Advanced Biomass Science and Technology for Bio-Based Products

Editors Chung-Yun Hse, Zehui Jiang, and Mon-Lin Kuo

> Associate Editors Feng Fu and Paul Y. Burns

Developed from a symposium sponsored by: Chinese Academy of Forestry & USDA Forest Service, Southern Research Station

> May 23-25, 2007 Beijing, China

Copyright 2009 by Chinese Academy of Forestry.

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 prior written permission of the copyright owner. Individual readers and nonprofit libraries are permitted to make fair use of this material such as to copy an article for use in teaching or research.

Printed in the People's Republic of China.

PREFACE

This book was developed from the proceedings of the Advanced Biomass Science and Technology for Bio-Based Products Symposium held in Beijing, China, May 23-25, 2007. The symposium was designed to provide a forum for researchers, producers, and consumers of biomass and bio-based products; to exchange information and ideas; and to stimulate new research and development related to biomass science and bio-based products.

The major subject matter areas covered in the book include supercritical fluid applications, liquefaction of woody biomass, rapid assessment techniques, nanotechnology, physical and chemical modification of biomass, bio-based products, and biofuel/bioenergy. In addition to the oral presentations devoted to those topics, a number of presentations were given as poster presentations. Papers based on both oral and poster presentations have been included in these proceedings, subject to peer review.

Our thanks go to the many people who contributed to the success of the symposium. In particular, we acknowledge the efforts of the authors. Without their cooperation, the symposium and this book would not have been possible.

Chung-Yun Hse, Zehui Jiang, Mon-Lin Kuo, Feng Fu, and Paul Y. Burns.

Symposium Planning Committee

Symposium Co-Chairs:

Zehui Jiang, Professor and Past President, Chinese Academy of Forestry, China. *Chung-Yun Hse*, Principal Wood Scientist, USDA Forest Service, Southern Research Station, U.S.A.

Proceedings Editors:

Chung-Yun Hse, USDA Forest Service, Southern Research Station, U.S.A. *Zehui Jiang*, Chinese Academy of Forestry, China. *Mon-Lin Kuo*, Iowa State University, U.S.A.

Associate Editors:

Feng Fu, Chinese Research Institute of Wood Industry (CRIWI), CAF, China. *Paul Y. Burns,* Louisiana State University, U.S.A.

Planning Committee Members:

Thomas L. Eberhardt, USDA Forest Service, Southern Research Station, U.S.A. *Benhua Fei*, Chinese Research Institute of Wood Industry (CRIWI), CAF, China. *Feng Fu*, Chinese Research Institute of Wood Industry (CRIWI), CAF, China. *Leslie H. Groom*, USDA Forest Service, Southern Research Station, U.S.A. *Chung-Yun Hse*, USDA Forest Service, Southern Research Station, U.S.A. *Anmin Huang*, Chinese Research Institute of Wood Industry (CRIWI), CAF, China. *Daochun Qin*, International Center for Bamboo and Rattan (ICBR), China. *Chi-Leung So*, Louisiana State University, U.S.A. *Ge Wang*, Chinese Research Institute of Wood Industry (CRIWI), CAF, China. *Zhong Yang*, Chinese Research Institute of Wood Industry (CRIWI), CAF, China. *Yan Yu*, International Center for Bamboo and Rattan (ICBR), China.

Rongjun Zhao, Chinese Research Institute of Wood Industry (CRIWI), CAF, China.

Contents

Preface
Chapter 1. Sub- and Supercritical Fluid Applications1
Reaction Behavior of Cellulose and its Related Saccharides in Sub- and Supercritical Water <i>Mitsuru Sasaki, Takashi Saito, and Motonobu Goto</i>
Sub- and Supercritical Water Treatment of Creosote-Treated Wood Waste Todd F. Shupe, and W. James Catallo
Mechanical and Acoustical Properties of Wood-SiO ₂ Aerogel Composites fabricated by the Supercritical Fluid CO ₂ Drying Process <i>Jian Qiu, Jian Li, Yixing Liu, and Mon-Lin Kuo</i>
Chapter 2. Liquefaction23
Wood Liquefaction by Thermal Conversion <i>Xavier Deglise</i> 24
Inclusion of Cellulose Complex in NaOH-Thiourea Aqueous System at Low Temperature <i>Ang Lue, Lina Zhang, and Dong Ruan</i>
Wood Liquefaction and its Application to Novolac Resin <i>Hui Pan, Chung-Yun Hse, and Todd F. Shupe</i>
Syntheses and Properties of Liquefied Products of Ozone-Treated Wood/Epoxy Resins having High Wood Contents Asano Toshiyuki, Masahiko Kobayashi, Bunichiro Tomita, and Mikio Kajiyama
Synthesis of Spinning Solution from Liquefied Wood in Phenol <i>Xiaojun Ma, and Guangjie Zhao</i>
Influence of Finishing Oils on Structure and Properties of Fibers from Cellulose in NaOH/Urea Aqueous Solution Haisong Qi, Jie Cai, Lina Zhang, Yoshiharu Nishiyama, and Aurélie Rattaz66
Investigation of Bio-Composites using Novolac Type Liquefied Wood Resin: Effects of Liquefaction and Fabrication Conditions <i>Hui Pan, Chung-Yun Hse, and Todd F. Shupe</i>

