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Title: Fabrication and machining of metal matrix composite

ABSTRACT

Metal Matrix Composites (MMCs) are known for their high strength to weight ratio, high hardness and wear resistance. Several processing techniques such as liquid phase fabrication, solid phase fabrication, two phase process and the powder metallurgy are used for fabrication of particulate reinforced MMCs. Machining of MMCs is difficult by conventional machines due to abrasive nature of reinforcement. Among non conventional machining methods, wire electrical discharge machining (WEDM) is the most versatile and useful machining process. Thus, the WEDM process parameters like pulse on time (P_{ON}), pulse off time (P_{OFF}), pulse current (P_C), wire drum speed (W_{DS}) and performance measures like surface roughness (SR), kerf width and material removal rate (MRR) are considered in the present study.

In this study, the Al7075/SiC/Al_2O_3 hybrid composite was fabricated by Inert Gas Assisted Electromagnetic Stir Casting Process using Al-alloy of 7xxx series as metal matrix and SiC and Al_2O_3 particulate (20-40 μm) as the reinforcements. The hybrid composite with four different compositions i.e. 5, 10, 15 and 20wt% each of SiC and Al_2O_3 particulates (each in 1:1 ratio), were successfully fabricated. The pilot experiments were carried out to decide about the machining parameters, their ranges and then final experiments were carried out using L_{27} orthogonal array. The process parameters

optimization was done using Taguchi method. Microstructure examination of cast hybrid composite revealed a fairly uniform and homogeneous distribution of Al_2O_3 and SiC particulates. The X-RD patterns confirm the presence of base element, aluminum, other constituents of the matrix alloy and the hard phase Al_2O_3 and SiC. No peaks of brittle phase Al_4C_3 were observed. TG, DTG and DTA analysis showed that there is negligible loss of material in the composite. Mechanical testing of the fabricated hybrid composite showed that the tensile strength and micro hardness are higher than that of the cast metal matrix 7075 Al- alloy. The tensile strength was highest for 15wt% sample showing an improvement of 65.7% and micro hardness was maximum for 20wt% sample showing an improvement of 13.5%. The percentage elongation and impact strength however showed reduction trend with increase in wt% of the reinforcement. In optimization of SR by WEDM, the linear parameters, P_{ON} was found to be the most significant parameter contributing 59.70%, followed by P_C (29.20%), P_{OFF} (7.58%) and second order interaction, P_{ON} x P_C (2.09%). Also the SR increased with increase in P_{ON} and P_C but decreased with increase in P_{OFF}. In optimization of kerf width, P_C was observed to be the most significant parameter contributing 47.16%, followed by P_{ON} (38.36%), W_{DS} (5.16%) and second order interaction P_{ON} x P_C (5.47%). Also the kerf width increased with increase in P_{ON}, P_C and W_{DS}. In optimization of MRR, P_{ON} was the most significant parameter contributing 46.04%, followed by P_C (34.72%) and P_{OFF} (10.23%). The contribution by interaction effect (P_{ON} x P_{OFF}) was 5.46%. Further, the results indicated that the MRR increased with increase in P_{ON}, P_C and W_{DS} but decreased with increase in P_{OFF}. The surface topography analysis showed that SR, MRR and kerf width were high at higher level of process parameters setting.