Conversion of agricultural waste, sludges and pulp residues into nanofibers for innovative polymer composites

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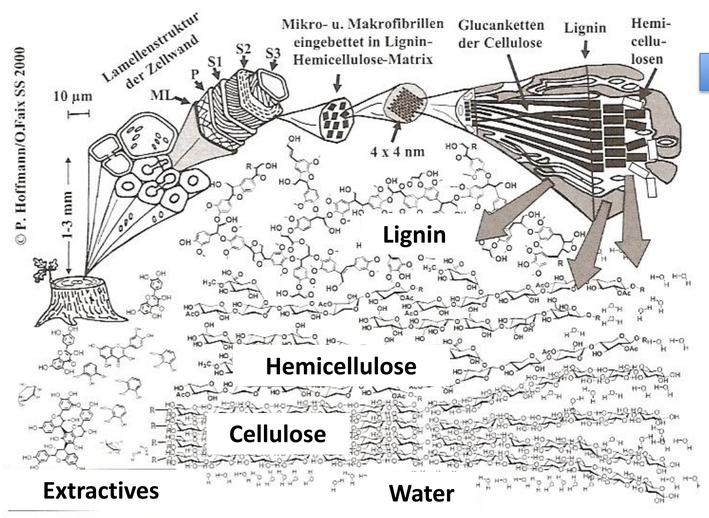
Abstract

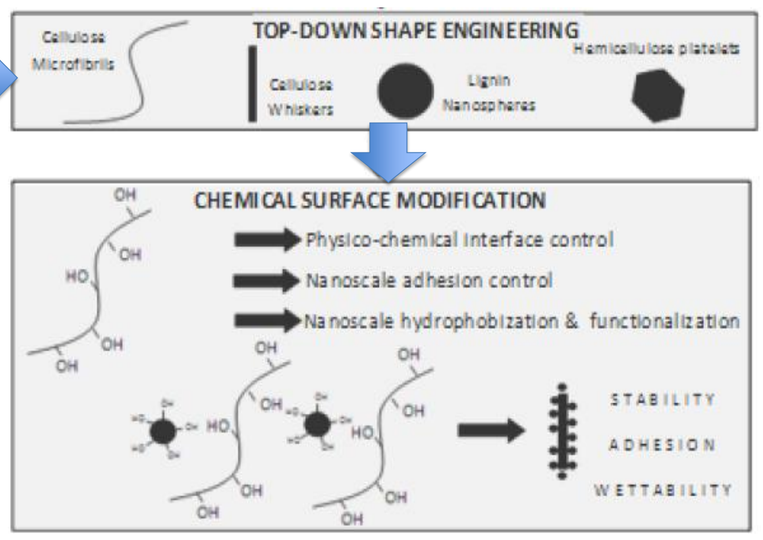
Agricultural waste fractions from seasonal crops (corn stover, bagasse, flax), sludges and paper pulp residues contain an important source of lignocellulosic materials that can be recovered and used as material fractions instead of being burnt for energy recovery. Due to the heterogeneity of named products, however, novel processing routes should be developed for the ***recovery of the lignocellulosic materials at nanoscale***. Therefore, we will use nanotechnological routes to transform the residues into nanoscale fibers, such as fibrillated cellulose and cellulose nanowhiskers.

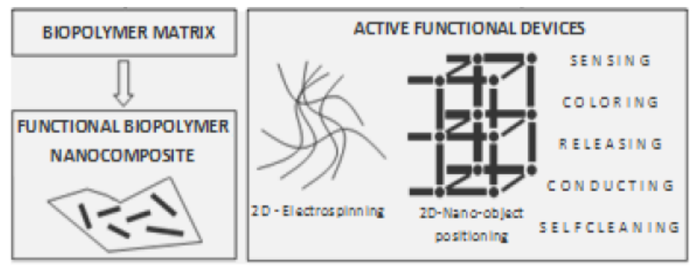
In first part of the project, we will inventory available residual streams and make full chemical and physical characterization of the available sources in order to be able to categorize them and getting insight in their heterogeneous properties. Based on this, the ***processing conditions for the transformation of the lignocellulosic fractions into novel nanoscale building-blocks with different geometries*** will be studied and optimized. Therefore, either mechanical or chemical conversion routes will be investigated. In particular, we will apply novel "green" solvent techniques for the conversion and separation of cellulose and lignin fractions. It is the goal to define optimum processing conditions for reproducible conversion of the biomass.

In second part of the project, the produced materials will be used as fillers and processed in combination with different bio-based polymers such as PLA (resulting from side-fractions of corn) in order to act as a reinforcement or active filler. Therefore, we will study and optimize the processing conditions for extrusion of the nanocomposite materials. Finally, we consider to build a ***valorization model for innovative and high-valued composite nanomaterials*** from named residues can contribute to a more sustainable development.

