PHYSICAL CHEMISTRY OF THE NANOSTRUCTURES OF LIGNIN-CARBOHYDRATE COMPOSITE

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Wood biocomposite structure is formed by cellulose microfibers, hemicelluloses and precursors of the aromatic polyfunctional irregular biopolymer (lignin) at nanolevel. Hierarchical structure of plants' cell walls is a composite of three groups of biopolymers at supermolecular level and is located in nanodomains. Main particles there are hemicelluloses, cellulose nanofibers (2-60 nm) and lignin's fractal nanoparticles (14-70 nm). Lignin and hemicelluloses form the matrix, and cellulose fibers fix it.

Formation of lignin's macromolecules in the plants (lignification) is a complex of complicated biological, biochemical and chemical processes. It runs through the stage of enzymatic dehydrogenational polymerization of *n*-hydroxystyrilic alcohols, followed by the occurrence of resonance-stabilized phenoxy radicals and their random combinations ("end wise" polymerization) with generation of dilignols (dimeric structures) and oligolignols and, finally, branched polymer - polylignol (lignin). Besides the reactions of radicals' linking, ionic reactions of intermediate quinine methides take place during the polymerization process. Variety of bonds that are arising between separate structural elements leads to formation of irregular polymer (lignin macromolecule).

That positions are in correspondence with the approach to delignification process and formation of the structure of wood matrix as nanocomposite from the point of view of Polymer Chemistry: wood is a ternary system of natural polymers (lignin-hemicelluloses-cellulose). The state of the system may be described with the particular values of thermodynamical parameters, defining its degree of stability. Reasonableness of that conclusion is approved by the established facts, depicting the existence of the stable lignin-carbohydrate complex in the wood, and the existence of thermodynamical compatibility: in lignin-hemicelluloses system under 0-11,2% and 84,3-100% of lignin's mass fraction, in hemicellulose-cellulose system under the components ratio 1:1 (defined

by us for the first time using developed thermodynamical research methods). Cellulose and lignin are thermodynamically incompatible polymers; any of their mixtures will segregate to the components.

Taking into account nano-dimension of the initial biopolymers of the cell wall and their thermodynamical compatibility, physico-chemical model of lignin-carbohydrate wood matrix formation was created.

Considering lignin-carbohydrate matrix from the position of forming natural nanocell formations and the dynamics of their transformation reveals new possibilities for studying natural nanocomposites, and applying nanotechnologies in complex biomass chemical treatment by directed chemical (organic and water-aprotic solvents, ionic liquids, homogenous selective catalysts of red-ox transformations, oxidizers, etc.) and physical (supercritical fluid mediums) influence upon the structures and properties of biopolymers at nanolevel, obtaining products with a broad number of applications (biological active substances, biosorbents, products of lignin's oxidative destruction, cellulose semifinished product with improved physical and chemical properties).