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Influence of machining parameters on wire electrical discharge machining performance of reduced graphene oxide/magnesium composite and its surface integrity characteristics

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ABSTRACT

Taguchi coupled grey relation analysis is adopted to study the effects of machining parameters of Wire Electrical-Discharge Machining (WEDM) on magnesium metal matrix composite reinforced with Reduced Graphene Oxide(r-GO). An optimal combination of process parameter was expected to be finalized in this research to attain maximum Material Removal Rate (MRR) with a minimal surface roughness (Ra) value. The composite was fabricated through solvent based powder metallurgy route for varying percentage of r-GO. Experimental combination for WEDM of developed composite specimens were finalized to be L27 orthogonal array (OA) using Taguchi's method mainly based on the control factors namely reinforcement weight percentage (wt.%), pulse ON time (P1), pulse OFF time (P2) and wire feed rate (Wfd). ANOVA results revealed that wt.% and P1 are the most influencing parameters for MRR and Ra. Outputs scaleup that the developed regression model augments well with the experimental values. Using grey relation analysis (GRA) the optimal parameter was set and the final results obtained based on the optimal combination was found to be with a maximum MRR (18.38 mm^3/min) and minimum Ra (3.29 μm). Traces of intermetallic formation are identified over the machined surface due to the action of machining parameters.

1. Introduction

In lieu of strategic development in the industrial sector, a trend in developing advanced materials that too with superior strength and many other relevant properties are quite increasing. This fact incites that the researchers should necessarily concentrate more towards the field of material science which will definitely fulfill the trending industrial requirements. One way to get a material with desirable properties for the determined application is composite fabrication; amongst the variations in the field of material oriented composite development processes, generally hard ceramic particles like SiC,TiC,WC etc., were used as the reinforcement material in order to enhance the desired properties of matrix material [1–5]. Above & beyond, now a days nano particle reinforced composite development has gained decent focus just because even little addition of nano particles equals with better strength when compared to micro sized reinforcements of same material [6–11]. Evenso, also reported that abnormal increase in addition of nanoparticle results in decrement on strength and allied characteristics due to the tendency of agglomeration. Carbon based nano materials like carbon nanotube (CNT) and graphene are used as reinforcements as because they majorily adhere high strength and low density besides possessing better mechanical and electrical properties [12–17].

In the last two decades Magnesium based Metal Matrix Composites (Mg-MMCs) has been given higher priority in the field of transport industries due its high strength to weight ratio and at the same time its lower density and good damping resistance highly supports for weight reduction and pollution free environment. Metal matrix composites (MMCs) were fabricated through different routes out of which the following are of high potential: stir casting, squeeze casting, powder metallurgy [18–22]. Among the list, traditional powder metallurgy(P/M) was the one that is mostly preferred to fabricate Mg-based composite at a reasonable cost. Also Mg-based MMC developed through P/M method exhibits good strength with uniform distribution of reinforcements and thus have made many newly developed materials highly suitable for the requirements of modern engineering industries [23–25].

Machining of composite material is an important process in acquiring fine shaped industrial parts as per the necessities; but however traditional machining like milling and turning was not effective for machining a MMC

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