Effect of Inorganic Acid Catalysts on Phenol Liquefaction of Recycled Particleboa Bencheng Zhu, Guangjie Zhao, and Junbo Shang	
Bond Quality of Phenol-Based Adhesives Containing Liquefied Creosote-Treated Wood	
Chung-Yun Hse, Feng Fu, and Hui Pan	.87
Preliminary Studies on the Alcoholysis of <i>Populus Tomentossa</i> with Ethylene Glyo Yanni Shen, and Yongming Fan	
Comparative Study on Liquefaction of Creosote and Chromated Copper Arsenate (CCA)-treated wood and Untreated Southern Pine Wood: Effects of Acid Catalyst Content, Liquefaction Time, Temperature, and Phenol to Wood Ratio	100
Hui Pan, Chung-Yun Hse, and Todd F. Shupe	102
Chapter 3. Rapid Assessment Techniques	110
Application of FT-Near Infrared Spectroscopy in Predicting Mechanical Properties Hardboard John F. Hunt.	
John I. Hum	
Application of Near Infrared Spectroscopy to Preservative-Treated Wood Chi-Leung So, Stan T. Lebow, Thomas L. Eberhardt, Leslie H. Groom and Todd F. Shupe	125
Use of Near Infrared Spectroscopy to Measure the Mechanical Properties of Solid Wood	
Huaqiang Yu, Benhua Fei, Feng Fu, Rongjun Zhao, and Zehui Jiang1	31
Characterization of Southern Yellow Pine Bark Layers by Attenuated Total Reflectance (ATR) and Fourier Transform Infrared (FT-IR) Spectroscopy <i>Thomas L. Eberhardt</i>	138
Chapter 4. Nanotechnology	144
Relating Nanoindentation to Macroindentation of Wood Robert J. Moon, Joseph E. Jakes, Jim F. Beecher, Charles R. Frihart, and Donald S. Stone	145
Cellulose Fibrils Isolated From Lyocell Fiber and its Reinforced PVA Nanocomposites	
Qingzheng Cheng, and Siqun Wang	160
Mechanical Characterization of Mature Bamboo Fibers with <i>In-situ</i> Imaging Nanoindentation	
Yan Yu, Zehui Jiang, and Genlin Tian	167

Multifunctional Nanoparticles at the Hydrophilic and Hydrophobic Interface Sangyeob Lee, Sheldon Q. Shi, and H. Michael Barnes
Mechanical Property Enhancement of Wood Flour/Polypropylene Composites Using Carbon Nanofiber
Jilei Zhang, Junli Shi, Charles U. Pittman, Jr., Hossein Toghiani, and Yubin Xue
Preparation of Composite Ultrafiltration Membrane with Microcrystalline Cellulose Liping Zhang, Guowei Chen, and Huanwei Tang
Chapter 5. Physical and Chemical Modification198
Wood Welding Antonio Pizzi
Plasma Enhanced Modification of TMP Fiber and Its Effect on Tensile Strength of Wood Fiber/PP Composite
Sangyeob Lee, Todd F. Shupe, and Chung Y. Hse
Characterization of Chitosan-Glucose Film Kenji Umemura, and Shuichi Kawai
Color Fastness of Dyed Veneer Treated with Chitosan Shuang-Ying Wei, Ji-You Gu, and Di Wang
Discoloration of Dye-Treated Veneers by UV-rays Yu Zhou, Iida Ikuho, Minato Kazuya and Kurosu Hiroshi
Investigations on the <i>Daemonorops Margaritae</i> Cane Discolorations Wen-Hua Lu, Hai-Qing Ren, Ben-Hua Fei, Yu-Zhang Wu and Ze-Hui Jiang247
Acylation of Cellulose with Fatty Acids by Microwave Irradiation Yu-Zhi Xu, Fu-Xiang Chu, Chun-Peng Wang, and Ming-Tao Lin
Chemical Components and Physical Properties of <i>Populus Tomentosa</i> Burl Wood <i>Chun-Lian Lu, Zhi-Jun Liu, Yu-Xin Yuan, and Zhao-Bin Sun</i> 260
Generation of Reactive Oxygen Species in <i>Pinus kesiya</i> var. <i>langbianensis</i>
Heartwood Treated with Laccase Yong-Jian Cao, Xin-Fang Duan, Yuan-Lin Cao, Jian-Xiong Lu, Bao-Lu Zhao, Jia-Qi Zhu, and Guang-Wu Zhou
Preliminary Study on the Wettability of Cotton Stalk Hongxia Ma, and Wenji Yu

