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Compatibilization of microfibrillated cellulose for bio-based nano-composites through functionalized interface engineering

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The abundant availability of cellulose resources and the favourable mechanical properties of its microfibrillated compounds make them as good candidate for reinforcing agents in biocomposites. However, problems in homogeneous dispersive and distributive mixing of the cellulose additives due to their highly hydrophilic nature often restrict the full capability of bio-based composites. Traditionally, surface modification of microfibrillated cellulose is often performed by introducing chemical moieties such as silanes, acrylates, vinyl etc. In view of developing a more sustainable and functional design of interface engineering, a new method is presented where nanoparticles including plant oil or wax are deposited onto the fiber surface and the required hydrophobicity can be controlled by thermal release of the hydrophobic moieties from the surface under thermal curing. In this work, the surfaces of microfibrillated cellulose are modified through decoration with poly(styrene-*co*-maleimide) nanoparticles that are synthesized in presence of with carnauba wax and soy oil. The fibers are added in an autoclave reactor together with the poly(styrene-*co*-maleic anhydride) precursors and ammonium hydroxide. During reaction, further fibrillation of the fibers together with the deposition of 20 – 100 nm nanoparticles onto the fiber surfaces is observed. Finally, a hydrophobic fibrous network is obtained with encapsulated hydrophobic agents. After thermal curing of the modified pulp fibers at temperatures of 125 to 250°C for different times, the gradual release of wax from the network is observed and final contact angles of 157° on the microfibrillated cellulose are measured. The modified fibers are characterized by thermal analysis (DSC, TGA, DMA) and chemical mapping by confocal Raman spectroscopy. The processing properties of the modified fibers are characterized by rotational rheometry. Finally, the beneficial properties of the modified fibers during melt-processing together with PLA result in an increase in mechanical properties for the composites with surface-modified fibers compared to the native fibers.

Biography

Pieter Samyn completed his PhD in Materials Science and Engineering at Ghent University (2007) and took several Post-doctoral research projects at Department of Textiles (Ghent), Department of Microcsystems Engineering (Freiburg) and was visiting professor at the Pulp and Paper Institute (Toronto). He is currently a Robert-Bosch Junior Professor at the University of Freiburg working on the processing of bio-based nanocomposites for coatings and structural applications. He has published more than 150 papers in the field of tribology, adhesion science and paper surface modification. He received a Heinz-Meier Leibnitz Price (2012) as excellent young researcher.

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