

**Proceedings of the
2019
Society of Wood Science and
Technology
International Convention**

**Convention Theme: Renewable
Materials and the Wood-based
Bioeconomy**

Edited by Susan LeVan-Green

*Overall General Chair: Eve Haviarova,
Purdue University, USA*

**October 20-25, 2019
Tenaya Lodge
Yosemite National Park, California, USA**

*Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA*

Table of Content

Keynote Speaker

Monday, October 21, 2019

The Dilemma of Fire and Firefighting

Chris Schow1

Early Stage Researchers

Monday, October 21, 2019

Modeling Changing Point of Specific Gravity with Cambial Age of *Daniellia oliveri*

Jerry Oppong Adutwum2

Activity of Organic Acids and Their Synergy Against the Wood-Decaying Fungus *Coniophora Puteana*

Alitor Barbero-López, Md Mokbul Hossain, Antti Haapala3

The Differentiating Anatomical Features of Five Tree Species from East Seram, Indonesia

Tekat Dwi Dahyono11

Study on VOCs Emissions from Veneered Plywood at Closed Circumstances

Tianyu Cao, Jun Shen12

Investigation of A Waste Newspaper Reinforced Soybean Based Adhesives for Interior Plywood

Hao Yin, Qiaojia Lin, Qinzhi Zeng, Jiuping Rao, Nairong Chen18

Measuring Device Development for a Hardwood High-Speed Disintegration Process Analysis

Ondrej Dvoracek25

Reducing the set-Recovery of Surface-Densified Scots Pine by Furfuryl Alcohol Modification

Lei Han26

Structure-related Vapor Sorption Phenomena in Wood

Raphaela Hellmayr, Rupert Wimmer27

Pyrolysis of Wood Residues in a Cylindrical Batch Reactor: Effect of Operating Parameters on the Yield of Products and Energy Balance of the Reactor

Ronald Kizza35

Industry 4.0 Readiness in the US Forestry Industry

Brooklyn Legg, Bettina Dorfner, Scott Leavengood, Eric Hansen36

Composition Analysis and Health Risk Assessment of Benzene Series for Nitrocellulose Paint Lacquered MDF

Huifang Li, Jun Shen37

Investigating the Thermal and Mechanical Properties of Fly Ash/Metakaolin-Based Geopolymer Reinforced with Alien Invasive Wood Species

Hamed Olafiku Olayiwola45

Portable microNIR Sensor for the Evaluation of Mold Contamination on Wooden Surfaces

Olena Myronycheva, Olov Karlsson, Margot Sehlstedt-Persson, Micael Öhman, Dick Sandberg46

Evaluating Stem and Wood Quality of Planted Longleaf Pines Using Bio-Imaging Techniques

Sameen Raut, Joe Dahlen52

Improvement of Leaching Resistance of Fire-Retardant Wood by Formation of Insoluble Compounds

Alexander Scharf54

Understanding Silvicultural and Process Variation and Its Influence on Life-Cycle Carbon Emissions for Durable Wood Products

Adam Scouse56

*Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA*

Cellulose Nanocrystals vs Cellulose Nanofibrils: Which One Performs Better in Flexible, Biodegradable and Multilayer Films for Food Packaging?	
Lu Wang.....	57
Influence of Particleboard Thickness and Veneers on Odor Emissions	
Qifan Wang, Jun Shen.....	58
Effects of Pyrolysis Temperature on Properties of Cardboard Biochar and the Resulting Biochar/High Density Polyethylene Composites	
Xiaoqian Wang.....	73

