

Enhancement of the Durability and Fire Performance of Veneer-Based Products Through Sustainable Wood Densification Process

Summary

The aim of this research is to enhance the durability and fire resistance of veneer-based wood products by developing and optimizing a sustainable wood densification process. The study seeks to improve performance characteristics of low-value hardwoods by the densification process, thereby increasing their value. Sustainable chemical modifications and energy-efficient low-temperature methods will be investigated for densification process and durability, and fire performance properties will be evaluated. The project addresses the following research questions: To what extent can fire performance be improved through densification without the use of synthetic fire retardants? What are the environmental impacts and sustainability metrics of the proposed densification process? How do changes in microstructure and chemical composition correlate with performance improvements? What new sustainable fire-retardant chemical can be used for densified veneers?

Description

The research

This PhD project focuses green chemistry fire retardant pretreatment of veneers before densification to optimize the densification process and increase the durability and fire performance. The aim is to develop sustainable, durable, fire-resistant veneer-based products from underutilized wood species.

The project will address the following key areas:

1. Fire Retardant Pretreatment – Developing environmentally friendly pretreatment methods to be suitable for densified veneers.
2. Optimization of Densification Process – Reducing the densification temperature while maintaining or improving efficiency.
3. Sustainable Utilization of Underutilized Wood Species – Expanding the potential of lesser-used wood species through densification.
4. Durability – Evaluating how well the densified wood resists swelling and shrinking, and spring back.
5. Fire performance – Analyzing the fire performance of densified wood for veneer-based products.

The outcomes of this research are expected to valorize underutilized wood species through energy efficient densification process. By providing environmentally friendly densification process, and increasing the fire performance, this project aims to drive innovation in the field of veneer-based products and contribute to the sustainable materials industry.

Responsibilities and (foreseen) tasks

- Compile an analytical framework for examining experimental approaches to analyze green fire-retardant pretreatment methods before and after wood densification.
- Study and test the low temperature densification process technologies.
- Test and characterize the structure, moisture resistance, dimensional stability, surface and properties.
- Study and characterize the fire performance of densified wood suitable for veneer-based products.
- Writing and publishing scientific papers for the project results in peer-reviewed journals and conference presentations.
- Contribute to the organization of research and practitioner workshops where project findings are presented.

Applicants should fulfil the following requirements:

- Master's degree in the field of wood technology, wood science, materials technology and science, wood chemistry, forestry.
- Familiar with methods, procedures and safety of wood chemistry, wood technology or composite material technology, materials technology and science which allows to work independently
- Excellent communication skills (written and spoken) in English
- A clear interest in the topic of the position
- Strong and demonstrable writing and analytical skills
- Capacity to work both as an independent researcher and as part of an international team
- Capacity and willingness to assist in organizational tasks relevant to the project

(The following experience is beneficial:)

- Previous experience in wood technology or materials technology and science would be highly appreciated.
- Previous experience in the most relevant characterization methods (surface roughness, contact angle measurement, tensile and flexural tests, fire testing) is also expected.
- Previous knowledge about durability and fire testing of the materials.
- Previous knowledge of material structural characterization.
- Working knowledge of data analysis and statistics.
- Data visualization and analysis in R

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks and propose theoretical lenses to be used.

We offer:

- 4-year PhD position in one of the largest, most internationalized and leading engineering and technology research centers in Estonia.
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of wood and composite materials technology and wood chemistry.

About the department

Department of Materials and Environmental Technology is an interdisciplinary research center of Tallinn University of Technology that focuses to lead the high-level, internationally recognized teaching, research and development in Estonia in the field of materials and environmental technology.

(Additional information)

For further information, please contact Prof. Heikko Kallakas heikko.kallakas@taltech.ee or visit <https://taltech.ee/en/departments-materials-and-environmental-technology>