RESEARCH in Progress

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Nanobiocides for Wood-Based Construction Materials

Changes in the forest resource have shifted building materials away from sawn wood to engineered composite products to make more efficient use of our forest resources. Properties of these new products are different from those of sawn wood products, especially with regard to their response to moisture and biodeterioration. Wood protection systems are needed for engineered composite products to improve their durability, but new environmentally friendly organic biocides are vulnerable to inactivation from heat needed for the manufacture of composite products. New types of delivery systems are needed that not only protect the biocide from the heat of the fabrication process but also slowly release the biocide during the service life of the product. An inert nanocarrier delivery system, such as clay nanotubules, may be able to protect the biocide from the heating process and release biocide over a long period of time.

Nanotubules are cylindrical straw-shaped materials made from ceramic, clay, metal or lipids.

Background

Several nanocarrier systems are recognized that may find an application in the field of wood protection, particularly for increased durability of engineered composites (such as oriented strandboard (OSB)). For example, a patented nanocarrier system utilizes 100-nm plastic beads embedded with biocide. Based on type of polymer comprising the bead, pore size in the bead, and biocide viscosity and solubility, biocide-embedded nanoparticles can be designed for slow, controlled release of the biocide. Other cylindrical, tubule-shaped materials (nanotubules) made from ceramics, clay, metal, or lipids have been used as carriers in various medical and industrial applications. A number of properties of nanocarriers would benefit the field of wood protection:

- Delivery and placement of biocide
- Slow release of a biocide
- Release of the biocide upon exposure to certain environmental conditions, such as high humidity
- Protection of heat-labile organic biocides during treatment processes or panel fabrication

Loaded nanotubules may be used for surface application, pressure impregnation, or as an additive to engineered products, films, coatings, or sealants. Some considerations include how to precisely control release of a biocide, whether the nanotubules are compatible with resin if used to treat composites; whether the resin itself may be a barrier to release of the biocide; the risk of release during finishing, refinishing, or sanding; calculating and regulating actual release rate; and development of methodology for analyzing release rate. Proper design could lead to increased applications for biocides that are otherwise unsuitable for exterior or in-ground applications, including, but not limited to soluble biocides, heat-labile biocides, and delivery of targeted nanobiocides.

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Objectives

This project has four objectives:

1. To load nanotubules with commercial or experimental biocides and study rate of biocide release in the lab using zone of inhibition
2. To test release rates for each loaded batch of tubules (called nanocide)
3. To evaluate nanocide-treated wood–plastic composite (WPC), paper, OSB, and ceiling tile for improved protection
4. To scale up nanocide production for commercialization

Approach

Preliminary research on nanocides suggests successful loading and slow release of biocide can be achieved in nanotubules. Cellulose-based products, such as medium-density fiberboard (MDF), OSB, WPC, and paper, will be treated with nanocide loaded with a commercial biocide and will be evaluated for inhibition of decay and mold fungi and changes in physical properties. Separate heat tolerance tests will be conducted to determine thermal stability of the biocide when loaded into the tubules. Prototype products will be fabricated with a range of concentrations of nanocide under conditions simulating those used for commercial products before commercializing a product line.

Expected Outcomes

Outcomes of this project will include the production and evaluation of nanocide paper, nanocide-treated WPC, and nanocide-treated OSB, followed by scale-up and commercialization of successful nanocide technologies.

Timeline

Fabrication of nanocide paper and nanocide-impregnated WPCs was completed in 2009. Fabrication and analysis of nanocide-treated OSB will be completed in 2011.

Cooperators

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