SUMMARY

In-situ synthesis of calcium phosphates derived from eggshells to improve wood reaction-to-fire properties

The flammability of wood and wood-based products can be altered by chemical means using fire and flame retardants. Studies showed that many compounds are to be effective fire retardants, however the challenges such as leachability of the additives and toxicity considerations to human health and environment still remain. Eggshell is a compelling source of calcium and can serve as a precursor for hydroxyapatite bioceramic. Bioceramics are biocompatible materials, i.e. not harmful or toxic to living body. By combining materials with conflicting properties, we seek to provide solutions to the circular, climate-neutral and sustainable economy.

Purpose and goals

The goal of this project is to enhance fire-retardant properties of wood by utilizing eggshells as a calcium source for bioceramic-reinforced wood materials. The in-situ synthesis of calcium phosphate-based material shall lead to wood mineralization and subsequently improved its fire performance.

Methods and implementation

Systemic studies have been caried out to study wet-chemistry pathway to obtain hydroxyapatite-mineralised wood. The solution pH, ion concentrations, precursors, impregnation time and pressure were varied to obtain desired phase of the in-situ precipitated mineral. Wood matrix saturation as well as morphological features and chemical composition of coprecipitated mineral was studied by scanning electron microscopy and energy dispersive X-ray spectroscopy (SEM/EDS). Thermal degradation of mineralized wood was studied by thermogravimetry (TG) coupled with mass spectrometry (MS).

Fire-properties of the hydroxyapatite-wood composite was evaluated by performing cone calorimetry (CC) and micro combustion calorimetry (MCC) tests.

Results

CC and MCC results showed that eggshell-derived mineral intercalation into wood matrix has positive effect on wood protection against thermal degradation. Total heat release (THR) was reduced and time to ignition (TTI) was delayed for the HAP-mineralised wood compared to the untreated Scots pine wood. MCC data showed that there is a difference between the sample from the surface and internal layer of the wood block, suggesting that the surface protection was highest. Overall results imply a potential in producing hybrid bio-based materials that could be attractive in the construction sector as an environmentally friendly building material.

PROJECT TEAM

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