**Impact of Forest Disturbances on Wood Quality
Monday, October 21, 2019**

Assessing the Resilience of <i>Tectona grandis</i> (Teak), <i>Ceiba pentandra</i> (Ceiba), <i>Triplochiton sclerxylon</i> (Wawa) and <i>Terminalia superba</i> (Ofram) plantations stand after fire occurrence	
Emmanuel Adu-Sarpong.....	73
Evaluating the Role of Europe’s Wood Value Chain in the Circular Bio-economy: the WoodCircus Project	
Mike Burnard.....	75
Comparison of Juvenile Wood Depictions to Wood Property Maps from Mature Longleaf Pine	
Thomas Eberhardt, Chi-Leung So, Daniel J. Leduc, Joe Dahlen.....	76
Life Cycle Assessment of Mass Timber Building Structural System	
Shaobo Liang, Hongmei Gu, Rick Bergman, Steve Kelley.....	84
Understanding the Uncertainty in Environmental Life Cycle Analysis for Biofuel Production from Forest Residue in the United States	
Kai Lan, Stephen S. Kelley, Sunkyu Park, Longwen Ou, Prakash Nepal, Yuan Yao.....	85
The Wood Density Variability of the French Forest Species, a New Data Base	
Jean-Michel Leban.....	87
Managed Forest Carbon Sustainability: Myths and Metrics	
Elaine Oneil.....	88
Life Cycle Assessment Can Improve Decisions to Optimize Wood Use	
Maureen Puettmann.....	89
Converting Industrial Waste Cork to Biochar as Cu (II) Absorbents via Effective Pyrolysis	
Qihang Wang, Zongyuan Lai, Demiao Chu, Jun Mu.....	90
The Contribution of the New Zealand Forest Harvest to Greenhouse Gas Emission Reduction	
Anne Wekesa, Bruce Manley, David Evison.....	91

**International Innovation, Trends and Education in Wood Science
Monday, October 21, 2019**

The More the Merrier? Perspectives of Female College Student Leaders on Gender Aspects in the Forest Sector	
Taylor Barnett.....	92
Suggestions for the Sustainable Development Goals of United Nations, Based on the 30-year Kenaf Research and Development in Japan	
Kazuhiko Sameshima.....	93
Development of Nano-cellulose Based Thermal Insulating and Encapsulated Phase Change Materials for Energy Efficient Buildings	
David DeVallance.....	94
Nature-inspired Sustainable Solutions for an Architectonic Environment – A Collection of Case Studies	
Eva Haviarova.....	95

*Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA*

Future Developments in the Forest Sector	
Ed Pepke, Kathryn Fernholz.....	96
Integrating Wood Science, Architecture, and Engineering in Research and Education: The TallWood Design Institute and the Renewable Materials Program at Oregon State University	
Evan Schmidt.....	107
The Forest for the Trees: Understanding the Experiences of Female PhDs in Forestry-Related Academia	
Amy Simmons.....	109

Biodegradation and Preservation
Tuesday, October 22, 2019

The Effect of Cattle Blood Based Coatings on Wood-rotting Fungi Growth	
Jan Baar.....	109
Search for the Decay Resistance Scots Pine, <i>Pinus sylvestris</i> L., Heartwood	
Anni Harju.....	111
Influence of Thermo-Mechanical Timber Modification on the Decay and Mechanical Deterioration against <i>Coniophora puteana</i>	
Juhani Marttila, Victoria Nwachukwu, Aitor Barbero-López, Vitaly Bulavtsev, Antti Haapala.....	112
Revisiting the Role of Bacteria in Wood Decay	
Lakshmi Narayanan.....	121
Evaluation of the Durability of Mass Timber Products Against Termites (<i>Reticulitermes spp.</i>) Using Choice Testing	
Jazmine A. McGinnis, Tamara S.F.A. França, C. Elizabeth Stokes, Juliet D. Tang, Iris B. Montague.....	122
Potential of Fast Pyrolysis for the Decontamination of Creosote-Treated Wood	
Abir Oueslati.....	123

