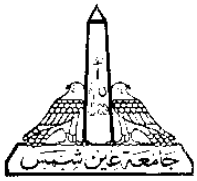


Ain Shams University

Faculty of Engineering

Design and Production Engineering

Preparation and investigation of composites on Aluminium surfaces by friction stir processing

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Mechanical Engineering

(Design and Production Engineering)

by

Ahmed Abdel Ghaffar Abdel Maboud

Bachelor of Science in Industrial Engineering

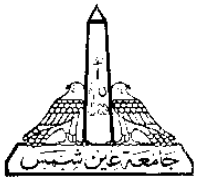
Faculty of Engineering, Helwan University, 2013

Supervised By

Prof.Dr: Nahed Abdel Hamid El Mahallawy

Dr: Said Hussein Mohamed Zoalfakar

Cairo – (2019)



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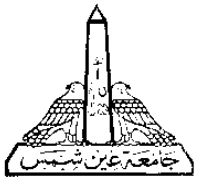
Supervising Committee

Name	Signature
Prof.Dr: Nahed Abdel Hamid El Mahallawy	…….
Dr: Said Hussein Mohamed Zoalfakar	…….

Date: 14 February 2019



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Examiners' Committee

Name	Signature
Prof.Dr: Ahmed Refat El Sisi	…….
Prof.Dr: Mohamed Abdel Hamid Hassan	…….
Prof.Dr: Nahed Abdel Hamid El Mahallawy	…….

Date: 14 February 2019

Statement

This thesis is submitted as a partial fulfilment of Master of Science in Mechanical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Signature

Ahmed Abdel Ghaffar Abdel Maboud Mohamed

Date: 14 February 2019

Researcher Data

Name	: Ahmed Abdel Ghaffar Abdel Maboud
Date of birth	: 13.01.1991
Place of birth	: Giza
Last academic degree	: B.Sc. in Industrial Engineering
Field of specialization	: Industrial Engineering
University issued the degree	: Helwan University
Date of issued degree	: 10.2013
Current job	: Mechanical Engineer

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Summary

Aluminium alloys are extensively used in many applications such as aerospace and defence industries due to the high strength to weight ratio and good ductility. Friction stir processing (FSP) is a technique based on the principles of friction stir welding (FSW) used to produce composites. In this work, the formulation of a mathematical model with process parameters of rotational speed, feed rate, number of passes and tool shape are used to predict the response or the mechanical properties of friction stir processed of 1050 aluminium alloy (yield strength, ultimate tensile strength, percentage elongation and microhardness). A central composite design with four factor, each factor with five levels was used and a response surface methodology (RSM) was applied to develop the regression models to predict the responses. Method of analysis of variance ANOVA was applied to figure out the significant process parameters that have effect on the responses. These results point out that the friction stir processing of 1050 aluminium alloy with 1500 rpm rotational speed , 116 mm/min feed rate , 3 FSP passes and square tool shape, have the maximum predicted responses using response surface methodology (RSM). Those optimum process parameters were used to fabricate AL/SiC composites with different volume fractions. The FSPed composites samples were investigated by optical microscopy (OM), scanning electron microscope (SEM) and EDX to analysis the microstructural changes within each sample. Mechanical and tribological properties were also investigated through microhardness and tension test in addition to wear resistance. The results show significant improvement in the FSPed and FSPed composites samples where a modified grain structure is obtained in the stir zone indicating the formation of fine equiaxed grains compared to the coarse

elongated grains of the as-received. The obtained volume fractions of the composites ranged from 7% to 16%. The microhardness of FSPed samples showed a significant increase up to 112 % compared to the as-received material. The strength of FSPed composites with volume fraction ≈ 16% increased by 10% compared to the as-received material. The wear resistance of the FSPed composites increased by 62 % compared to the as-received material.

Keywords: Friction stir processing, response surface methodology, aluminum alloy, process parameters optimization, ANOVA, mechanical properties, microstructural evaluation, , Al composites, SiC particles, wear resistance, optical microscopy, SEM, EDX.

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