Biotechnological processing of lignocellulosic materials

Lignocellulose (wood and annual plants) - based composites are becoming extremely important and highly perspective sustainable and renewable natural materials. Due to susceptibility to different biotic and abiotic factors they can deform and degrade. Various physico-chemical approaches have been used in the past to address these drawbacks, but generating new problems since these treatments might be harmful to the environment and/or be energy demanding.

To address these shortcomings, this project proposes development of an eco-friendly biotechnological/enzymatic (laccase-based) technological processes for crosslinking and covalent grafting of functional molecules (chemically different non-toxic phenolics) onto lignocellulose material surfaces, thus introducing targeted (multi)functional surface properties (wettability, hydrophobicity, antimicrobial activity, UV and flammability resistance, and/or colouration). To exploit enzymes' main advantage (substrate specificity and regional selectivity), the project focuses to better understand lignin (chemical and morphological) surface structure present in different lignocellulosic materials; to better understand and guide enzymatic activation and modification of lignin in lignocellulosic materials; to better understand and guide enzymatic activation and graft polymerization of chemically different phenolic monomers onto activated lignin; and to obtain a novel low molecular weight bacterial laccase as a better alternative to commercially available fungal laccase. Finally, the new processes will be evaluated for their economic and environmental impact and compare with the existing products.

The nature and efficiency of newly developed procedures for biotechnological lignocellulosic material functionalisation will be investigated by standard and non-standard methods, respectively used in the fibre and wood science and technology. Several spectroscopies like fluorescence confocal microscopy (FCM), fluorescence microspectroscopy (FMS), electron paramagnetic resonance spin trapping (EPR ST), FTIR and Raman spectroscopy will be optimised for molecular characterization of lignocellulose surface structure, lignin and phenolic monomers activation, modification and polymerization using laccase. In addition, EPR ST 1D imaging will be developed to tackle depth-dependent activation.

New knowledge and methodologies will considerably contribute to the development of several scientific fields: wood science, fibre science, chemistry of polymers, biophysics of polymers, and biotechnology. New strategies for modification of lignocellulose fibres and wood-based products will be identified to contribute to the sustainable development of local, regional and European textile and wood industry. Since innovative, environmentally friendly materials and technologies can help to increase the added value of their products, a special care will be taken to disseminate the results within the scientific, professional and broader public communities.

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