Controlled chemical modification of a cellulose based model system

Background

At Innventia AB research on using wood fibres as an alternative to e.g. glassfibres in engineering polymer composites is performed. For composite material the stress transfer in the interface between reinforcing fibres and matrix polymer is essential to the mechanical properties. This stress transfer is dependent on the adhesion between surfaces and could be altered by changing the bondning and surface energy of the reinforcing elements or the matrix. Suitable standard methods for fast evaluation of interface properties in wood fibre composites are not available today and the development of such methods would largely facilitate the evaluation of results from ongoing research. Single-fibre testing is generally too time consuming in practice. For fibre composites, only uniaxial longitudinal and transverse orientations are suitable for mechanical analysis to quantitatively assess stress-transfer ability. Due to inherent difficulties to achieve unidirectional wood-fibre composites, existing models to quantify internfactial stress-transfer are unwieldy and based on yet unvalidated assumptions.

There is therefore a need to develop a method for stress transfer evaluation, with a well-defined microstructure appropriate for modelling. A suitable model material is needed, where parametric experimental studies can be carried out to assess different surface treatments.

Earlier research at Innventia AB has resulted in a technique for preparing spherical particles of cellulose. Since these particles have an aspect ratio of one, they would be appropriate as a cellulose surface model. A protocol for the production of composite model systems based on cellulose spheres and polymer matrix is also available. To evaluate the interfacial properties, dynamic mechanical analysis (DMA) is used to determine properties from which the interfacial properties are calculated using micro mechanical models.

In the next phase of this project we want to use this model system to study the influence of a number of chemical modifications on the interfacial properties. The interface will be altered through chemical modification of the cellulose sphere surface. Initially it will be of interest to vary the adhesion between cellulose and matrix through increased and decreased wettability.

Project description

The approach can be outlined as follows:

- Literature survey of modification of cellulose surfaces with the aim to influence interaction with polymers
- Set up an experimental plan for a number of different approaches
- Evaluate modifications using relevant analytical techniques such as ft-IR and NMR.
- If possible make composites using modified spherical cellulose particles and evaluate by dynamic mechnical analysis (DMA). Different matrix polymers such as polylactic acid, PLA and polystyrene will be used.

- Apply existing micromechanical models to back-calculate the interfacial efficiency, and discuss the results from this model material in relation to industry-relevant fiber composites. If available comparisons will be made with other model systems, such as a surface force apparatus and wetting angle measurements.
- Writing of a M.Sc. thesis
- Oral presentations at Innventia AB and home university
- Duration between 20-30 weeks dependant of specific requirements the project will be carried out at Innventia AB situated in Stockholm. The starting date can be set as soon as a suitable candidate has been identified. The goal is that the results should be of sufficient scientific quality to be used in a journal publication.

Prerequisites
The work will focus on chemical modification and chemical analysis so a strong background in chemistry is a prerequisite. Other areas where experience is advisable are material science, or polymer processing technology. An interest in materials mechanics is welcome. The candidate should preferably be a last-year student at a M.Sc. program in Chemical Engineering or equivalent.

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