



Book of Abstracts

**COST Action
FP1407
Final Conference**

**LIVING
WITH
MODIFIED
WOOD**

Belgrade, Serbia
12-13 December 2018

University of Belgrade – Faculty of Forestry

COST Action FP1407

Understanding wood modification through an integrated scientific and environmental impact approach (ModWoodLife)

Living with modified wood

Final COST Action FP1407 International Conference

Belgrade, Serbia, 12 – 13th December 2018

Book of Abstracts

Editors: Goran Milić, Nebojša Todorović, Tanja Palijsa, Andreja Kutnar

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Table of contents

Local organiser preface	7
Preface.....	8
Conference Program	9
Keynote	15
Shift Your Thinking for Research Innovation	16
Session 1: <i>Modified wood in use</i>	19
Human interaction with wood – what to measure, how to measure?	20
Can modified wood compete with untreated wood in preference of people?	22
EcoModules - an on-line Eco-design Tool	24
Online tool for generating Environmental Product Declarations (EPD-tool) for modified wood products.....	26
Session 2: <i>Novel modification technologies</i>.....	29
Review: wood modification techniques based on cell wall bulking with non-toxic chemical reagents.....	30
The potential application of Maillard-type reactions during thermal modification treatment.....	32
Effect of polymerization temperature during ϵ -caprolactone modification on wood properties	34
Wood sawdust and alkali activated slag bio-composite	36
Wood protection from the olive industry	38
Session 3: <i>Projections and monitoring of modified wood</i>.....	41
Projection of the effects of climate change on decay risk of external timber: United Kingdom case study	42
State of the art of wood modification in Spain. Researches, industrial treatments and examples of end uses in real cases.....	44
Monitoring of the performance of thermally modified wood in buildings.....	46
Durability of modified wood and bio-based materials under outdoor conditions	48
Furfurylated wood durability in a cyclic hydrothermal environment	50
Termite and decay resistances of Bioplast-spruce green wood plastic composites.....	52
Session 4: <i>Beyond wood modifications</i>.....	55
Wastewater remediation with formaldehyde free tannin-furanic foam powders.....	56
The application of water pretreatment in the pellet production process.....	58
Charring of Norway spruce wood surface as a surface modification technique.....	60
Wood modification related researches at the University of Sopron	62
Networking in European wood research.....	64
Session: <i>Short Term Scientific Missions</i>.....	67
Engineered wood products in contemporary architecture	68
Effect of silane treatment on mechanical properties of degraded wood	70
The impact of temperature increase rate during thermal modification on wood surface-coating interaction.....	72
Cutting forces assessment when machining wood over all grain orientations – example of thermally modified poplar	74
Experimental and numerical analysis of fracture toughness of thermally modified beech in mode II.....	76
Mechanosorptive creep tests on thermally modified wood	78

