Chapter 38
Non-Wood Lignocellulosic Composites

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ABSTRACT

It would seem that with appropriate treatment almost any agricultural residue may be used as a suitable raw material for the wood-based panels like particle- and fiberboard production. The literature on wood-ligno-cellulose plant composite boards highlights steady interest for the design of new structures and technologies towards products for special applications with higher physical-mechanical properties at relatively low prices. Experimental studies have revealed particular aspects related to the structural composition of ligno-cellulose materials, such as the ratio between the different composing elements, their compatibility, and the types and characteristics of the used resins. Various technologies have been developed for designing and processing composite materials by pressing, extrusion, airflow forming, dry, half-dry, and wet processes, including thermal, chemical, thermo-chemical, thermo-chemo-mechanical treatments, etc. Researchers have undertaken to determine the manufacturing parameters and the physical-mechanical properties of the composite boards and to compare them with the standard PB, MDF, HB, SB made from single-raw material (wood). A great emphasis is placed on the processability of the ligno-cellulose composite boards by classical methods, by modified manufacturing processes, on the types of tools and processing equipment, the automation of the manufacturing technologies, the specific labor conditions, etc. 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.

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INTRODUCTION

Large amounts of lignocellulosic residues suitable for composites production (about 2.4 billion tons) are produced every year after the end of the agricultural season of the various agricultural species. These residues are either burned down or left over in the ground without any further utilization. In most cases, such residues cause also various disposal problems to the farmers. The agricultural residues are a part of the annual biomass production, and mainly include flax, hemp, bagasse, straws of wheat, barley, oats, rye, rice straw, sugar cane, the stalks of maize, cotton, tobacco, bamboo and the husks or shells of walnuts, almonds, etc.

The lignocellulosic residues are excellent raw materials for production of wide range of composites following various chemical or mechanical methods (Kozlowski et al., 2004). In general, the economical feasibility of such uses is influenced by the cost of production, the availability of raw material, and the physical and chemical properties of the lignocellulosic fibers.

Also the growing demand for wood-based panels and the increasing price of chips has led to continuous efforts to find new resources as an alternative to wood. The use of other renewable resources such as agricultural residues in the production of composites (i.e. particleboard and fiberboard) has recently been reconsidered attractive both from the economical and environmental point of view. Value-added lignocellulosic composites made from industrial residues can be considered as an alternative solution to this problem.

Composites based on lignocellulosic particles or fibers can be divided into the following groups:

- Conventional panel-type composites like particleboard, fiberboard, insulating boards, etc.
- Lignocellulosic-mineral composites, which are based on inorganic binders (i.e. cement).
- Natural fibers reinforced polymers.
- Non-woven textile-type composites.

Non-wood lignocellulosic material is an organic residue which consists of mainly cellulose, lignin and hemicelluloses. These structural elements are produced by plants to form the cell walls, leaves, stems, stalks, and woody portions of the plant (Idi & Mohamad, 2011).

According to Fengel and Wegener (1989) and Argyropoulos and Menachem (1997) there is 250 – 400 billion tons of cellulose and 200 – 300 billion tons of lignin in the earth, representing 40% and 30% of organic matter carbon, respectively, with other polysaccharides comprising 26% (Sharif, 2009).

The literature on wood-lignocellulosic plants composites highlights steady interest for the design of new structures and technologies, towards products for special applications with higher physical and mechanical properties at relatively low prices.

A detailed study of literature sources on the use of non-wood plant fibers for sheet composites with up to 1,165 literature sources compiled Youngquist et al. (1994).

A number of studies on the utilization of a variety of the residues of agricultural crops in the production of composites have been conducted (Alma & Shiraishi, 1998; Chow et al., 1996; Dalväg et al., 1985; Sain & Kokta, 1994; Takase & Shiraishi, 1989; Woodhams et al., 1984). It will be beneficial to use the agro-fibers in the production of composites in terms of environmental and socio-economic aspects (Rowell, 1995). It has also been found that with the combination of wood particles, modification of agro-fibers, and addition of some water-resisting agent, it is feasible to produce particleboard from the residues of agricultural crops (Grigoriou & Ntalos, 2001), wheat (Cooper & Balatinecz, 1999), cot-

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