Chemical Composition Analysis of Bamboo <i>Guadua amplexifolia</i> Jin-Mei Xu, Rong-Jun Zhao, and Ben-Hua Fei	280
Decolorization Properties of Modified Sawdust Li-Ping Zhang, and Jie Du	
Chapter 6. Bio-Based Composites	291
Possibility and Problems of Woodfiber-Plastic Composites (WPC) as New E Wooden Products in Japan -Weathering Performance of WPC Makoto Kiguchi, Yutaka Kataoka, Hiroshi Matsunaga, Ikuo Momohara, Koichi Yamamoto, and Philip D. Evans	
Partitioning of Pine Bark Components to Obtain a Value-Added Product for Manufacture	-
Thomas L. Eberhardt, Karen G. Reed, and Chi-Leung So	302
Application of Wood Charcoal to the Electric Double-Layer Capacitor Mitsuhiro Morita, and Ryohei Asakura	310
Biomorphic SiC Ceramic Produced with Bamboo Dong Sheng Zhang, Zhehui. Jiang, Hai Qing Ren, and Xiao Hong Cheng	
Measurement of Orthotropic Fiberboard Properties for use in Finite Element of 3D Engineered Fiberboard	-
John F. Hunt	
Optimal Design of Molded Bark Particleboard used in Heated Flooring System Ping Yang, Hidefumi Yamauchi, and Hikaru Sasaki	340
Development of Light-Weight Binderless Fiberboard from Kenaf Core J.Y. Xu, R. Widyorini, Hidefumi Yamauchi, E.D. Wong, and	247
Shuichi Kawai	347
Effect of PF Impregnation and Surface Densification on the Mechanical Prop Small-Scale Wood Laminated Composite Poles	perties of
Huaqiang Yu, Chung Y.Hse, and Zehui Jiang	357
Bio-Based Adhesives and Reproducible Rapid Small-Scale Bond Strength T Charles R. Frihart, Brice N. Dally, James M. Wescott, and Michael J. Birkeland.	U
Formulations and Applications of some Protein-based Wood Adhesives Monlin Kuo, and John F. Schmitz, Jr.	371

