CHAPTER 57

TECHNOLOGY
MANUFACTURING PROCESSES
&
AUTOMATION ENGINEERING

Doctoral Thesis

01. POOJA (Dwivedi)
Surface Modification Through Friction Stir Processing (FSP).
Supervisors: Prof. Sachin Maheshwari and Prof. Arshd Noor Siddiquee
Th 26924

Abstract

Recently, the FSP is evolved as a preferred route for fabricating metal matrix composite (MMCs). Addition of metallic powders to ceramics is reported to contribute multitude of benefits and result in overall material properties enhancement. Homogeneous particle distribution over the entire processed zone is one of the biggest challenges of FSP, as it deteriorates the overall mechanical properties of composites. The issues of agglomeration, difficulties in the distribution and dispersion of ceramic power can be effectively handled by adding low melting point metallic power. The addition of metallic powder may contribute the particle distribution in multiple ways and also enhance the properties of resultant composites such as through thermal conductivity and ductility apart from the strengthening. Therefore, this investigation reports a maiden work on surface composite fabricated by FSP through hybrid reinforcement on aluminum alloys to remove the aforementioned problems. AA5083 base material (BM) plate of thickness 6 mm and a mixture of SiC, Fe, Mn and Sn powder were used to fabricate surface composites. Process parameter window was obtained from trial experiments and past experiences. Therefore, Taguchi's standard L18 orthogonal array has been opted for the experimentation with rotational speed of range 710-1120rpm, traverse speed was in between 40-63mm/min and shoulder diameter was in between 21-24mm. The results are analysed through comprehensive microstructural, mechanical and electrochemical evolutions at room and warm temperature. In microstructural examination, distribution of grains and flow of material from one region to another have been clearly seen and phases evolved during the processing were visible in SEM and EDS results. MINITAB software was used to analyze the effect of processing parameters to the response variables. To obtain optimal parameters, the study employed the multi-response variable technique called Grey relational analysis was used. Thus, homogeneous particle distribution is attempted through FSP.

Contents

1. Introduction 2. Literature survey 3. Methodology and experimentation 4. Results and discussion 5. Conclusion and future scope of work. Reference. Appendices and Curriculum vitae.

02. NARENDER KUMAR

Some Studies on Carbon Nanostructures in Electrical Discharge Machining

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Abstract

Electro-discharge machining (EDM) is a widely used advanced material removal technique for difficult-to-machine metals, offering high precision and surface quality. However, conventional EDM has limitations in tool wear rate (TWR), surface roughness (SR), and material removal rate (MRR). To address the drawbacks of conventional EDM, magnetic field-assisted powder mixed electrical discharge machining (MFAPM EDM) is used, utilizing an electric field, a permanent magnetic field, and a dielectric fluid mixed with conductive powder. This technique enhances performance through multiple discharge events, Lorentz force, and the influence of powder characteristics and magnetic flux density. Carbon nanotubes (CNTs) are a promising candidate for MFAPM-EDM due to their unique properties. The study aimed to improve conventional EDM performance using CNTs and magnetic field density. A setup was developed for EDM machining of aluminum matrix composites (AMCs), focusing on optimizing significant input factors such as peak current, CNTs concentration, pulse on and off time and magnetic field density. The AMC (AA 7050 matrix composite) was fabricated with nano-sized B4C and Al2O3 reinforcements using the stir casting method, optimized through the Taguchi L9 orthogonal array method. The optimal conditions achieved a tensile strength of 304 MPa and Vickers hardness of 194 HV, with stirring speed being the most significant factor. MFAPM-EDM machining was conducted using Taguchi`s L27 orthogonal array, employing single-objective optimization and multi-objective optimization with grey relational analysis. Optimal values obtained using single and multi-objective optimization show the better performance of the hybrid EDM process as compared to conventional EDM. From the optimization results, it was observed that peak current is the most crucial parameter influencing the hybrid EDM performance. Results also showed that CNTs powder and magnetic field significantly improved MRR and reduced TWR and surface roughness, leading to overall improvements in conventional EDM performance.

Contents

1. Introduction 2. Literature survey 3. Materials and methodology 4. Analysis of AA 7050 B_4C/Al_2O_3 composite 5. Results and discussion of MFA CNT_S mixed EDM 6. Conclusion and future work. Reference. List of publications.