AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Design and Production Engineering

Processing of Ultra-High Strength Composite Materials via Non-Traditional Methods

A Thesis submitted in partial fulfillment of the requirements of the degree of
Master of Science in Mechanical Engineering

(Design and Production Engineering)

By

Riham Mohamed Sobhy El-Sheikh

Bachelor of Science in Mechanical Engineering
(Manufacturing Engineering and Production Technology)

Modern Academy for Engineering and Technology, 2013

Supervised By

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German University in Cairo

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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

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Riham Mohamed Sobhy El-Sheikh

Date: 2019

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Abstract

For the past few decades, Metal Matrix Composite has encountered an extensive improvement. Composite processing is an objective because of its ultra-high strength structural materials. Aluminum Metal Matrix composite introduced ultra-high strength and high performance if compared with conventional metals and alloys. Direct Metal Oxidations (DIMOX) along with Semi-Solid process (Rheocasting and Thixocasting) are introduced to control structural micro constituents. There is a limited understanding about DIMOX including its processes parameters (Temperature, Holding Time, and Alloying Elements). The control of micro structure components into a hybrid composite processing is a goal with a new emerging technique and economic aspect. In addition, the effect of boron addition, via the addition of boric acid or borax, is also introduced.

The control composite micro components, shape, size and morphology is also introduced via semisolid reaction processing. Microstructural analysis is introduced by Optical Microscopy, Scanning Electron Microscopy (SEM), and energy dispersive X-ray spectroscopy (EDS). Mechanical characterization is also introduced using tensile testing, 3-point bending test and hardness test. Boron has a distinguishable effect as dispersed phase in whiskers or as coating phase. Semisolid processing, Rheocasting induces alloy segregation more dominated into a bulk hybrid composite processing. In contrast, semisolid, Thixocasting processing dominates more surface coating rather than bulk processing. The application of liquid state processing, DIMOX, with the control of micro constituents with the synergetic effect of boron is introduced for new nontraditional hybrid structural materials.

Keywords: Alloy segregation, Boric acid, Borax, DIMOX, Hybrid, Recycle, Rheocasting, and Thixocasting.

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