Technological Roadmap







Selection of residual fraction → **Conversion and Processing** → **Application**

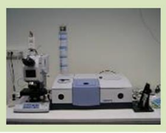
Project Context

Task 1: Residual biomass inventarization and characterization

Elemental Analysis
AAS
ICP-OES
ICP-MS
XRF

Chromatography
IC
GC GC-MS
HPLC
GPC
LC-MS

Spectroscopy
NMR
FTIR
UV-VIS-NIR
MS
Raman



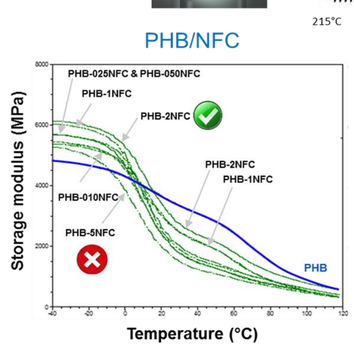
Rheology
Plate
Cone

Thermal Analysis
DSC TGA
DMA TMA

Coupled Techniques
Headspace-, thermal desorption-, pyrolysis – GC-MS, IC-ICP-MS
FT-IR microscopy
TG coupled techniques TG-FT-IR,TG-MS, TG-TD-GC-MS

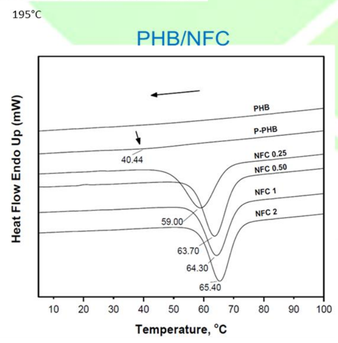
PHB/NFC

PHB/NFC

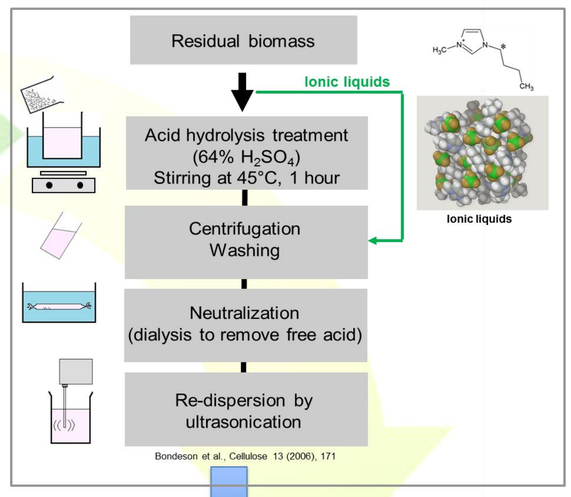


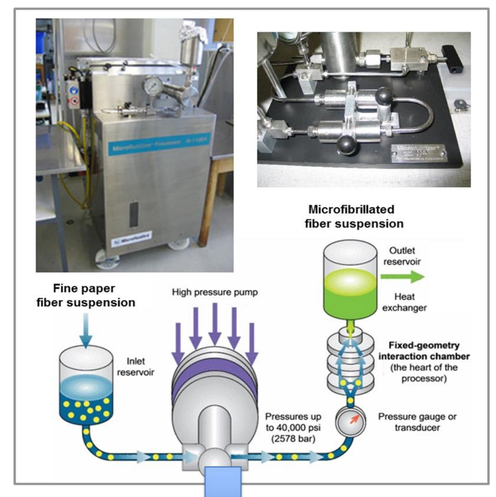
Task 4: Processing & characterization innovative products

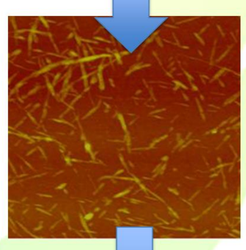
PHB/NFC

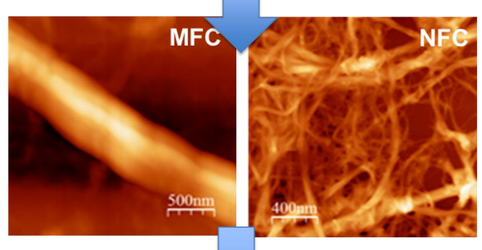


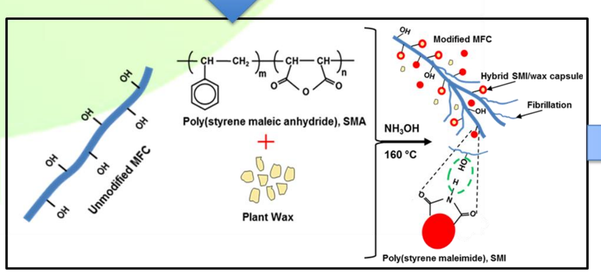
Task 2: Nanotehnological Conversion

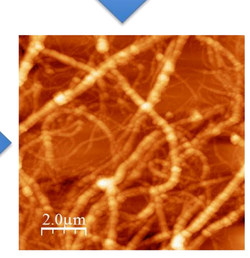












Task 3: Surface Modification

What we offer…

- Characterization of biomass & innovative products
- Lab-scale processing
- Material functionalization
- Application-oriented research and industrial services

What we are searching for…

- Residual biomass sources
- Pulp and paper companies
- Polymer compounders & processing
- Textile industries