

**ADVANCES
IN MATERIALS
ENGINEERING**

Volume 2

**Edited By:
Md Abdul Maleque
Iskandar Idris Yaacob
Zahurin Halim**



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Table of Content

Chapter 1	Page
Amorphous Coating of Iron Nickel Alloy	1 Suryanto
Chapter 2	
Characterization of Electroplated Nanocrystalline NiFe Alloy Films	7 Yusrini Marita and Iskandar I. Yaacob
Chapter 3	
Corrosion Behavior of Zinc in Potassium Hydroxide Aqueous Solution	13 Suryanto
Chapter 4	
Development of Carbon Doped TiO ₂ Photocatalyst for Pigment Degradation	19 Muh Rafiq Mirza Julaihi, Asep Sofwan Faturohman Alqap and Iis Sopyan
Chapter 5	
Dynamic Mechanical Analysis of Carbon Fibre Composites	25 Hazleen Anuar, Sahrim Hj. Ahmad and Rozaidi Rasid
Chapter 6	
Effect of Composition on Phase Transformation of Iron-Platinum Nanoparticles	31 Koay Mei Hyeie and Iskandar I. Yaacob
Chapter 7	
Effect of Nanosized Alumina Reinforcement in Intermetallic Nickel Aluminide on the Formation of γ' Precipitates	37 Roslina Ismail and Iskandar I. Yaacob
Chapter 8	
Effect of Sintering Temperature on Protein Foaming-consolidation Porous Alumina-tricalcium Phosphate Composites	43 Ahmad Fadli and Iis Sopyan
Chapter 9	
Electrical Property of ITO Thin Film Deposited by Rf Magnetron Sputtering	49 Agus Geter Edy Sutjipto, Nurul Hajar and Farah Diana
Chapter 10	
Electrochemical Study of Zinc Selenide Thin Films Prepared for Photovoltaic Applications	55 Souad. A. Mohamad, A. K. Arof
Chapter 11	
Electrodeposited CdS / CdTe Solar Cells	61 Souad. A. Mohamad
Chapter 12	
Fabrication of Biomass Pellet from Mesocarp Fiber	65 Zahurin Halim and Nurshazana Mohamad
Chapter 13	
Fabrication of Kenaf Sandwich Panel	68 Siti Khadijah Abdul Rahman and Zahurin Halim

Chapter 14		
Foam Impregnation Method for Artificial Bone Graft Application		78
: Study on the Effect of Drying Time	Fariza Abdul Rahman and Zuraida Ahmad	
Chapter 15		
Foam Impregnation Method for Artificial Bone Graft Application		84
: Study on the Effect of Sintering Temperature	Zuraida Ahmad and Fariza Abdul Rahman	
Chapter 16		
FTIR Analysis - Aluminium Hydroxide Treated with Silane Coupling Agent		89
	Noorasikin Samat, Nor Suhaila Nor Saidi and Muhammad Saffuan Sahat	
Chapter 17		
Inorganic / Organic /Inorganic Double Junction Thin Film Solar Cells		92
	Souad. A. Mohamad	
Chapter 18		
Investigation on The Effect of Ultra Violet on Cotton Albumen Composite		96
	Zahurin Halim , Zuraida Ahmad and Fauziah Md Yusof	
Chapter 19		
Measurement of Oxygen Permeability in Bulk Alloys by Internal Oxidation of Dilute Constituent		100
	Mohd Hanafi Bin Ani and Raihan Othman	
Chapter 20		
Natural Dye Coated Nanocrystalline Tio ₂ Electrode Films for DSSCs		106
	Souad. A. Mohamad and Iraj Alaci	
Chapter 21		
Normal Deposition to Anomalous Deposition		109
	Suryanto	
Chapter 22		
Polymer Clay Nanocomposites: Part II- Synthesis of Polymer Nanocomposites		115
	Noor Azlina Hassan, Norita Hassan	
Chapter 23		
Production of Porous Calcium Phosphate Ceramics through Polymeric Sponge Method		120
	Asep Sofwan Faturohman Alqap, Nur Ain Rakman, and Iis Sopyan	
Chapter 24		
Silicone Doped Calcium Phosphate Powder Synthesized via Hydrothermal Method		126
	Asep Sofwan Faturohman Alqap, Iis Sopyan and Zuria Farhana Kushaili	
Chapter 25		
Stress Analysis of Backend Metallization		132
	Iskandar I. Yaacob and Goh Chia Lan	
Chapter 26		
Study on Metal Removing from Alumina Ceramics		137
	Agus Geter Edy Sutjipto and Muhyiddin Bin Budah@Udah	

