AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Design and Production Engineering

Fabrication and Assessment of Metal Matrix Composites MMC's

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

Master of Science in Mechanical Engineering

(Design and Production Engineering)

by

Mohamed Hazem Abd El-Aziz Hassan

Bachelor of Science in Mechanical Engineering
(Design and Production Engineering)
Faculty of Engineering, Ain Shams University, 2013

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Cairo - (2019)

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Statement

This thesis is submitted as a partial fulfillment 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

……...…….

Mohamed Hazem Abd El-Aziz

Date: 2019

Acknowledgment

Thanks to Allah for giving me the knowledge and opportunity to achieve this work. It was a great honor to work under the academic supervision of Prof. Dr. Adel El-Shabasy and Dr. Mohamed Zaky. I am grateful for their mentoring and their tremendous efforts. None of this work could be achieved without their continuous support and knowledge throughout all my study and research phases.

I would like to thank Prof. Dr. Hala Hassan and also Faculty of Engineering, Ain Shams University academic team for giving all the required academic support.

I would like to thank Friction Stir Welding and Processing lap team at Suez University and Tebbin Institute for Metallurgical Studies for giving me their time, resources and technical support whenever is needed.

Finally thanks will never be enough for my family. They are my backbone and support in every step I take. They were always there for me every second of my life.

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Thesis Summary

Super light materials with high mechanical and thermal properties become a critical need in modern industries. Aerospace, automotive, trains and other many industries use Metal Matrix Composites to fulfill this need.

Friction Stir welding (FSW) as a solid state welding process has been used since its introduction in 1991 by TWI of England to weld the super lightweight materials in NASA space shuttle tanks. Friction stir processing (FSP) was developed based on the same principles of FSW mainly to enhance the surface properties of various materials and to produce surface composites.

Surface metal matrix composites of AA7075-T1 and T6 as the metal matrix were developed using FSP. Two ceramic particle types were used for reinforcement of surface composite, micro sized Al_2O_3 particles and ultra-fine SiO_2 particles. A groove of 3 mm depth and 1.2 mm width was machined on the surface of AA7075 to provide the highest reinforcement volume fraction on the produced surface composites. FSP tool used was made from tool steel having 20 mm shoulder diameter, 3.5 mm pin length and 7 mm pin width. Tool pin profile of square and cylindrical was designed and manufactured to produce FSP specimens. The tool had a concave shoulder and tapered bottom pin. The FSP parameters used were rotation rate of 600 rpm and traverse speed of 50 mm/min. The tool was heat treated to both HRC 45 and 60 before FSP. The previous mentioned experiments was conducted on friction welding machine at the friction stir welding and processing laboratory at Suez University. Preliminary experiments was conducted to evaluate other workshops machine suitability for the process. Number of variable have been changed, tool design, rotational speed, traverse speed, tool penetration procedure and groove dimensions were also studied.

The developed surface composites were evaluated using different metallographic techniques to investigate the macro and micro features. The hardness profile was also measured across the processed zone.

The surface composite hardness was improved by 10-30% compared to the unreinforced alloy. The tool with the above mentioned dimensions enables obtaining sound surface without any visible defects. Squared tool pin profile enhanced reinforcement particle distribution. Moreover, number

of processing passes effect on surface composite was evaluated. The surface composites achieved by three consecutive passes of processing showed uniform particle distribution on the surface. The hardness and the microstructure of surface metal matrix composite have been investigated. Many parameters can influence the properties of such surface composites the current results are compared with those from other similar composites reported in the literature.

Keyword: Friction Stir Processing, Surface Composite, Metal Matrix Composite, Aluminum alloys, Silicon oxide particles, tool design in FS

Contents