gas emission, upsurge fuel efficiency for the reason of fossil fuel exhaustion and several environmental issues [8–10]. Whatsoever, Mg based material pose inferior wear resistance that limits the possible range of its application. Composite fabrication was one way to improve the basic and functional behaviour of base materials. Composites reinforced with nano particles are well known ongoing research topics of interest. Different reinforcement particles viz. graphene oxide, nano SiC, TiC, graphite, BN etc., have been used to achieve better mechanical properties that includes high hardness, wear resistance and high elastic modulus [11–18].

It is a widely accepted fact that ceramic reinforced composite materials exhibits poor machinability owing to the abrasive nature of hard reinforcement particles that has the ability to cause rapid tool wear. To machine composites by adopting any of the distinguished conventional machining process could be awkward and costly, in the current era; above and beyond such usages also slow down the commercial exploitation of developed novel composite materials [19–22]. As well, traditional machining processes are easy to implement and execute over non-traditional processes. However, it is very difficult to cut complicated and complex shapes in hard materials using traditional processes and hence, there is a noticeable demand for developing efficient and precision machining techniques for composite materials. Therefore to fulfill the aforesaid criteria's, a non-traditional machining technique is required; among the availability, the Wire Electric Discharge Machining (WEDM) is an accepted method to manufacture complex profiles in composite material. Non-traditional machining processes like electric discharge machining and WEDM are very useful for precision industries like automobile and sheet metal, especially, for the manufacturing of punch, dies, jigs, and fixtures [23–26]. In many cases, WEDM plays an important role in machining complicated and intricate shapes in hard tool steels. Often times, the information provided by the supplier is not sufficient to achieve the required output from the material; therefore, in

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