Improvement of strength properties and reduction of emission of volatile organic compounds by enzymatic modification of lignin containing biopolymers and composites

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Lignin powder after extraction from wood.

Hemp fibres & shives

After blending of lignin with natural fibres like hemp and additives various products could be produced.

The lower picture : Musical instruments (flute & harmonica) with sound properties of solid wood, partially made by injection moulding process.

Introduction

A bio-composite material of engineering grade was developed by using residual lignin (Alkali-Lignin, Aquasolv-Lignin), lignocellulose fibres and additives. The fibre-reinforced composite can be processed with adapted extrusion and injection moulding technology. This allows the production of furniture parts, casings for computer, television, or mobile phones or watches and musical -instruments.
The material combines the physical properties of solid wood and plastics in the manufacture process.
As a by-product of the paper industry lignin is produced in amounts of 50 million tons per year. Approximately 95 % of the lignin is burned. There is therefore a huge potential for such material.
However, the high emission rate of volatile organic compounds (VOC) and the unfavourable odour characteristics prevent the material from the use for several value added products.

Background

The main source for these emissions are low molecular parts of lignin and hemicellulose. The emissions contain monoterpenes, sesquiterpenes, phenols (e.g. guajacol), aliphatic alcohols (nonanol) and aldehydes (e.g. furfural, nonanal). It became obvious that the odour characteristics of the material are very important for the application of the material. In previous trials treatment of the lignin with phenol-oxidising enzymes in combination with surfactants leads to a significant reduction of guajacol emission of the final polymer product.
In other investigations a short incubation of lignocellulose fibres with hemicellulases improved the fibre to fibre bonding and the extraction of mono- and disaccharides with extracting agents.
All these effects will be investigated for the development of bio-composite from lignin materials with reduced emissions and improved mechanical properties.

Objektives

The aim of the project is to develop enzyme complexes for the efficient degradation or polymerisation of lignin- and hemicellulose based compounds, which are responsible for emissions of volatile organic compounds (VOC). This in particular concerns the following tasks:

1. Investigations to the mechanism of the enzymatic catalysed degradation and modification of the VOC-emission relevant compounds of lignins and carbohydrates using selected substrates with varying pre-treatments.
2. Development and production of special lignin-modifying enzymes and hemicellulases for the application.
3. Optimisation of the incubation processes for of lignin and lignocellulose fibres.
4. Development of effective injection moulding processes with modified biopolymer materials.
5. Production of a new fibre-reinforced biopolymer material with reduced VOC emission and improved physical properties and its use for commercial products.

Expected results

- Specific enzyme complexes of phenol-oxidising enzymes and hemicellulases.
- Knowledge about enzymatic modification mechanisms.
- Optimised incubation procedures.

➢ New fibre-reinforced biopolymer with reduced VOC emission and improved physical properties.

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