# Preface

The world's most environmentally friendly material to support a wide range of human needs is wood, a renewable natural resource that provides food, clothing, housing, and is used in industries such as pharmaceuticals, aerospace, automotive, etc.

Wood, as an engineering material, requires constant updating of the research knowledge in order to provide accurate responses to industrial processing problems. A wide scope of research is open all along the production chain, starting with raw materials, processing methods, and production means, and covering end users who demand high quality final products, and the industry, which requires low production costs. *Research Developments in Wood Engineering and Technology* is a book oriented towards engineering wood products and processing technologies, where, for different final products' sizes and uses, a specific process is necessary that needs a certain degree of optimization, new materials, adhesives, tools, and design techniques in order to generate. This book will innovate the way in which this material can be used and will provide solutions that optimize the available resources.

In this context, wood material has acquired great importance due to the short supply of wood and increasing environmental awareness among users and manufacturers. Subsequently, wood material has the advantage that it can be used efficiently in engineering applications. For that reason, a compiled book referencing the latest advances in wood material as an engineering product can be very useful when the innovation needs of environmentally friendly materials like wood are always present.

The aim of this book is to provide to readers a broad range of the latest research advances and technological developments in the field of wood engineering and technology, to illustrate the state-of-the-art research developments for engineering wood products of solid wood or wood based products, to cover from general concepts through in-depth novelties for this twenty-first century material, and to discuss its processing techniques, engineering capacities, process control measures, quality, and perspectives. This book may be used as a textbook for undergraduate and graduate students, researchers, and practitioners, serving also as a support and reference guide to all those interested in the field of wood engineering and technology.

The main topics covered in the chapters are: wood-based composites: its history, classification, and markets; the wood and fiber panel technology: wood as a substrate, the types of panels, and production condition parameters when gluing; the non destructive testing of wood-based panels and its process control; adhesives, binders, and matrices for wood and fibers composites; the non-destructive evaluation of wood products with ultrasonic means; ultrasound glulam testing; image evaluation techniques for wood analysis; the lignocellulosic agricultural residue as raw material for panel production; and finally, the wood material processing problem from a tool wear point of view.

An overview on wood composites is presented in chapter 1 by Barbu et al., starting with generalities and history of the wood-based composites, its impressive range of engineering properties, technological developments, and new market and regulative requirements, including the classification of wood-based panels, and the wide range of possibilities of engineering materials made with wood-based composites.

In chapter 2, Prof. Pizzi describes the influence on the preparation of wood and fiber panels of adhesives and wood, with concepts such as surface wettability, wood plasticization, and glass transition temperature, and models of cell walls buckling are presented and discussed. In addition, the parameters of manufacturing at an industrial level are presented, and the relationship between panel properties and a number of manufacturing parameters such as press temperature, type of pressing cycle, maximum pressure, and relative surface/core moisture content are discussed. A scanning electron microscopy showing the appearance of the adhesive/wood interface is briefly presented. The concept of density profile in relation to panel properties and how to influence it is discussed. Different manufacturing equipment is presented, in particular fundamental differences between single daylight, multidaylight, and continuous panel presses and their effect on panel properties and performance.

Barbu et al. (chapter 3) illustrate the development of the wood-based panel industry and the production capacity of the manufacturing lines, describing the utilization of advanced manufacturing systems, where it is important to take into account the new requirements for an on-line control of the manufacturing process. The authors indicate that only on-line Non-Destructive Testing (NDT) technologies are able to survey, detect, and forecast the quality of the raw materials, level of production parameters, and development of the panel properties. The intelligent implementation and integration, use, and understanding of on-line NDT methods in wood panel manufacturing is a big challenge, which includes a better understanding of the overall process and its limits, an updated state of the art knowledge, as well as an open and continuous dialog between the equipment producers, board manufactures, and users, which could be another important key for the development of an environmentally friendly modern wood-based panel industry in the world.

