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Biopolymer composites from high-cellulose pulps and/or nanocellulose

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Biocomposites from wood pulp nanofibres

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Abstract

Increasingly our society seeks an economy based on renewable resources (bio-based economy) with the goal of providing materials of high value and from renewable resources. One popular renewable resource is cellulose, or forest products in general. In this study, cellulose will be combined together with bio-plastics to produce granules of thermoplastic nano-biocomposites by melt processing. The intention is to get bio-based materials of high mechanical performance that can be shaped into complex geometries using widely used industrial melt-processes such as extrusion or injection molding.

Project criteria

- Industrial relevance and interests, potential for applications (packaging, molded industrial products).
- Thermoplastics for extrusion or injection molding.
- A larger proportion of biobased materials in thermo-plastics is desirable, “green” perspective, and improved mechanical properties.

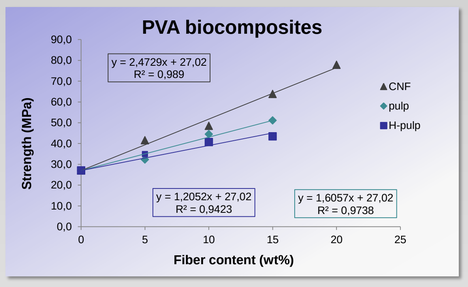
Scientific challenge

- What is the effect of cellulose fiber/fibril size? (processing and properties)
- Compatibility aspects (matching polymer-fiber, chemical pretreatment)

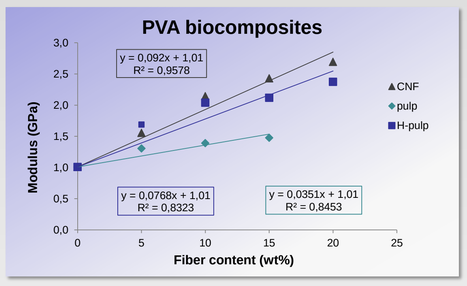
HYPOTHESIS: Pulp fibers can be chemically pretreated and then disintegrated in the mixing extruder, so that a high-performance biocomposite with well-dispersed nanofibres is obtained.

PVA biocomposites

PVA solution (Water soluble biopolymer) + PULP suspension → PRE-MIXING (Fiber hydrolysis) → Freeze-drying → Mini - extruder → Hot press / Inj. molding



Superior tensile mechanical performance for cellulose nanofibres with respect to dissolving pulp or hydrolyzed dissolving pulp.



In-situ fibrillation of pulp during extrusion

15% PULP	2 min	7 min	12 min	22 min
Modulus (GPa)	1,48	2,31	2,30	2,33
Strength (MPa)	51,11	50,26	59,39	58,91
Strain at max. (%)	9,69	4,28	4,32	4,56

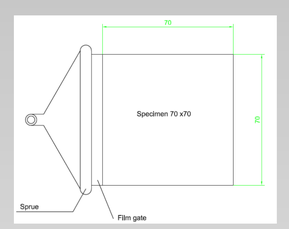
15% H-PULP	2 min	7 min	12 min	22 min
Modulus (GPa)	2,12	2,14	2,57	2,55
Strength (MPa)	43,40	48,76	48,46	48,59
Strain at max. (%)	4,16	4,27	3,18	3,21

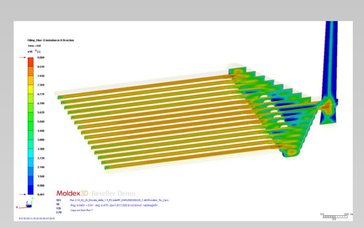
The fiber hydrolysis helps the *in-situ* fibrillation process of pulp fibers, however the extent of the hydrolysis shortened the fiber length and reduced their reinforcing capacity.

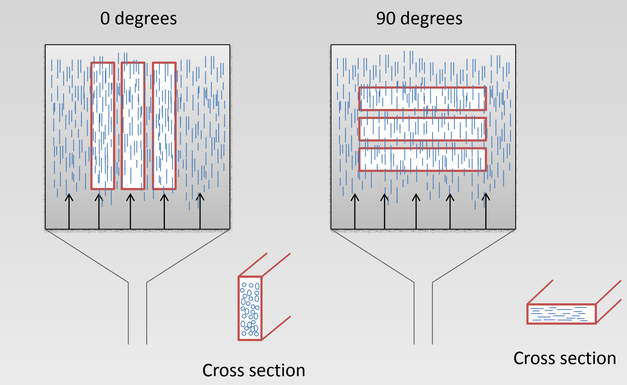
PP biocomposites

Fiber Anisotropy in PP Composites during injection molding

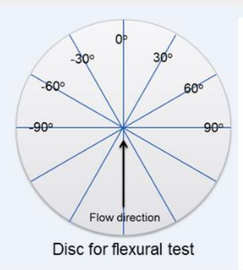
A film-gate injection molding plate promotes the orientation of the fibre/nanofibre reinforcement.

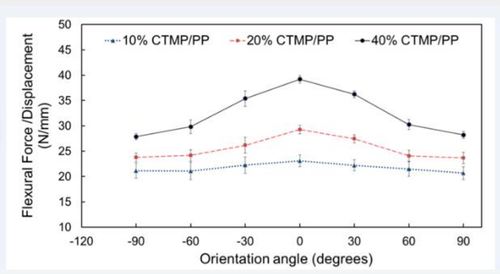


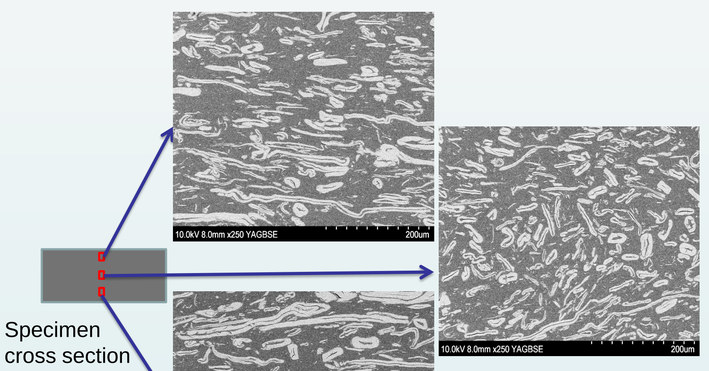




Bending properties at different fiber orientation angle







The fiber orientation factor is higher near the mold surface. While fibers at the surface are highly oriented towards the injection flow, they tend to be transverse to the flow in the bulk inner section.
This explains the behavior under bending stress.

CONTACT INFORMATION

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