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## **Development of environmentally friendly adhesives from renewable plant polymers**

Production of wood-based composites and furniture in Europe consumes more than 5 million tons synthetics adhesives. At present, formaldehyde-based adhesives such as urea, melamine- and phenol-formaldehyde resins are used predominantly. However, formaldehyde-based adhesives are not environmentally friendly products. Formaldehyde is a suspected carcinogen and may be emitted in the production or in use of wood composites bonded with these resins. Moreover, these adhesives are based on non-renewable petrochemicals and thus ultimately limited in supply, and also, their cost is rapidly increasing. Therefore, there are many reasons to return to or look for environmentally friendly adhesives derived from natural, renewable resources. Adhesives from natural sources were mostly substituted with synthetic resins in the first half of 20th century. In the past decades, several attempts have been made to develop and bring back natural adhesives to the industry. However, they were not successful, because the production of these adhesives was too expensive and the properties did not meet the requirements. Nowadays, situation is totally changed. Increased price of oil makes these products competitive. New procedures for production of natural polymers from renewable sources have been developed and patented.

The project has three basic objectives: (1) to develop and produce adhesives from natural, renewable and harmless sources; (2) to prepare wood adhesives with appropriate rheological and mechanical properties in order to substitute the existing synthetic adhesives; and (3) to study the quality of bonding of new adhesives in different wood-based composites and to use as much residues from other productions as possible to gain competitiveness on the market. Potentially suitable natural and renewable raw material is wood residues, which can be liquefied by patented procedures and then introduced into adhesives as a substitute for phenol. By-products, such as "cellulignin" in the production of tannin, can also be liquefied. Condensed tannins, which are natural polyphenolic substances found in abundance in many woody plants and cork, can be used as a raw material for the production of tannin-formaldehyde wood adhesives. Efforts have been made to reduce formaldehyde emissions from the production and use of wood composites bonded with tannin-based wood adhesives by the replacement of formaldehyde with formaldehyde derivatives. Lignin-natural adhesive in wood, which is a by-product in pulp and cellulose production, can be modified and used instead of phenol in the adhesive formulation.

The research is focused on fundamental and deep study of the characteristics of new natural polymers, which show sufficient adhesion potential and appropriateness to be used in adhesives. Chemical composition (FT-IR, UV), rheological properties (rheometer), surface energetics (tensionmeter) and curing kinetics (DSC and DEA) are determined. Because mechanical testing is the method which is used to determine the quality of the adhesive in practice, the strength development of adhesive during cure (ABES) is examined. LCA method will be used to evaluate ecological aspect of new adhesives.

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