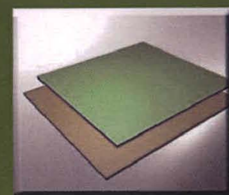
ADVANCES IN COMPOSITE MATERIALS



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IIUM PRESS

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

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IIUM Press

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Iskandar Idris Yaacob, Md Abdul Maleque & Zahurin Halim: Advances in Composite Materials.

ISBN: 978-967-418-231-1

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN. BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan

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Chapter 030

Synthesis and Characterization of Nickel Iron–Silicon Nitride Nanocomposite

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Keywords: Electroplating, Nanocomposite, Nickel-iron alloy coating, Si3N4 nano-particulates

Abstract: Nickel iron-silicon nitride nanocomposite thin films were prepared by electrodeposition technique. The deposition was performed at current density of 11.5 A dm^{-2}. Nano-size silicon nitride was mixed in the electrolyte bath as dispersed phase. The effects of silicon nitride nanoparticulates in the nickel-iron nanocomposite thin films were investigated in relation to the amount of silicon nitride in the plating bath. X-ray diffraction (XRD) analysis showed that the deposited nickel iron film has face-centered cubic structure (FCC). However, a mixture of body-centered cubic (BCC) and face-centered cubic (FCC) phases were observed for nickel iron-silicon nitride nanocomposite films. The crystallite size of Ni-Fe nanocomposite coating decreased with increasing amount of silicon nitride in the film. From elemental mapping procedure, Si_3N_4 nanopaticles were uniformly distributed in the Ni-Fe film. The presence of silicon nitride increased the hardness of the film. The microhardness of the nickel-iron nanocomposite increased from 495 Hv for pure NI to 846 Hv for film with 2 at. % Si. The coercivity of Ni-Fe nanaocomposite films increases with decreasing crystallite size.

Introduction

Composite electroplating is a method of co-depositing fine particles of metallic, non-metallic or polymeric compounds in plated layer to improve the properties of material such as wear resistance, lubrication, or corrosion resistance [1]. During this process, insoluble filler materials are suspended in the plating electrolyte and then captured in the deposited metal film. Nanocomposites of a metallic matrix containing dispersion of second phase particles usually display a variety of novel properties. The second-phase material can be powder, fiber or encapsulated particles. In general, the presence of a second phase particles in a co-deposited film offers a variety of benefits on physical and mechanical properties compared to pure metal coatings, such as increased microhardness, tensile strength and improved wear resistance [2]. The mechanical property of the nanocomposite material is improved due to extremely fine microstructure of the materials. The emergence of this new technology revives electrodeposition techniques by which a variety of new nanostuctured materials are synthesized. These include nanocrystalline deposits, nanotubes, nanomultilayers and nanocomposites. For the purpose of increasing the hardness of various electrodeposited metal and metal alloy based coatings, various inorganic particles including SiC [3], Al_2O_3 [4], and TiO_2 [5] are incorporated within the coating.