Composites and Adhesives 1
Tuesday, October 22, 2019

Anisotropy of 3D Printed Parts Using Bio-Filaments	
Levente Dénes.....	124
The Compatibility between Components of Wood-Plastic Composites using Chemical Force Microscopy	
Bernard Effah, Martina Meincken.....	125
Thermo-Hydrolytic Recycling of Urea Formaldehyde Resin-Bonded Laminated Particleboards	
Qilan Fu.....	134
Wood-Based Material Applications in 3D Printing for Composites	
Douglas Gardner.....	135
Characterizing Accelerated Weathering Conditions	
Micah Sutfin, Fred Kamke.....	136
Effect of Element Morphology on Strength of Wood-PLA Composite	
Tibor Alpár.....	137
Improvement of Ash (<i>Fraxinus Excelsior</i> L.) Bonding Quality with One Component Polyurethane Adhesive and a Primer for Glued Laminated Timber	
Peter Niemz, Gaspard Clerc, Milan Gaff.....	147
Synchrotron-based Analysis of Densified Wood Impregnated with Curing Resin	
Matthew Schwarzkopf.....	154

*Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA*

**Wood Chemistry
Tuesday, October 22, 2019**

Preparation and Characterization of Bio-Oil Produced from Sawdust of Selected Wood Species	
Idowu Abimbola Adegoke.....	155
Dewatering Wood Using Supercritical CO₂	
Salonika Aggarwal, Shelly Johnson, Marko Hakovirta, Bhima Sastri, Sujit Banerjee.....	156
Investigating the Influence of High Residual Lignin on the Properties of Lignin Containing Cellulose Nanofibers/films	
Hang Chen.....	162
Cellulose I and II Nanocrystals Derived from Sulfuric Acid Hydrolysis of Cellulose I Substrates	
Jin Gu, Lichao Sun, Lida Xing, Yun Hong, Chuanshuang Hu.....	163
Mineralization in Situs of Tropical Hardwood Species: Calcium Carbonate Formation and Wood Properties	
Roger Moya.....	164
In-Situ Penetration of Ionic Liquids into Surface-Densified Scots Pine	
Benedikt Neyses, Kelly Peeters, Lauri Rautkari, Michael Altgen.....	165
Biomass Derived High Surface Area Carbon Materials for Shale Gas Flowback Water Purification	
Jingxin Wang.....	167

**Student Posters
Tuesday, October 22, 2019**

Characterization and Utilization of Epoxy/Pyrolysis Bio-Oil in Oriented Strand Board Production	
Osei Asafu-Adjaye.....	168
Modeling Changing Point of Specific Gravity with Cambial Age of <i>Daniellia oliveri</i>	
Jerry Oppong Aduwum, Junji Matsumura.....	169
Membrane-Based Thermal Energy Recovery System to Improve the Energy Efficiency of Kiln Drying Processes	
Nasim Alikhani, Darien Dewar, Ling Li, Jinwu Wang, Douglas Bousfield, Mehdi Tajvidi.....	170
Evaluation of NHLA Graded Yellow-Poplar Lumber Regraded for Structural Use in CLT Panel Production	
Rafael Azambuja.....	179
Design Validation of Cross Laminated Timber Rocking Shear Walls	
Esther Baas.....	181
Activity of Organic Acids and Their Synergy Against the Wood Decaying Fungus <i>Coniophora puteana</i>	
Aitor Barbero-López, Md Mokbul Hossain, Antti Haapala.....	182
Perspectives of Female College Student Leaders on Gender Aspects in the Forest Sector	
Taylor Barnett.....	191
Evaluation of Shear Performance of Cross-Laminated Timber Shear Wall Connections under the Effects of Moisture	
Shrenik Bora, Arijit Sinha, Andre Barbosa.....	192
Study on VOCs Emissions from Veneered Plywood at Closed Circumstances	
Tianyu Cao, Jun Shen.....	193
UV-light Protection Cellulose Nanocrystals Films Prepared through Trivalent Metal Ions	
Cong Chen, Lu Wang, Jinwu Wang, Douglas Gardner.....	199
Reducing the Set Recovery of Surface-Densified Scots Pine by Furfuryl Alcohol Modification	
Lei Han, Dick Sandberg.....	200
Structure-Related Vapor Sorption Phenomena in Wood	
Raphaela Hellmayr, Rupert Wimmer.....	201
The Effect of Pore Size on Specific Capacitance for Activated Carbon Supercapacitors	
Jiyao Hu, Changlei Xia, Sheldon Shi.....	209

*Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA*

Sustainable Development – International Framework – Overview and Analysis in the Context of Forests and Forest Products with Quality	
Annika Hyytiä.....	210
Evaluation of Bond Integrity in Low-Value Blue=Stain Ponderosa Pine CLT	
Sina Jahedi, Lech Muszynski, Mariapaola Riggio, Rakesh Gupta.....	211
A Science Comic Poster: The Gender Diversity Tale in the US, Canada, Finland and Sweden Forest Sector	
Pipiet Larasatie, Eric Hansen.....	219
Rayleigh Mode Excitation at the Half-Space Boundary in Wood Using Embedded Elastic Waveguides	
Yishi Lee, Mohammad Mahoor, Wayne Hall.....	220
Industry 4.0 Readiness in the US Forestry Industry	
Brooklyn Legg, Bettina Dorgner, Scott Leavengood, Eric Hansen.....	228
Composition Analysis and Health Risk Assessment of Benzene Series for Nitrocellulose Paint Lacquered MDF	
Huifang Li, Jun Shen.....	229
Using Crack-Growth Experiments to Study the Moisture and Thermal Durability of MDF, OSB and PB	
Sweta Mahapaatra, Arijit Sinha, John Nairn.....	237
Moment-Rotation Behavior of Beam-Column Connections Fastened Using Compressed Wood Connectors	
Sameer Mehra, Iman Mohseni, Conan O’Ceallaigh, Zhongwei Guan, Adeayo Sotayo, Annette M. Harte.....	238
Evaluation of a Renewable Wood Composite Sandwich Panel for Building Construction	
Mostafa Mohammadabadi, Vikram Yadama.....	239
Dynamic Assessment of Dimensional Change of Wood-Based Composite Materials in Moist Environments	
Luis Molina, Fred Kamke.....	240
Investigating the Thermal and Mechanical Properties of Fly Ash/Metakaolin-Based Geopolymer Reinforced with Alien Invasive Wood Species	
Hamed Olafiku Olayiwola, Stephen Amiandamhen, Luvuyo Tyhoda.....	241
Potential of Fast Pyrolysis for the Decontamination of Creosote-Treated Wood	
Abir Oueslati, Hassine Bouafif, Ahmed Koubaa.....	242
Evaluating Stem and Wood Quality of Planted Longleaf Pines Using Bio-Imaging Techniques	
Sameen Raut, Joe Dahlen.....	243
Development of a Leach Resistant Fire-Retardant System for Wood	
Alexander Scharf.....	245
Mycelium-Assisted Bonding: Influence of the Aerial Hyphae on the Bonding Properties of White-Rot Modified Wood	
Wenjing Sun, Mehdi Tajvidi.....	247
Characterizing Accelerated Weathering Conditions	
Micah Sutfin, Fred Kamke.....	248
Influence of Particleboard Thickness and Veneers on Odor Emissions	
Qifan Wang, Jun Shen.....	249
Converting Industrial Waste Cork to Biochar as Cu (II) Absorbents via Effective Pyrolysis	
Qihang Wang, Zongyuan Lai, Demiao Chu, Jun Mu.....	263
A Novel Method for Fabricating an Electrospun poly(vinyl alcohol)/Cellulose Nanocrystals Composite nanofibrous Filter with Low Air Resistance for High-Efficiency Filtration of Particulate Matter	
Qijun Zhang, Siqun Wang.....	264

Regular Posters

Tuesday, October 22, 2019

Characterization and Utilization of Epoxy/Pyrolysis Bio-Oil in Oriented Strand Board Production	
Osei Asafu-Adjaye, Jason Street, Brian Via.....	265
Environmental Impacts of Redwood Lumber: A Cradle-to-Gate Assessment	
Kamalakanta Sahoo, Richard D. Bergman.....	266

**Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA**

Data Science at the University of Primorska: Combining Fundamentals with Data and Challenges from Buildings, Wood and Processing Science	
Mike Burnard, Klavdija Kutnar	278
Quantifying Dimensional Changes in Wood Pellets as a Function of Relative Humidity	
Daniel Burnett, Fahimeh Yazdan Panah, Shahabaddine Sokhansanj, Hamid Rezaei	279
Linear Expansion and Durability Properties of Composite Board (MDF Coated with Three Selected Wood Veneers	
Tekat Dwi Cahyono, Hikma Yanti, Laela Nur Anisah	280
A Potential Thermal Energy Storage Material Used for Green Buildings	
Xi Guo, Jinzhen Cao	281
Analysis of Color After CO₂ Laser Cutting of the Oak Wood	
Robert Corleto, Gianluca Ditommaso, Gourav Kamboj, Fatemeh Rezaei, Milan Gaff, Miroslav Sedlecký, Adam Sikora, Štěpán Hýsek	282
Physical, Decay Resistance and Microstructural Characteristics of Stem and Branch Wood of <i>Terminalia superba</i> (ofram) from Ghana	
Peter Kessels Dadzie, Martin Amoah, Paul Inkum	283
Cutting Performance of Multilayer Coated Tungsten Carbide in Milling of Wood Composites	
Wayan Darmawan	284
Wood Performance Changes Related to Mechanical Properties Alteration after Processing with Laser Cutting Machine	
Gianluca Ditommaso, Milan Gaff, Štěpán Hýsek Adam Sikora, Miroslav Sedlecký, Gourav Kamboj, Robert Corleto, Fatemeh Rezaei	285
Improvement of Weathering Performance of Painted Wood Applying Laser Micro Incisions	
Satoshi Fukuta	286
Improve the Performance of Soy Protein-based Adhesives by a Polyurethane Elastomer	
Qiang Gao	287
Monotonic and Cyclic Testing of Large-Scale CLT Diaphragms	
Cody Beairsto, Thomas Miller, Rakesh Gupta	289
Performance Test of Chairs – Joints Design by Use of Lower Tolerance Limits	
Eva Haviarova, Mesut Uysal	290
Mechanical Properties of 3D Printable Sustainable Bio-based Sandwich Structures	
Eva Haviarova, Nadir Ayrilmis, Manja Kiteck Kuzman	291
Improving Bonding Quality of Plywood by Vacuum Hot Pressing	
Lu Hong, Xiaoning Lu, Qian He, Nicolas Brosse	292
Fire Resistance of Unprotected Cross-Laminated Timber Assemblies of Walls and Floors Made in U.S	
Seung Hyun Hong, Lech Muszynski, Rakesh Gupta, Brent Pickett	293
Preparation of Biomorphic Porous SiC Ceramics from Bamboo by Combining Sol-Gel Impregnation and Carbothermal Reduction	
Ke-Chang Hung, Tung-Lin Wu, Jin-Wei Xu, Jyh-Horng Wu	294
Development of Termite Severity Probability Map of FUTA Campus Using Geographical Information System (GIS) Technology	
Owoyemi Jacob, Joshua Tosin Olarenwaju, Emmanuel Uchechukwu Opara, Samuel Olumide Akande	302
Fire-Retardant and Sound Absorption Performance of WM Board	
Seok-un Jo, Hee-jun Park, Chun-won Kang	303
Thermal Stability of Glued Wood Joint Reinforced with Nanocrystalline Cellulose in Shear Loading	
Gourav Kamboj, Milan Gaff, Vladimír Záborský, Gianluca Ditommaso, Robert Corleto, Adam Sikora, Fatemeh Rezaei, Miroslav Sedlecký, Štěpán Hýsek	308
Wood Modification Using in situ Polyesterification Treatment with Cost-Effective and Eco-friendly Biomass Material	
Shanming Li, Enguang Xu, Xuefeng Xing, Lanying Lin, Yongdong Zhou, Feng Fu	309
Wood Bonding Design for Strength Enhanced Southern Pine Wood Products	
Ming Liu	317
Effects of Physical Extraction on the Acoustic Vibration Performance of <i>Picea jezoensis</i>	
Yuanyuan Miao, Rui Li, Xiaodong Qian, Yuxue Yin, Xianglong Jin, Bin Li, Zhenbo Liu	318

**Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA**

“Green” Bio-thermoset Resins Derived from Soy Protein Isolate and Condensed Tannin	
Jing Luo	319
The Stress-Strain Behavior of Joint Components in the Surrounding of Oak Dowels	
Jaromir Milch, Pavlina Suchomelova, Hana Hasnikova, Martin Hataj, Martin Brabec, Jiri Kunecky	320
Lignocellulosic Materials as Biocompatible Drug Delivery System for Opioid Addiction Treatment	
Gloria Oporto, Kelsey O’Donnel, Noelle Comolli, Luis Arroyo, Marina Galvez-Peralta, Gustavo Cabrera	322
Intensified Pulping Process to Produce High Value Materials from Underutilized Appalachian Hardwood Biomass	
Gloria Oporto, Rory Jara-Moreno, Joseph McNeel	323
Comparison of Small- and Intermediated-Scale Fire Performance Tests of Southern Pine Cross-Laminated Timber	
Bryan Dick, Perry Peralta, Phil Mitchell, Ilona Peszlen	324
Hierarchy of Efficient Carbon Displacement and Storage in Products	
Bruce Lippke, Maureen Puettmann, Elaine Oneil	325
Potential Use of Hardwood Lumber in Cross Laminated Timber: A Manufacturer Perspective	
Henry Quesada	326
Mass Spectrometry Imaging of Wood Surface Cut by Laser Beam	
Fatemeh, Rezaei, Roberto Corleto, Gianluca Ditommaso, Milan Gaff, Gourav Kamboj, Miroslav Sedlecký, Štěpán Hýsek, Adam Sikora	327
Optimization of Milling Process of Iroko Wood (<i>Chlorophora excelsa</i>) Depending on Temperature of Thermal Modification	
Miroslav Sedlecký, Milan Gaff, Fatemeh Rezaei, Gourav Kamboj, Gianluca Ditommaso, Roberto Corleto, Monika Sarvasová, Kvietková, Adam Sikora, Štěpán Hýsek	328
Behavior of Layered Beech Wood Reinforced with Glass and Carbon Fibers under Bending Loading	
Adam Sikora, Milan Gaff, Tomás, Štěpán Hýsek	329
Impact of Gas Concentrations on the Self-Activation of Wood Biomass throughout its Processing	
Lee Smith, Sheldon Q. Shi	330
Survey of the Needed Changes in Forestry Related Curricula – For Improving the Competitiveness of Estonian Forest Sector	
Meelis Teder	331
Comparison of Acoustic Non-Destructive Methods and Semi-Destructive Methods for Logs and Timber Assessment	
Jan Tippner, Michal Kloiber, Jaroslav Hrivnák, Jan Zlámal, Václav Sebera	333
Preparation and UV-Aging Resistance Properties of Eu(III) Complex-Modified Poplar Wood Based Materials	
Di Wang	341
Impact of Torrefaction on the Chemical Component of Nigerian Grown <i>Pinus caribaea Morelet</i>	
F.A. Faruwa, M. Anyacho, E.A. Iyiola, A. Wekesa	342
Novel Enzyme-Modified Lignin Adhesive to Substitute PVAc Carpenter’s Glue?	
Raphaela Hellmayr, Sabrina Bischof, Georg M. Guebitz, Gibson Stephen Nyanhongo, Rupert Wimmer	351

**Composites and Adhesives 2
Thursday, October 24, 2019**

Characterization of Plastic Bonded Composites Reinforced with <i>Delonix regia</i> Pods	
B. Ajayi, A.T. Adeniran, O.E. Falade, B.O. Alade	355
Mycelium-Assisted Bonding, Influence of the Aerial Hyphae on the Bonding Properties of White-Rot Modified Wood	
Wenjing Sun, Mehdi Tajvidi	364
Characterization and Properties of PLA-Based Biomass Composites for FDM Technology	
Rui Guo, Min Xu	365
Evaluation of a Renewable Wood Composite Sandwich Panel for Building Construction	

*Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA*

Mostafa Mohammadabadi, Yikram Yadama	367
The Use of Soy Flour to Replace pMDI in Wood Composites	
Brian Via, Osei Asafu-Adjaye, Sujit Banerjee	368
UV-Light Protection Cellulose nanocrystals Films Prepared through Trivalent Metal Ions	
Cong Chen, Lu Wang, Jinwu Wang, Douglas Gardner	369
Study of Refiner Plates as a Possibility to Improve the Production of Wood Fiber Insulation Materials	
Simon Barth, Andreas Michanickl	370
Environmentally-Friendly Bio-adhesives from Renewable Resources – WooBAdh Project	
Milan Sernek, Jasa Sarazin, Siham Amirou, Antonio Pizzi, Marie-Pierre Laborie, Detlef Schmiedl, Thelmo A Lú Chau, María Teresa Moreira	371

Business, Marketing and Regulations
Thursday, October 24, 2019

Keeping the Home Fires from Burning: The Latest on Fire-Retardant-Treated Wood and the Model Codes	
Mike Eckhoff	372
Marketing of Urban and Reclaimed Wood Products	
Omnar Espinoza, Anna Pitti, Robert Smith	381
Drivers Impacting Supplying Decisions of Construction Companies: A Case Study in the Southeastern Region of the US	
Henry Quesada, Robert Smith, Alison Bird, Joe Pomponi	382
Productivity of Firms in the Swedish Industry for Wooden Single-Family Houses	
Tobias Schauerte, Alexander Vestin	383
Building the Future with Social Media	
Candra Burns	392

Wood Physics and Mechanics
Thursday, October 24, 2019

Sorption Hysteresis in Wood and Its Coupling to Swelling Investigated by Atomic Modeling	
Jan Carmeliet, Mingyang Chen, Benoit Coasne, Dominique Derome	393
Sorption, Swelling and Mechanical Behavior of Wood: A Multiscale Study	
Chi Zhang, Mingyang Chen, Benoit Coasne, Jan Carmeliet	394
Effect of Pyrolysis-Oil Based Microemulsions on Mechanical Properties of Scots Pine	
Antti Haapala, Vitaly Bulavtsev, Aitor barber-López, Juhani Marttila	395
Thermal Modification Influences on Permeability and Sorption Properties of Wooden Shingles	
Dominik Hess	400
Rayleigh Mode Excitation at the Half-Space Boundary in Wood Using Embedded Elastic Waveguides	
Yishi Lee, Mohammad Mahoor, Wayne Hall	401
The Mechanics of Engineered Wood Flooring	
Joseph R. Loferski	409
“Water in Wood – the Gel-Theory Revised”	
Martin Nopens, Michael Fröba, Bodo Saake, Uwe Schmitt, Andreas Krause	411
Cell Morphology and Mechanical Properties of Transgenic Poplar with Reduced Cellulose Content	
Ilona Peszlen, Zhouyang Xiang, Perry Peralta	413
Cu Thin Films on Wood Surface for Robust Super hydrophobicity by Magnetron Sputtering Treatment with Perfluoro carboxylic Acid	
Daxin Liang, Jian Li	414
Triboelectrical Charging of Wood: A Neglected Wood Property with Potential Applications	
Roman Myna, Stephan Frybort, Raphaela Hellmayr, Falk Lieber, Rupert Wimmer	421

*Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA*

**Timber Engineering and Mass Timber
Friday, October 25, 2019**

Evaluation of NHLA Graded Yellow-Poplar Lumber Regraded for Structural Use in CLT Panel Production	
Rafael Azambuja, David DeVallance, Joseph McNeel, Curt Hassler	429
Evaluation of Shear Performance of Cross Laminated Timber Shear Wall Connections under the Effects of Moisture Intrusion	
Shrenik bora, Arijit Sinha, Andre Barbosa	431
Evaluation of Bond Integrity on Low-Value Blue Stain Ponderosa Pine CLT	
Sina Jahedi, Lech Muszynski, Mariaapaola Riggio, Rakesh Gupta	432
Flexural Properties of Dowel-Type Fastener-Laminated Timber	
Olayemi Ogunrinde, Meng Gong, Ying-Hei Chui, Ling Li	440
Mass Timber Building Construction Cost and Life Cycle Cost Analysis with Comparison to Concrete and Steel Buildings	
Hongmei Gu, Shaobo Liang	441
Moment-Rotation Behavior of Beam-Column Connections Fastened using Compressed Wood Connectors	
Sameer Mehra, Iman Mohseni, Conan O’Ceallaigh, Zhongwei Guan, Adeayo Sotayo, Annette M. Harte	442
Experimental Investigation of a Mass Plywood Panel Self-Centering Rocking Wall System	
Ian Morrell, Rajendra Soti, Arijit Sinha, Byrne Miyamoto Dillon Fitzgerald	443
Adhesive Performance under Elevated Temperatures: Small and Intermediate Scale Testing	
Samuel L. Zelinka, Keith J. Bourne, Nathan J. Bechle, Douglas R. Rammer	444
Comparison of Hydrothermal Aging Properties of Three Typical Bamboo Engineering Composites	
Haiying Zhou, Ge Wang	452

In-situ penetration of ionic liquids into surface-densified Scots pine

Benedikt Neyses, Wood Science and Engineering, Luleå University of Technology, Sweden, benedikt.neyses@ltu.se

Kelly Peeters, InnoRenew CoE, Slovenia, Kelly.peeters@innorenew.eu

Lauri Rautkari, Department of Bioproducts and Biosystems, Aalto University, Finland, lauri.rautkari@aalto.fi

Michael Altgen, Department of Bioproducts and Biosystems, Aalto University, Finland, michael.altgen@aalto.fi

Surface densification of solid wood leads to an increase in hardness and wear resistance, proportional to the increase in density of the surface. This may lead to an increase in value of low-density wood species, such as Scots pine, which are abundant in boreal and temperate forests. To exploit the positive effects of surface densification commercially, a fast and cost-efficient surface densification process is required. To achieve this, several problems need to be solved. Hitherto, research into surface densification was focused on the lab-scale, and methods to reduce the moisture-induced set-recovery of the densified wood either take a long time in an open system or require a closed system. This prevents the large-scale commercialization of surface-densified wood products. A previous study has shown that a fast pre-treatment with ionic liquids can reduce the set-recovery from 90% to 10-50%, depending on the process parameters. There was also an increase in Brinell hardness in comparison to the untreated surface-densified wood. A pre-treatment with ionic liquids does not require a closed system and takes less than 10 minutes. In order to implement the combined pre-treatment and surface densification process as an industrial process, it is necessary to understand how the chemical treatment interacts with the wood material, resulting in reduced set-recovery. We studied the penetration depth of the chemical treatment and cellular level chemical changes by FT-IR spectroscopy and confocal Raman microscopy. We found that the penetration of chemical agents into the wood was limited to only a few cell layers. This low penetration cannot explain the achieved reduction in set-recovery and the increase in Brinell hardness, as the surface-densified layer has a thickness of several millimeters. Based on these findings, we hypothesize that the high temperature of the press platen during the densification process (>200°C) vaporizes the ionic liquid, which then diffuses deeper into the wood surface, where it is activated by the heat. The activated ionic liquid cleaves hydrogen bonds between cellulose chains, which allows plastic deformation of the wood cells. Further exposure to temperatures over 200°C decomposes the ionic liquid, allowing the formation of a new hydrogen bond

*Proceedings of the 62nd International Convention of
Society of Wood Science and Technology
October 20-25, 2019 – Tenaya Lodge, Yosemite, California USA*

network between the cellulose chains for a permanent reduction of the set-recovery. To test our hypothesis, we will conduct GC-MS and TGA-FT-IR analysis of the decomposition products to be found in the pre-treated wood after surface densification. The knowledge obtained from this study will enable us to implement an improved version of the treatment process, especially with regard to the development of a large-scale surface densification process.

Keywords: compressed wood, wood modification, chemical treatment, green chemistry, confocal Raman microscopy

ISBN 978-0-9817876-9-5



90000>



9 780981 787695