Chapter 27		
Surface Quality of <i>Dipterocarpus Spp</i> under Tropical Climate Change: Effect of Pre-Weathering		146
	Mohd Khairun Anwar Uyup, Hamid Hamdan, Paridah Mat Tahir, Hazleen Anuar, Noorasikin Samat, Siti Rafidah Mohamed	
Chapter 28		
Surface Topography of Sulphuric Treated Carbon Fibre		151
	Hazleen Anuar, Sahrim Hj. Ahmad and Rozaidi Rasid	
Chapter 29		
Synthesis and Characterization of Electrodeposited Iron-Platinum Nanostructured Thin Films		157
	Seoh Hian Teh and Iskandar I. Yaacob	
Chapter 30		
Synthesis of Magnetic Nanoparticles in Water-in-Oil Microemulsions		164
	Iskandar I. Yaacob	
Chapter 31		
The Effect of R-ratio on Fatigue Crack Propagation in Plasticised PVC and Modified PVC		170
	Noorasikin Samat, Alan Whittle and Mark Hoffman	
Chapter 32		
The Effect of R-ratio on Fatigue Crack Propagation in Un-plasticized PVC and Modified PVC		175
	Noorasikin Samat, Alan Whittle and Mark Hoffman	
Chapter 33		
Thin Film of Indium Tin Oxide and Its Deposition Technology Deposition		180
	Agus Geter Edy Sutjipto, Sugrib Kumar Shaha	
Chapter 34		
X-ray Photoelectron Studies on the Surface Chemical States of Yttria-Stabilized Zirconia Thin Film in Aqueous Acid Hydrofluoric		186
	Sukreen Hana Herman, Mohd Hanafi Ani, and Susumu Horita	
Chapter 35		
ZnO / Polymer Junction Growth for Hybrid Solar Cell Applications		194
	Souad. A. Mohamad	

Synthesis of Magnetic Nanoparticles in Water-in-Oil Microemulsions

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Abstract. Magnetic nanoparticles were synthesized using a novel method called microemulsion processing. In this process, the aqueous cores (typically 5-25 nm in diameter) of water/cetyltrimethylammonium bromide (CTAB)/n-butanol/octane microemulsions were used as constrained microreactors for the precipitation of magnetic particles directly at room temperature. The typical size of the material was in the range of 3-10 nm. The particle size and size distribution were determined by TEM. The particles were then collected and washed. Phase analysis using X-ray diffraction (XRD) showed broad diffraction peaks corresponding to either magnetite (Fe_3O_4) or maghemite ($\gamma\text{-Fe}_2\text{O}_3$). The crystallite size estimated from the XRD is roughly 3.66 nm and is similar to the physical size of the particles probed by TEM indicating that they were largely monocrystals. Magnetization curve showed an absence of hysteresis indicating that the particles were superparamagnetic.

Introduction

Synthesis of particles with nanometer size dimensions is of increasing scientific and technical interest. Materials with single phase nanoparticles in the size range of 10 to 100 Å exhibit novel electronic, optical, magnetic, and chemical properties due to their extremely small dimension [1]. It is however difficult to obtain ultrafine and monodispersed nanoparticles by classical methods. In this respect, the aqueous cores of water-in-oil microemulsions have been shown to be ideal reaction media for this purpose [2].

A microemulsion is defined as a thermodynamically stable isotropic dispersion of two immiscible liquids consisting of microdomains of one or both liquids stabilized by an interfacial film of surface active molecules [3]. In water-in-oil microemulsions, the aqueous phase is dispersed as nano-size droplets (typically 5 – 25 nm in size) surrounded by a monolayer of surfactant and co-surfactant molecules in the continuous hydrocarbon phase. If a water-soluble metal salt is incorporated in the aqueous phase of the microemulsion, it will reside within the aqueous droplets surrounded by oil (continuous phase). These aqueous droplets continuously collide, coalesce and de-coalesce, resulting in a continuous exchange of solute content [4,5]. Conceptually, if two reactants A and B is controlled by the rate of coalescence of droplets and inter-droplet exchange [5, 6].

Microemulsions have been used as microreactors to produce ultrafine particle since Boutonnet *et al.* [2] first obtained ultrafine monodispersed metal particles of Pt, Pd, Rh and Ir by reducing corresponding salts in the aqueous droplets of water-in-oil microemulsions with