Processing and mechanical properties of novel wood fiber reinforced cellular composites

Background

In the wake of climate change and increasing oil prices, a demand for renewable and light weight products (e.g. renewable packaging materials) has surfaced. Wood fibers are an appealing alternative to e.g. glass fibers in engineering polymer composites. In contrast to man-made fibers, wood fibers are renewable, biodegradable, recyclable and show less concern with regard to safety and health. There is currently an emergent interest in using wood fibers as a load bearing constituent in composite materials. It would also be desirable to develop cellular composites based on this renewable resource, for application in the fields of packaging and insulation materials.

Project Description

The aim of this project is to develop a process to produce foam structures, where the solid phase is a composite material of a polymer, e.g. polylactic acid (PLA), and wood fibers. Preforms based on polymer and wood fibers will be prepared using a commingling technique developed by Innventia. These will be placed into a closed, heated and pressurized, vessel where supercritical CO2 will be used to foam the composite preforms. This gas foaming process has developed at EPFL-LTC for other PLA based systems. Processing windows for the foaming of the novel composites will be determined. Different processing parameters (e.g. gas saturation temperature and pressure, depressurization and cooling rate, etc.) will be varied to control pore sizes and distributions and allow nucleation and growth of pores while maintaining the position of the reinforcement. The microstructure and mechanical properties will be experimentally determined and simple micromechanical models will be used to determine the reinforcing potential of wood fibers in cellular composites.

Tasks

The approach can be outlined as follows:

- Read relevant literature
- Material selection (wood fiber type, polymer) and perform preparation
- Compounding and rheological characterization of components
- Foaming process (determine process window)
- Microstrucutral characterization (e.g. microscopy or microtomography)
- Experiments to determine the compressive stiffness and strength
- Use micromechanical models to predict the reinforcing effect of the wood fibers
- Report writing (in English)
- Poster and oral presentation at the participating institutions
- Poster and oral presentation at EPFL-LTC

For a duration of 20 weeks starting at the earliest convenience, the project will be carried out at first at Innventia in Stockholm, Sweden (commingling and perform preparation) then at EPFL in Lausanne, Switzerland (processing and material characterization).

Prerequisites
A strong background in material science, polymer and composite processing technology, is advisable. An interest in material mechanics is welcome. The candidate should preferably be a last-year student in a suitable M.Sc. programme in Engineering.

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