BIO-BASED COMPOSITES FOR HIGH-PERFORMAMCE MATERIALS – From Strategy to Industrial Application, Wirasak Smitthipong, Rungsima Chollakup and Michael Nardin (Eds.), CRC Press Taylor & Francis Group, 2015, 324 pp. ISBN 978-1-4822-1448-2 (Hardback)

At present, there is an increasing interest to substitute fossil raw materials with renewable ones based on biomass. Biomass is not only renewable, but it is also available in huge quantities and can be a viable option for obtaining almost all the products derived from oil. Besides, there are a lot of technologies that allow transforming biomass according to the principles of green chemistry. Chapter 1- *Bio-based composites: an introduction* discusses the advantages of introducing natural fibers in structures with corresponding properties to be applied in different fields. The combination of natural fibers and natural plastics produces the necessary performance on its own or with the addition of petroleum-based polymers, offering a path to achieve eco-friendly materials. Under these conditions, it is important to analyze the access to the raw materials, taking into account some aspects presented in Chapter 2- *Bio-based strategy: food and non food markets*. It is known that obtaining biochemicals from resources claimed by the food industry opens up a competition, especially when the starch represents the main raw material. Thus, the sustainability and the economic opportunity of shifting the industry to other biomass resources processed by biorefining should be considered. Bio-based economy success has to include increased productivity, investments in innovation, technology development, access to capital, supportive stable policies and ready market.

Biomass can be used to obtain both energy and chemicals. The development of the technologies to be applied has to be based on a *Strategy of bio-based resources: material versus energy* (Chapter 3). Having in mind the involved resources, starch as well as plant fibers can be used for energy, but at the same time composite applications can be of interest. The best solution will be correlated mainly with the cost. Other issues generating interest are material engineering, energy consumption, expanding world population, maintaining wilderness areas, cleaning up the environment, and excessive consumption of natural resources.

Structural biological materials are complex and can represent models to obtain composites. Thus, in Chapter 4 some examples concerning *Bio-inspired materials* are presented. Several attempts have been made to imitate biological structures and functions by using bottom-up strategies to design molecules that are capable of self-assembly. These refer to the use of peptide amphiphiles and nucleic acids, or to creating lightweight materials and building design, or taking gecko feet, natural glues produced by mussels and the layered structure of abalone shells as models.

Natural fiber-reinforced composites mainly consist of two natural fiber components that act as fillers or reinforcing materials and polymer matrices (Chapter 5- *Natural fiber surface treatments and coupling agents in bio-based composites*). Natural fibers present hydrophilic properties and they have to be modified by different treatments (with alkali, by acetylation, benzoylation, fatty acid derivatives, peroxide, permanganate, fungal, enzymatic treatments) to become hydrophobic to interact with synthetic polymers. At the same time, to improve strength resistance, the following coupling agents are recommended: silanes, isocyanates, maleated coupling agents and triazine derivatives. Chapter 6- *Reinforcement of polymers by flax fibers: role of interfaces* is devoted to interfaces in composite materials reinforced by flax fibers. First, the structure and organization of flax stems and fibers are presented and the influences of these constitutive elements on the mechanical and thermal behaviors of the fibers are described. The surfaces of flax fibers and their adherence capacities for different polymers are analyzed. The results of various treatments and the characterization of adherence are discussed, along with the obtaining of composites, the influence of dispersion of reinforcements, the appearance of defects, and the choice of manufacturing route. Another example is presented in Chapter 7- *Effects of reinforcing fillers and coupling agents on performances of wood-polymer composites*. In this case, the composites are obtained using polypropylene as matrix and wood flour, rice husk flour and dried distiller grains (commercial animal feed pellet). Maleic anhydride grafted polypropylene was used as coupling agent. The resulted composites were characterized as to their morphology, thermal and mechanical properties. It was established that the properties of composites can be adjusted by mixing various reinforcement species for filler blends. Six polypropylene homopolymers were selected as matrices and were filled with industrial natural French pine wood flour without other chemical molecules. Their characteristics assessed by rheological measurements, differential scanning calorimetry, tensile testing and water absorption are discussed in Chapter 8- *Natural fiber polyolefin composites: processing, melt rheology and properties.*

At present, there is an increased interest in *Polysaccharides bio-based composites: nanofiber fabrication and application* as results from Chapter 9. In this review, the utilization of composites nanofibers for medical application via electrospinning processes is presented, stating that the improvements of the mechanical properties and compatibilities of natural polymeric composites nanofibers and innovative production processes are suitable for real-life use. Chapter 10 describes the *Recent advances in cellulose nanocomposites*. The main aspects discussed refer to the preparation and characterization of cellulose nanofibres, as well as obtaining of composites. The surface properties and applications are also included. The composite materials are assessed as to their mechanical properties. In some cases, the obtained composites try to mimic natural structures. Such a case is presented in Chapter 11- *Improvement of damage resilience of composites*, analyzing the possibilities to obtain bio-fiber composites. This concept was mimicked in the design of a deltoid of a T-joint and a novel UD composite with artificial microtubules. The results show that the biomimetic approach has a great potential to produce novel composites to achieve an acceptable level of cost-effectiveness in terms of damage resilience and production costs.

Wood-polymer composites are known to be used in building, construction, automotive and marine infrastructures. To analyze *Life durability of bio-based composites* (Chapter 12) we have to take into consideration the polymer matrix, fillers (wood and starch flours), along with the processing techniques. The influence of these parameters on the photostability and natural weathering of composites was studied and correlated with the fillers used. The characteristics of the composites can be modified and influenced by different factors, as confirmed in Chapter 13- *Mechanical properties of natural fiber-reinforced composites*. The viscoelastic and mechanical properties of natural fibers-reinforced rubber composites are considered. The characteristics of the composites depend on fiber loading and their nature and chemical treatment (alkalization, silanization, bonding agent, compatibilizer, matrix modification and surface morphology). The effects of thermal annealing on the mechanical properties of natural fiber-reinforced composites are discussed for the use of polyethylene, polypropylene, polyester and natural rubber as matrices.

Chapter 14- *Characterization and strength modeling of laminated bio-based composites* is focused on a specific type of structural bio-based composite made by laminating layers of natural fiber, veneer, strands or other small elements to form timber- and lumber-like products. The modeling strategies for predicting the mechanical responses of bio-based laminates with and without macrovoids in their meso-structures are described. Large composite structures are usually modeled with shell elements following a continuum mechanics approach (Chapter 15- *Micromechanical modeling of bio-based composites*). In this chapter, the underlying principles of micromechanical simulation of bio-based composites are described. First, experimental methods that allow the identification of relevant micromechanical properties required as input for micromechanical simulation are presented and then advice is given for identifying and setting up representative volume elements for micromechanical simulation of composites. At last, Chapter 16 is dedicated to *Life cycle assessments of bio-based composites: a review*. Life cycle analysis (LCA) is a tool for evaluating the environmental impacts associated with products throughout their life cycle (from extraction of raw materials to the end of their lives – from the cradle to the grave). In this chapter, recent literature data are reviewed concerning the LCA of natural fiber composites. The LCA steps of goal definition, functional unit and system boundaries, data, and impact assessment are compared and common trends are revealed.

This book provides an overview of the state of the art and emerging trends in the area of bio-based composites, demonstrating the existence of a lot of solutions, and underscoring the idea that their applications require interdisciplinary understanding, particularly in the fields of materials science and engineering.

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