



**Universitatea *Transilvania* din Braşov**

## **HABILITATION THESIS**

### **SUMMARY**

# **Development of wood and lignocellulosic based composites**

**Domain: Forest engineering**

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## **Summary of the habilitation thesis entitled** **“Development of wood and lignocellulosic based composites”**

This habilitation thesis presents the author's contributions in the fields of theoretical, experimental and industrial research or implementation in production processes; conducted after graduating two doctoral studies in 1996 (Braşov) and the 1997 (Vienna). The thesis is structured in three parts: scientific and professional achievements (B-i), career development plans (B-ii), and references (B-iii). Chapter B-i contains three distinct topics that are the most important aspects of the author's research, conducted from 2002 to 2016. Chapter B-ii includes the evolution of professional experience, teaching and research, also the development plans of the activities in these areas.

This habilitation thesis contains some of the research conducted by the author during his activity within Transilvania University of Brasov (UTBv), but also at the University of Natural Resources and Life Sciences (Boku) Vienna, Ludwig Maximilian University (LMU) Munich, Leopold Franzen University Innsbruck (Ulbk), Holzforschung Austria (HFA) Vienna, Technical University Graz (TUG), Salzburg University of Applied Sciences (FHS), Hamburg University (UHH) and Technical University in Munich (TUM).

The research activity is presented in three main directions (Cap.B-i):

- 1 - development of wood and other lignocellulosic based composites, including issues related to technology, testing and identification of new uses (B-i1);
- 2 - optimization of lightweight composites using low densities core and adaptation of these innovations in the state of the art applications (B-i2); and
- 3 - development and optimization of manufacturing technologies and implementation of prototype equipment for reducing consumption and ecological footprints (B-i3).

The first main direction of research (B-i1) includes composite materials made under author's supervision from lignocellulosic plant fibres (e.g. flax, coconut shell nuts etc.), perennials (e.g. bamboo, date palm, coconut tree wood etc.), agriculture residues (e.g. corn, sugar cane etc.) and from tree bark. Research with flax fiber resulted in the reinforcement of particleboard, coconut fiber for high pressure laminates (HPL), a partial replacement for phenol-formaldehyde (PF) resin made of coconut shells, multi-layered solid wood panels (SWP) from coconut tree wood with decorative but also structural function for cross laminated timber (CLT), oriented strands lumber (OSL) made of bamboo stripes, thermal insulation materials from straw fibres, etc. Research on tree bark resulted in the prototype densified thin decorative layers, blocks for (euro)pallets, insulation boards with oriented particle structure, glued with formaldehyde-based resins, but also with tannins. A patent for "Heat insulation boards made of tree bark" was obtained in Austria (AT512707A1 / 10.15.2013); two doctoral theses were completed and several articles were published in ISI indexed journals.

The second research direction (B-i2) included innovation with lightweight boards, with a primary emphasis in furniture construction. The author coordinated research teams that have developed, for example, a technology for boards with foam core expandable in situ; another one focussed on the core layers with a predefined geometry and the optimization of existing technologies for panels with honeycomb cores, and also included controlled reduced density of



classic solid wood boards (SWB), plywood (PY), particleboard (PB), fibreboard (MDF) etc. Thus resulted an European patent "Lightweight wood-based board and process for producing it" (EP63424/06.12.2007) issued for Australia (2007332593/12.05.2013) Canada (CA2672169A1/19.06.2008), China (200 780 051 220), CIS (015 211/30.06.2011), Indonesia (IDP0033156/01.03.2013), Japan (JP2002338373A), New Zealand (NZ578195/28.02.2012), USA (US2010/0098933A1/22.04.2010), two co-supervised doctoral theses were completed and several articles were published papers in ISI/BDI indexed journals. Other boards with core lamellae arranged in a predefined network variable geometry with hollows are patent pending. The third research direction (B-i3) included in this habilitation thesis deals with the optimization of technological processes for the production of wood based composites and especially with the analysis of production processes in order to optimize the parameters and product performance, implementation of prototypes in already existing production technologies, mitigating the impact of technology of wood industry on the environment (water, air), developing and implementing non-destructive techniques (NDT) to online quality control processes. Most of these projects involved industrial partners and thus were confidential, so the results have been partially published or completely after a specified period of time, only by mutual consent. Another European patent (EP1185587 B1 / 19.02.2003), titled, "Wood-fibre semi-finished product and method for producing the same" was developed. Manufacturing of lamellae from timber by slicing, using band saws with thin blades, non-destructive grading of lamellae using X-ray technology, ultrasounds and microwave and achieving the first finger joint for CLT boards were innovative technologies that were successfully implemented in production; and now are considered state-of-the-art in the timber industry.

Chapter B-ii presents the progress and career development plans from the professional, scientific and academic point of view. Professional and teaching experience includes many foreign universities where the author was involved as visiting professor. The courses taught in multiple languages at these higher education institutions are cataloged in tables. Also mentioned are the graduation works coordinated by the author and the international collaboration during the last 15 years of activity. Scientific research experience is reflected by the number and type of international projects in which the author was established as a manager or expert. This section also includes doctoral supervision held at higher education institutions in Europe; and the organizing, management and moderation at national and international scientific events. Career development plans are focused on maintaining and developing collaboration agreements with universities in Europe, Asia, North and South America, Africa. This includes further supporting the Faculty of Wood Engineering in Braşov by supervising doctoral theses, organizing training courses for specialists from Romania and other countries, and strengthening Faculty for Wood Engineering's relations with the socio-economic environment.