

# ADVANCES IN MATERIALS ENGINEERING

---

## Volume 1

Edited By:  
Zahurin Halim  
Iskandar Idris Yaacob  
Md Abdul Maleque



IIUM PRESS

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

# **ADVANCES IN MATERIALS ENGINEERING VOLUME 1**

Edited By:

Zahurin Halim  
Iskandar Idris Yaacob  
Md Abdul Maleque



**IIUM Press**

Published by:  
IIUM Press  
International Islamic University Malaysia

First Edition, 2011  
©IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

ISBN: 978 -967-418-167-3

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

# Table of Content

<b>Chapter 1</b> Preparation and Characterization of Thermoplastic Natural Rubber (TPNR) Nanocomposites <i>Noor Azlina Hassan, Sahrim Hj. Ahmad, Rozaidi Rasid and Norita Hassan</i>	1
<b>Chapter 2</b> Polymer Clay Nanocomposites: Part I <i>Noor Azlina Hassan and Norita Hassan</i>	6
<b>Chapter 3</b> Effect of Processing Parameters on the Tensile Properties of TPNR Reinforced Short Carbon Fibre Composite <i>Hazleen Anuar, Sahrim Hj. Ahmad and Rozaidi Rasid</i>	11
<b>Chapter 4</b> Effect of Maleic Anhydride Polyethylene on Damping Properties of HDPE/EPDM Nanocomposite <i>Hazleen Anuar, Nur Ayuni Jama, and Shamsul Bahri Abdul Razak</i>	16
<b>Chapter 5</b> Comparative Study on the Effect of Plasticizer on Thermal Properties of Polylactic Acid <i>Hazleen Anuar and Muhammad Rejaul Kaiser</i>	22
<b>Chapter 6</b> Quality of Copper Film Electroplated on Silicon Wafer Using Different Current Densities <i>Shahjahan Mridha</i>	28
<b>Chapter 7</b> Laser Nitriding of Titanium <i>Shahjahan Mridha</i>	39
<b>Chapter 8</b> Composite Coating on Titanium Alloy Using High Power Laser <i>Shahjahan Mridha</i>	45

<b>Chapter 9</b>		
Measurement of Moisture Absorption in Borophosphosilicate Glass (BPGS) Films		50
	<i>Shahjahan Mridha and Shiau Khee Tang</i>	
<b>Chapter 10</b>		58
The Effect of Processing Parameter on Tensile Properties of Thermoplastic Natural Rubber Nanocomposites		
	<i>Noor Azlina Hassan, Sahrim Hj. Ahmad, Rozaidi Rasid and Norita Hassan</i>	
<b>Chapter 11</b>		64
Comparison of Mechanical Properties Between Untreated and Sulphuric Acid Treated Short Carbon Fiber Reinforced Thermoplastic Natural Rubber (TPNR) Composite		
	<i>Noor Azlina Hassan, Norita Hassan, Sahrim Hj. Ahmad and Rozaidi Rasid</i>	
<b>Chapter 12</b>		69
Water Absorption of TPNR Reinforced Short Carbon Fibre Composite		
	<i>Hazleen Anuar, Sahrim Hj. Ahmad and Rozaidi Rasid</i>	
<b>Chapter 13</b>		74
Enhanced Tensile Strength with Sulphuric Treated Short Carbon Fibre		
	<i>Hazleen Anuar, Sahrim Hj. Ahmad and Rozaidi Rasid</i>	
<b>Chapter 14</b>		79
Effect of Fibre Length on Tensile Properties of TPNR-Kenaf Fibre Composite		
	<i>Hazleen Anuar, Sahrim Hj. Ahmad and Rozaidi Rasid</i>	
<b>Chapter 15</b>		84
Effect of Nanoclay on Mechanical Properties of PLA-Clay Nanocomposite		
	<i>Hazleen Anuar and Muhammad Rejaul Kaiser</i>	
<b>Chapter 16</b>		90
Extraction of Glucose From Kenaf Core by Using Chemical Pre – Treatment Process		
	<i>Nurhafizah Seeni Mohamed, Hazleen Anuar, Maizirwan Mel, Rashidi Othman, Nur Aisyah Mohd Norddin, Nur Aimi Mohd Nasir, Mohd Adlan Mustafa Kamalbhrrin</i>	
<b>Chapter 17</b>		96
Wear of Nitride Coating Produced by Ti-Al Melt Synthesis in Nitrogen Environment		
	<i>Shahjahan Mridha</i>	
<b>Chapter 18</b>		103
Effect of Dispersant on Protein Foaming-Consolidation Porous Alumina Containing Hydrothermal Derived Hydroxyapatite Nanopowder		
	<i>Iis Sopyan and Ahmad Fadli</i>	