Preliminary Study on Gluing Technology of Modified Soy-based Protein Adhesive Ya-Hui Zhang, and Wen-Ji Yu	'9
Strength Reduction in Slash Pine (<i>Pinus elliottii</i>) Wood Caused by Decay Fungi Zhong Yang, Zhehui Jiang, Chung Y. Hse, and Todd F. Shupe	3
Wood-Plastic Composites Based on Recycled Urban Materials as an Alternative for Roofing	
R.H. Cruz-Estrada, G. Canche-Escamilla, P.J. Herrera-Franco, P.I. Gonzalez- Chi, G.E. Martinez-Tapia, S. Duarte-Aranda, A. May-Pat, C. Martín-Barrera.39)1
Physical Properties of Particleboard and Medium Density Fiberboard from <i>Pennisetum americanum</i> Straws	
Ding-Guo Zhou, Yang Zhang and Yong-Lan Xu	8
Physical and Mechanical Properties of Flakeboard Reinforced with Bamboo Strips <i>Ge Wang, Zhehui Jiang, Chung Y. Hse, and Todd F. Shupe</i> 40)2
Construction Mechanism of the Reticular Structure of Plant Fiber <i>Yongqun Xie, and Yan Chen</i> 41	2
Drying of Expanded Plant Fiber Buffer Wrapper Wenbin Yang, Yongqun Xie, and Zhangjing Chen41	18
Chapter 7. Biofuel and Bioenergy42	6
New Biofuel/Bioenergy Sources from Recovered Wood Xavier Deglise, Andre Donnot, and Anthony Dufour42	27
A Novel High Productivity Reactor for Continuous-Flow Biodiesel Production	43
Bingjun He, Arvinder P. Singh, and Joseph C. Thompson	
Display of CandidaTtropicalis Xylose Reductase on Surface of	
	4
Display of <i>CandidaTtropicalis</i> Xylose Reductase on Surface of <i>SaccharomycesCcerevisiae</i> Cells	4
Display of <i>CandidaTtropicalis</i> Xylose Reductase on Surface of <i>SaccharomycesCcerevisiae</i> Cells <i>Lufei Chen, Hongli Du, Ying Lin, and Qikai Zeng</i> 45 Structure Composition and Enzymatic Hydrolysis of Steam-Exploded <i>Lespedeza</i>	
Display of <i>CandidaTtropicalis</i> Xylose Reductase on Surface of <i>SaccharomycesCcerevisiae</i> Cells <i>Lufei Chen, Hongli Du, Ying Lin, and Qikai Zeng</i> 45 Structure Composition and Enzymatic Hydrolysis of Steam-Exploded <i>Lespedeza</i> Stalks	52
 Display of <i>CandidaTtropicalis</i> Xylose Reductase on Surface of <i>SaccharomycesCcerevisiae</i> Cells <i>Lufei Chen, Hongli Du, Ying Lin, and Qikai Zeng</i>45 Structure Composition and Enzymatic Hydrolysis of Steam-Exploded <i>Lespedeza</i> Stalks <i>Kun Wang, Fang Wang, Jian-Xin Jiang, Li-Wei Zhu, and Hong-Zhuai Fan</i>46 Transesterified Chinese Spicehush (<i>Lindera communis</i>) Seed Oil as a Biodiesel Fuel 	52 1 59

Xiao-Yan Zhang, and Guang-Jie Zhao482
Management of Recovered Wood in Japan Bunichiro Tomita
Chapter 8. Poster Presentations501
Experimental Study on Fire Properties of Particleboard with Cone Calorimeter Zhang-Kang Wu, Fang Dong, and Shi-You Li
Physical, Mechanical, and Chemical Properties of Gypsum Sawdust Board Zhen-Hua Han, Yu-He Deng, Jia-Yan Luo, De-Xin Zai, and Wen Lei507
Research on Sputtering a Thin Metal Film on a Wood Surface De-Long Chang, Tie-Yi Qiu, Qun-You Wang, Wen-Hao Huang, Wei-Hua Hu, Yun-Ling Zhang and Yu-Yan Li
Within Tree Variability of Tensile Strength Parallel to Grain of Chinese Fir and Hybrid Poplar Plantation Wood <i>Ming Xu, Hai-Qing Ren and Xia-Zhen Li</i>
Wood Properties of Populus alba×P. glandulosa, Populus alba, and Populus tomentosa-30 Jing-Feng Zhao, De-Ju Feng, and Li Yan
Preliminary Study on Properties of Cotton Stalks De-Jun Feng, and Jing-Feng Zhao
Visual Grading of Chinese Fir Structural Lumber Wei Guo, Haiqing Ren, and Yafang Yin531
Influence of Spectra Pre-processing on NIR Analysis for Wood Chemical Composition of <i>Populus×euramericana</i> cv. "74/76" <i>Li Zhang, R.J. Zhao, and B.H. Fei</i>
Physical and Mechanical Properties of Laminated Bamboo Strips Lumber Yi-Ping Ren, Zheng Wang, and Zhi-Ling Wang
Research on Processing of Ceramic-Wood Composite Materials Fang-Wen Zhang, Bo Liu, Zhi-Lin Cheng, Feng Fu, Jin-Lin Wang, and Shuang-Bao Zhang
Research Progress on Electromagnetic Shielding and Electric Capability of Wood- Metal Composite Materials in China - A Review <i>Tie-Yi Qiu, and De-Long Chang</i> 548
Production of Taxol by Microbe Fermentation

Dong-Po Zhou, Wen-Xiang Ping, Kai Zhao, Xi Ma, Yan Chi, Wei Wang, Tao Jin, Jing Zhu, Xuan Wang, Yang Chen, Ying Wang, and Nan Ge......556

Catalytic Pyrolysis of Bamboo (Pubescens)	
Changwei Hu	560