Characterisation of subfossil oak wood from central Serbia using SEM and FTIR spectroscopy	80
Generalised thermal modification kinetic model of poplar wood under different technologies	82
Properties of multi-layer plywood made from combinations of densified and non-densified veneers in one structure	84
Decay and insect resistance of modified wood with epoxidized plant oils	86
Poster Session	89
Strategies for improvement of visibility and acceptance of modified wood	90
Volatile organic compounds emitted from heat and vacuum-heat treated wood	92
In-service performance of floorings with modified wood top layer.....	94
Thermo-hydro mechanical densification process of <i>Nothofagus pumilio</i> and <i>Nothofagus antarctica</i> and the effect of annual width ring on modulus of hardness, and dynamical mechanical properties	96
Enhancing outdoor durability of heat treated wood surface by photo-stabilization with waterborne acrylic coating using bark extract.....	98
Changes in wood surface properties caused by aging techniques	100
Photostability of thermally modified poplar wood coated with alkoxysilanes	102
Wood properties and extractive exploitation from thermally modified chestnut wood	104
Antimicrobial particleboards – part 1: preparation and strength	106
Antimicrobial particleboards – part 2: resistance to bacteria and fungi	108
Selected mechanical properties of lignocellulosic layered composites produced in various temperature conditions	110
Assessment of lignocellulosic-substrate fungi-based materials	112
The compressive resistance of low density mycelium boards.....	114
Variability of hemp concrete material performance: a focus to modulus and their calculation methods	116
Characterization of two liquefied agricultural wastes.....	118
Influence of hydrothermal modification on the properties of cellulose and lignin after-service-life valorisation of wood.....	120
Improving hydrophobicity and thermal stability of wood through esterification with fatty acids	122
Preservation of wood structures in non-controllable environment by the example of pre-stressed laminated timber bridge deck with two curved geometry.....	124
Sensitivity and reliable design of a timber beam considering crack growth and environmental effects	126
Creep response of European species under environmental and mechanical loadings in outdoor conditions	128
Understanding shrinkage and fracture process of green wood using X-ray microtomography	130
Modified wood – research on selected physical and mechanical properties	132
Paper tissue reinforcement – coating with nanocellulose and silanes.....	134
Preliminary analysis of bio-sourced hybrid resins as coatings for wood protection.....	136
Nano-modified adhesives for composite wood panels manufacturing.....	138
Session 5: Thermally modified wood – properties.....	141
Influence of heating rate during thermal modification on some properties of maple wood	142
The evaluation of the quality control methods for thermally modified wood	144
Physical and elastomechanical properties of full-size fir (<i>Abies alba</i>) sawnwood after heat treatment with different intensities	146

Local organiser preface

It is both a pleasure and a privilege for the Department of Technologies, Management and Design of Furniture and Wood Products, Faculty of Forestry to host the final conference of COST Action FP1407. This honour has given us an opportunity to establish a more visible position within the European network of wood related institutions.

Wording of the title - “Living with modified wood” - signifies that the time in which we live has provided us with technologies of wood modification that will ensure that never again will this material be regarded as a lesser material with a short life-span. Wood, as one of the rare living materials, is experiencing a worldwide renaissance, one that could not have been considered possible just a generation ago. For these very reasons, the primary goal of this conference is to foster, forge and encourage the cooperation and exchange of ideas between wood modification researchers and experts in related fields and, hopefully, help them grow.

Belgrade, as a city with a long and rather eventful history, is an environment where sparse moments of peace and prosperity have instilled a way of thinking that appreciates the little things in life. This setting emphasises even more the pressing need of the modern age to live more organically, ethically and above all, ecologically – and what better way than living with an organic material such as wood.

Success of this event would not have been possible without the effort of the entire team of my colleagues. I would like to thank them and to express my deepest gratitude to Andreja Kutnar, Chair of COST FP1407, for leading this fantastic Action, and for her continuous help in organising this Final Conference.

Last but not least I would like to thank all of the participants and contributors of the Final COST FP1407 Conference. I wish you to have a memorable time in Belgrade.

So let us look forward to an exciting conference!

Goran Milić

Preface

Welcome to the fourth and final international conference of COST Action FP1407 “Understanding wood modification through an integrated scientific and environmental impact approach” (ModWoodLife). This conference, “Living with modified wood”, held in Belgrade, Serbia December 12 and 13, 2018 brings researchers and professionals together to share and disseminate their work. Their research contributes significantly to our Action’s objectives. It is especially rewarding too see contributions that have resulted from collaborations developed and strengthened through this network. Since the beginning of the Action in 2015, we have delivered new knowledge in the field of wood modification and environmental impact assessment. We can all be proud that during our Action, the European Union recognized the need to strategically approach activities, research, and policy to reduce climate change. Among the key strategies that were accepted in the past three years are the Circular Economy (2015), the Paris Agreement (2016), the Research and Innovation Roadmap 2050 – A Sustainable and Competitive Future for European Raw Materials (2018), as well as the recently renewed Bioeconomy strategy. Although our Action did not directly contribute to these documents, I am convinced that the activities of our network and its participants accelerated their adoption. At the same time, it is clear that our collaboration must continue after the Action ends on March 9, 2019. Going forward we should jointly contribute to “closing the loop” of product lifecycles through greater recycling and re-use and bring benefits for both the environment and the economy.

