

NANO HIGHLIGHT

Nanotechnology for the Forest Products Industry

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To America's forest products industry, nanotechnology represents a major opportunity to develop new high performance multifunctional products, substantially reduce processing costs, and open radically new market opportunities. Nanotechnology provides the ability to dramatically transform the production of engineered wood and wood-based materials, create significant new applications for composite and paper products, and create new generations of multi-functional nanoscale lignocellulosics. At the same time, advances in genomics are allowing us to understand how wood, an orthotropic composite cellular material, is synthesized. Within tracheid cell walls, some of the cellulose is assembled into crystalline nanofibrils--whose properties can rival those of carbon nanotubes. We are now developing an understanding of how molecular and nanoscale cell wall components (i.e. cellulose, hemicelluloses, and lignin) are assembled; and how this architecture and self-assembly is controlled by the tree during growth and how nanoscale cell wall architecture in turn controls material properties. By understanding and influencing how these components and structures are assembled, we should be able to create novel, functional surfaces on existing cellulose substrates, create new or enhance existing products, and integrate nanoscale organization into new products. In addition, cellulosic materials, being one of nature's most abundant polymeric biomaterials, have always been generally found to be safe to humans.

To move nanotechnology ahead, The American Forest and Paper Association's Agenda 2020 Technology Alliance* (AF&PA Agenda 2020) created the first nanotechnology roadmap for the US forest products industry (March 2005, www.nanotechforest.org). Since then, AF&PA Agenda 2020 has created a nanotechnology task group, developed an industry forest products technology roadmap (July 2006, www.agenda2020.org) in which nanotechnology opportunities are identified. AF&PA Agenda 2020 has also formed a formal linkage to the National Nanotechnology Initiative (NNI) and actively encourages nanotechnology research involving wood and wood-based materials. To further strength nanotechnology research involving wood, the USDA Forest Service has joined the NNI Nanoscale Science, Engineering and Technology Subcommittee of the National Science and Technology Council Committee on Science. Recently the Agenda 2020 Nanotechnology Task Group has prioritized six areas where nanotechnology is of greatest interest. These areas are: 1) improving the strength to weight performance of forest products; 2) developing commercially important wood-derived nanomaterials; 3) understanding and controlling water-lignocellulose interaction in order to modify wood and wood-based material properties; 4) modifying nanoscale surfaces and developing inorganic-organic nanocomposites; 5) exploiting the photonics and electronic/piezo-electric properties of wood; and 6) using nanomaterials and modifications to dramatically increase wood processing energy efficiencies.

* The Agenda 2020 Technology Alliance is an industry-led partnership with government and academia that holds the promise of reinventing the forest products industry through innovation in processes, materials and markets. The Agenda 2020 Technology Alliance is a Special Project of the American Forest & Paper Association (AF&PA), the national trade association of the forest products industry.