In-Line Processing of Nanocellulose / Polypropylene Composites Through Fibrillation in Twin-Screw Extrusion

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The fibrillated nanocellulose provides a favourable source of bio-based fibers with high mechanical strength and stiffness, but their processing and dispersibility in nanocomposite materials may be costly and problematic. The single batch processing of micro- or nanofibrillated cellulose under mechanical homogenization requires extremely high energy input and results in aqueous dispersions with low fiber consistency and are not feasible for further processing with a polymer matrix as they cannot be re-dispersed. Therefore, nanocellulose composites should be directly produced in a continuous one-step process without intermediate steps. This can be done by twin-screw extrusion of pre-swollen cellulose fibers, subsequent fibrillation and incorporation in a polymer matrix. In this study, it is illustrated how softwood cellulose pulp fibers are pretreated by swelling in a selection of alternative solvents, including a selection of ionic liquids (IL), deep-eutectic solvents (DES) and natural deep eutectic solvents (NADES). The influences of swelling media and conditions were studied in relation to the variations in fiber morphology and microstructure through electron microscopy, rheology, FTIR/Raman spectroscopy, XRD and thermal analysis. In a second step, the tendency for microfibrillation of the swollen cellulose fibers during extrusion was successfully demonstrated by morphological fractionation and rheological testing. The different fractions of the fibrillated particles were subsequently compounded with a polypropylene matrix. The efficiency of the continuous processing is illustrated by rheological methods and mechanical testing of the final nanocomposites, indicating improvement in mechanical properties of the nanocellulose-reinforced polypropylene after fibrillation in the continuous processing line.

Biography

Pieter Samyn studied from 1996-2001 Materials Science and Engineering at Ghent University (Belgium) and completed his Ph.D. in 2007 on polymer tribology. After post-doc positions at Department of Textiles (Ghent) and Department of Microsystems Engineering (Freiburg), he was appointed as a Juniorprofessor in Bio-based Materials Engineering at University of Freiburg (2010-2016). He moved to University of Hasselt in 2016, focusing on valorization of biomass for functional biocomposites and devices. In particular, he works on the processing of bio-based composites and papers providing new surface properties and technological functionalities, in combination with analytical service tools. He is currently involved in the implementation of biobased materials in functional coating applications for industrial applications at Sirris, Belgium.

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