Technology Offer

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Empa
Materials Science and Technology

Durable, Eco-friendly Protection of Wood against Microorganisms by Enzyme-enhanced Iodination

Untreated wood
Inoculated with wood decay fungi and blue stain fungi

Laccase-iodide teated wood
Inoculated with wood decay fungi and blue stain fungi

Invention

Preservation of wood materials in outdoor applications against decay through fungi and other microorganisms is preferably both persistent and eco-friendly. This invention enables the use of a simple, non-toxic and widespread chemical – iodine – as the antimicrobial agent. By enzymatic modification of the wood surface iodine is bound and stabilised against leaching.
The wood preservative is applied by immersion painting or impregnation, or on-site as water-soluble instant powder for paint-brushing of existing wood structures.

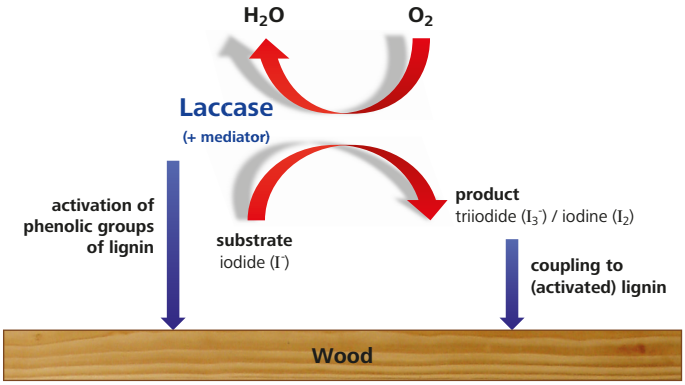
Background

Current wood preservatives often rely on biocidic chemicals which are toxic to humans and to the environment. An eco-friendly alternative are natural bioactive preservatives with focused control of wood degrading microbes and vastly reduced side effects. Iodine, for instance, is a favourable antimicrobial agent, since it is non-toxic and readily available. However, like other environment friendly agents, it is challenged by a lack of long-term stability, mostly due to leaching.
The invention introduces laccase-catalysed grafting of iodine and other bioactive molecules onto ligno-cellulosic materials. Laccase catalyses the oxidation of iodide (I^-) to tri-iodide (I_3^-) which is in equilibrium with elemental iodine (I_2), resulting in a highly microbiocidal solution. Iodine and tri-iodide bind considerably stronger than iodide to the activated phenolic groups at the lignin surface, leading to enhanced leaching resistance and thus long-term effectivity of the iodine treatment.

Advantages

The invented wood preservation method is environment-friendly and highly cost-effective while making use of largely harmless base materials:

- Non-toxic, inexpensive ingredients: iodide salts are inexpensive and non-hazardous, and bacterial resistance to iodine is unknown.
- Enzymatic/catalytic mode of action (multiple use of substance): even small amounts of laccase ensure effective protection of wood surfaces
- Non-leachable: strong binding of iodine to lignin surface ensures long-term protection
- Easy to handle: wood preservative is activated on-site using only water, and applied as spray or with a paintbrush.



Applications

The invention can be applied for wood treatment processes at manufacturing sites of indoor and outdoor wood construction elements, or as instant powder of, e.g., lypophilised enzymes and iodide salts that are activated at the treatment site by adding water.
Iodinated, antimicrobial wood is preferably used in environments with elevated infection pressure, like hospital furniture, door handles or sheathing of weather-exposed façades. Enzymatic iodination can be applied also to small wood particles or ligno-cellulosic materials like shavings, strands, splints, lignin rich microfibrillated cellulose or even lignin residues from paper production processes. These materials can then be used as antimicrobial additives in varnishes/coatings or composite materials.
Prototype materials (e.g. elements of the wood façade, door handles) are demonstrated and monitored in the NEST module 'Vision Wood' at Empa Dübendorf (https://www.empa.ch/web/nest/visionwood).

Ownership

Empa, Swiss Federal Laboratories for Materials Science and Technology, Überlandstrasse 129, CH-8600 Dübendorf; European Patent No. 2 871 962

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Keywords

wood decay fungi, wood protection, blue stain discolouration, iodination, laccase, leach resistance, biocatalysis, phenol, enteric bacteria, microorganisms

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