In chapter 4, Prof. Pizzi shows the recent developments and trends in the field of bio-based adhesives. The more recent developments in tannin adhesives without the use of aldehyde-yielding compounds under the conditions of processing, or even without the use of hardeners are described. Lignin adhesives are discussed next. The combination of these two types to yield natural environment-friendly matrices for non-woven fiber mats is also reviewed. In addition, the new trends in the development of protein adhesives and in carbohydrate adhesives are addressed. The author describes the unsaturated oil adhesives based on epoxidized unsaturated vegetable oils. Finally, the chapter addresses the new process of solid wood friction welding without the use of adhesive, in which the wood interface itself is used as the binder.

The use of ultrasonic techniques to evaluate the properties of engineered wood-based materials is discussed in chapter 5 (Beall and Reis) with respect to research to date and the use of more advanced techniques. The latter is critical because of the rapid evolution from solid wood to reconstituted structural materials. In addition, although considerable research has been done, there have been few introductions into manufacturing. This chapter traces the history of the use and latest developments of ultrasonics in several key areas, particularly the measurement of adhesive curing and quality in composites and laminates, and detection of flaws in solid wood materials. The techniques reviewed apply to product development, material properties, process control, product quality assessment, and evaluation of products in service.

In chapter 6, Sanabria et al. provide an overview of novel non-destructive testing methodologies for bonding quality assessment in glued laminated timber, where the main focus is set on air-coupled ultrasound testing, which has previously been applied to wood-based panels. The authors indicate that this novel prototype is capable of transmitting ultrasound signals through up to 500 mm thick glulam, being also the computerized-scanning system capable to imaging the position and geometry of defects within the bonding planes. An overview of the main findings is as well provided, where the investigations allowed an improved understanding of the wave propagation phenomena in thick laminated timber components through both analytical calculations and finite-difference numerical simulations. Future research is planned to combine the developed theoretical and experimental tools in a tomographic inspection method.

In chapter 7, Fernández et al. address the issue of non-destructive testing techniques allowing the analysis of wood characteristics. In this sense, wood morphology, wood density, moisture content, and wood decay are some of the features detectable by means of different non-destructive methods. In particular, the authors' look at Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) because of their ability to measure information in a three-dimensional fashion without altering its end-use capabilities. This enables scanning volumetrically an entire tree log, giv-

ing the measurements of each location of the analyzed volume. The output data can provide information about of internal structures or physiological features, which can then be used for optimizing industrial processing or for research purposes.

In chapter 8, Barbu et al. describe some non-wood lignocellulosic composites made with agricultural residue, which are evaluated as raw material for wood-based panels like particle- and fiberboard production. A great emphasis is placed on the processability of the ligno-cellulose composite boards by classical methods, by modified manufacturing processes, and on the types of tools and processing equipment, the automation of the manufacturing technologies, and the specific labor conditions. The combinations of wood and plant fibers are successful, since there is obvious compatibility between the macro- and microscopic structures, their chemical composition, and the relatively low manufacturing costs and high performances, as compared to synthetic fiber-based composite materials.

In chapter 9, Méausoone and Aguilera describes the tool wear phenomena, where the first dominating phenomenon is a corrosive attack that decreases the mechanical strength of the surface. The second is an abrasive attack whose work is facilitated by the reduced resistance of the surface. Repeated shocks degrade the cutting edge with temperature acting as an amplifier to the wear. Understanding of the wear patterns can allow for wear measurement and the finding of ways to extend tool life with the development of tool coatings, while maintaining optimal conditions for woodworking to get the best finish.

In this book, we present only a small part of the research, innovation, and development in Wood Engineering and Technology. Indeed, this work is intended to contribute with some advances to an area that is continuously showing more and more development. Having as a core this important material, but focusing it from the point of view of "wood as an engineering material," we move towards applications that are more friendly with people and the environment with regard to non-cellulosic material. For this reason, the best environmentally friendly material that we can use today and for future generations is without a doubt wood, applying innovative techniques and clean processes.

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