I would like to thank you for your great collaboration. Besides the new knowledge we created, our new friendships will continue for many years more!

Wishing you a successful and memorable conference in Belgrade.

Andreja Kutnar
Chair, COST FP1407

Strategies for improvement of visibility and acceptance of modified wood

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Perception is defined as a recognition and interpretation of sensory information. Perception also includes how we respond to the information and how we interact with the surrounding environment. Knowledge about human sensory perception of materials is playing an increasingly important role in the selection and combination of materials within manufactured products (Zuo *et al.* 2016). One of the main recent advances in wood technology is the development of modified wood. New products offer enhanced durability and improved performance in unique ways. Wood modification includes several treatments that change

material properties on different levels (Hill 2006). They include active modifications, that change chemical nature of materials (e.g., chemical, thermal, enzymatic), or passive, that do not alter materials chemistry (e.g., impregnation, surface treatments). Consequently, various properties of wood are changed to different extents.

A previous study demonstrated that not only physical characteristics of materials are important in materials experience, but also sensory properties of materials and the meanings and emotions triggered by them (Karana *et al.* 2015). Customers formulate a perception of the product partly based on its sensory properties (e.g., colour, texture, sound, smell, taste) when experiencing the product for the first time. Sijtsema *et al.* (2016) highlighted the importance of obtaining insight into perceptions of laypeople about new technologies. In some cases (e.g., genetic modification), new technologies are not generally accepted and might even be rejected by consumers, even if professionals see many benefits in them. Similarly, “modified wood” might impair the impression due to specific background knowledge (e.g., containing “chemistry” and/or manipulated/no more natural). Material perception shall be investigated in certain contexts and applications. Modified wood used for food contact materials should be safe for human health and do not transfer organoleptic characteristics of food (European Commission, 2004). Therefore, the selection of materials with particular sensory properties and placing them in certain usage context might enhance the product’s overall image and the market’s perception of its value (Zuo *et al.* 2001). The project “Perception of modified wood” is a joint project of seven partners with the overall goal to investigate reception of modified wood in order to improve its visibility and acceptance. Within this research, we aim to investigate preferences in using modified wood from psychological, physiological and cultural perspectives. Influences of modification processes on human health and wellbeing will be investigated with preference tests by using both virtual and real samples. Special focus will be directed towards implementing alternative assessment methods (e.g., wearable sensors that can capture physiological responses) while assessing respondents.

References

- Hill A.A.S. 2006. Wood modification. Chemical, thermal and other processes. John Willey and Sons, UK
- Karana E., Barati B., Rognoli V., van der Laan A.Z. 2015. Material Driven Design (MDD): A Method to Design for Material Experiences. *International Journal of Design*, 9, 2: 35-54
- European Commission 2004. Regulation (EC) No 1935/2004 of the European Parliament and of the Council of 27 October 2004 on Materials and Articles Intended to Come into Contact with Food and Repealing Directives 80/590/Eec and 89/109/EEC *Official Journal of the European Union* 338, pp. 4-17
- Zuo H., Hope T., Castle P., Jones M. 2001. An investigation into the Sensory Properties of Materials, *Proceedings of the International Conference on Affective Human Factors Design*, Singapore, 27-29 June. London: Asean Academic Press, pp. 500-507
- Zuo H., Jones M., Hope T., Jones R. 2016. Sensory perception of material texture in consumer products *The Design Journal*, 19: 405-427
- Sijtsema S.J., Onwezen M.C., Reinders M.J., Dagevos H., Partanen A., Meeusen M. 2016. Consumer perception of bio-based products—An exploratory study in 5 European countries, *NJAS - Wageningen Journal of Life Sciences*, 77, 61-69

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