<b>Chapter 19</b>	109
Effect of Yolk Addition on Protein Foaming-Consolidation Porous Alumina-Calcium Phosphate Composites	
	<i>Iis Sopyan and Ahmad Fadli</i>
<b>Chapter 20</b>	115
Investigation of the Effect of Starch Addition on Protein Foaming-Consolidation Porous Alumina Containing Hydroxyapatite Nanopowder	
	<i>Ahmad Fadli', Iis Sopyan, Nur Syahidah and Nur Nadia</i>
<b>Chapter 21</b>	120
The Influence of Hydroxyapatite Loading on Protein Foaming-Consolidation Porous Alumina Sintered at 1300°C	
	<i>Ahmad Fadli 'and Iis Sopyan</i>
<b>Chapter 22</b>	126
High Density Polyethylene (HDPE) as an Alternative Material in Fuel Tank Production	
	<i>Afiqah Afdzahuddin and Md Abdul Maleque</i>
<b>Chapter 23</b>	132
Porous Alumina-Hydroxyapatite Composites via Protein Foaming-Consolidation Method: Effect of HA Loading on Physical Properties	
	<i>Iis Sopyan, Ahmad Fadli and Nur Izzati Zulkifli</i>
<b>Chapter 24</b>	137
Preparation and Characterisation of Low Density Polyethylene/Layered Silicate Nanocomposites	
	<i>Salina Sharifuddin , Iskandar Idris Yaacob</i>
<b>Chapter 25</b>	144
Effects of Sodium Dodecyl Benzene Sulphonate (NaDBs) on Li Imide-PMMA Based Solid Polymer Electrolyte	
	<i>Fauziah Mohd Yusof and Iskandar Idris Yaacob</i>
<b>Chapter 26</b>	149
Effect of Milling Time on Mechanochemically Synthesized Nanohydroxyapatite Bioceramics	
	<i>Iis Sopyan, S. Adzila and M. Hamdi</i>
<b>Chapter 27</b>	155
Morphological Analysis of Mechanochemically Synthesized Nanohydroxyapatite Bioceramics	
	<i>Iis Sopyan, S. Adzila and M. Hamdi</i>
<b>Chapter 28</b>	160
Sodium Doped Nanohydroxyapatite Bioceramics through Mechanochemical Synthesis	
	<i>S. Adzila, Iis Sopyan and M. Hamdi</i>

<b>Chapter 29</b>	165
Thermal Profile Analysis of Composite Brake Rotor	
<i>Md Abdul Maleque and Abdul Mu'min Adebisi</i>	
<b>Chapter 30</b>	172
The Effect of Fibre Content on Thermal Property of Coir Fibre Reinforced Cement-Albumen Composite	
<i>Faridatul Faezah Razali, Nur Humairah Abdul Razak and Zuraida Ahmad</i>	
<b>Chapter 31</b>	178
Pulsed Electrodeposition	
<i>Suryanto</i>	
<b>Chapter 32</b>	184
Electroless Nickel Based Coatings From Solution Containing Sodium Hypophosphite	
<i>Suryanto</i>	
<b>Chapter 33</b>	189
Characterization and Utilization of Fly Ash	
<i>Suryanto</i>	
<b>Chapter 34</b>	195
Workability of Coir Fibre- Reinforced Cement-Albumen Composite	
<i>Nur Humairah Abdul Razak and Zuraida Ahmad</i>	
<b>Chapter 35</b>	201
Preparation of Rice Husk for Raw Material of Silicon	
<i>Hadi Purwanto and Nor Fazilah Mohd Selamat</i>	

# Thermal Profile Analysis of Composite Brake Rotor

Md. Abdul Maleque<sup>1</sup> and Abdulmumin Adebisi<sup>2</sup>

<sup>1,2</sup>Department of Manufacturing and Materials Engineering  
International Islamic University Malaysia  
53100 IIUM Gombak, Kuala Lumpur, Malaysia  
e-mail: [maleque@iium.edu.my](mailto:maleque@iium.edu.my), [debisi1@yahoo.com](mailto:debisi1@yahoo.com)

---

**Keywords:** Brake rotor, finite element analysis, composite material, heat transfer, thermal profile, hot spot.

**Abstract.** The thermal profile analysis of the composite brake rotor for frictional heat generation is performed using the finite element analysis. To analyze the temperature distribution of the rotor surface the heat transfer phenomenon in the braking process is considered. A mathematical model has been developed to produce a systematic thermo-mechanical coupling to predict the surface temperature distribution. The ANSYS/LS-DYNA software was used for the analysis and the result was presented in 3D thermal profile for the brake rotor. The result shows that a remarkable heat distribution profile was achieved due to the high thermal conductivity of the composite material when compared to the conventional cast iron material. Based on the results, excessive heat generation on the rotor surface was prevented which could lead to regions of hot spots as a result of localized high temperature contact regions.

## Introduction

The application of finite element method for brake rotor analysis is utilised as a preferred procedure for studying brake performance. It has the ability to provide solutions to a variety of engineering problems involving complex and advanced material properties. Thermal distribution profile generated during braking significantly affects the brake rotor performance as a result of excessive frictional heat generation rate. Frictional heating and thermal deformation in sliding contact systems affect the contact pressure and temperature on the friction surfaces. If the sliding speed is excessively high, these coupled thermal and mechanical behaviors can be unstable leading to localized high temperature contact regions called “hot spots” on the sliding interface [1]. Regions of hot spots on the rotor surface can influence material damage and thermal crack which in turn can induce an undesirable frictional vibration in the brake rotor systems. Consequently, the frictional vibration imposes design constraints on high performance of the automotive brake rotor. The FE techniques can be used as a reliable tool to solve brake rotor problems which include heat generation, thermal distribution, contact pressure and thermal instability analyses approach.

Recent studies have shown that the use of finite element for composite material application is a potential technique for brake rotor development due to its thermo-physical properties [2]. In a study by Gao and Lin [3], they observed that considerable evidence has shown that the contact temperature distribution is an integral factor influencing the combined effect of load, speed, friction coefficient and the thermo-physical and durability properties of the materials. In another study Lee and Yeo [4] stated that the uneven distribution of temperature at the surfaces of the rotor could bring about thermal distortion which causes thermal judder and excited vibration. Chandrupatla and Belegundu [5] stated that temperature distribution analysis is mostly performed using FE method