RESEARCH in Progress

100 Years of Service
Forest Products Laboratory
1910 – 2010

Characterizing Wood Protection Properties of Nano-Metals

Nanotechnology has the potential to greatly impact the wood protection industry through the creation of nano-materials with unique properties. Nano-sized particles of metal (such as copper or zinc) are one example of new materials that may possess biological, physical, or chemical properties that are completely different than larger particles of the same metal. Enhanced antimicrobial properties for a nano-metal could be useful in development of a new biocide or co-biocide. Their small size may alter wood treatability properties such as penetration and biocide distribution. Identifying and characterizing the properties of nano-metals is a critical step in understanding the role nanotechnology will play in the future of wood protection.

Nanozinc oxide (30 nm) protects against UV degradation in southern pine and is leach resistant.

Background

Used either alone or in combination with existing biocides, nano-metals may provide the basis for the next generation of wood protection products. Nano-metals are created by altering particulate size either in the liquid phase (such as metal oxide sols, colloidal metals), gas phase (such as flame synthesis, plasma-based vapor phase synthesis), or solid phase (such as high-energy ball milling). Nano-metal preparations of silver, zinc, copper, and other metals have high dispersion stability and low viscosity, allowing for more uniform particulate distribution over a surface.

Dispersion stability coupled with controlled particle size may offer several types of improvements in wood protection:

- Preservative penetration in commercial lumber species
- Treatability of refractory wood species that are of low commercial value
- Durability of engineered composites
- Stability of finishes and coatings for aboveground applications
- Nonleachable or hydrophobic treatments
- Photostability of treated wood
- Leach resistance of aqueous treatments

Objectives

This project has three primary objectives:

1. To evaluate characteristics (decay, termite and mold resistance, leach resistance, ultraviolet (UV) protection, and moisture repellency) of nano-metals compared with their soluble metal oxides
2. To assess the mechanism of action of nano-metals for imparting improved resistance to biodeterioration of wood compared with their soluble metal oxide

USDA
Forest Products Laboratory

U.S. Department of Agriculture
Forest Service • Forest Products Laboratory
www.fpl.fs.fed.us

T.C. İSTANBUL ÜNİVERSİTESİ 1453

3. To assess field performance of nano-metal-treated wood that shows improved durability in laboratory tests

Approach

In the presence of moisture, metals oxidize, which results in the release of metal ions. The ionic form of the metal is often the form that is responsible for microbial inhibition. Smaller particles have a higher surface area, which results in a greater area available for oxidation. Also, the size of the metal particle has been shown to affect microbial inhibition; the smaller the particle, the greater the antimicrobial activity. Particles with diameter less than 100 nm have the necessary surface area to allow a continuous release of metal ions. Some potential advantages of nano-metals include the following:

- Non-volatile
- Non-degradable over time
- Odorless
- Long-term efficacy

Expected Outcomes

Unique properties of nano-metals will be identified and characterized with regard to their use as a wood treatment. The ability for nano-metals to be utilized as a biocide or co-biocide for wood preservation will be evaluated in the laboratory and in field tests. This information will be useful in assessing the role of nano-metals in the development of the next generation of wood preservatives.

Timeline

The characterization of physical properties (leachability, UV stability, water absorbance, retention) of nano-copper, zinc, or silver will be completed in 2010; characterization of biological properties (decay, mold, and termite resistance) is ongoing and will be completed by 2011. Field performance of wood treated with selected nano-metals is ongoing and will be completed by 2013.

Cooperators

USDA Forest Service, Forest Products Laboratory
Istanbul University

Contact Information

Carol A. Clausen
USDA Forest Service
Forest Products Laboratory
Madison, Wisconsin
(608) 231-9253; cclausen@fs.fed.us