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Ph.D. thesis (2018-2021)
LGP2 (D. Beneventi; D. Chaussy)

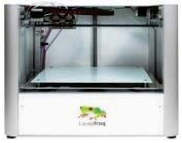
Multi-material 3D printing of a structural bio-based and functional object from the lignocellulosic biomass

Impression 3D multi-matériaux d'un objet fonctionnel à base de la biomasse ligno-cellulosique

Context

Three-dimensional (3D) printing is a revolutionary manufacturing technology:

- low material loss;
- complexity of the object ≠ its cost.
- easy cost-effective product customization;
- one machine ➔ infinity of objects.



Cellulose, the most abundant bio-based material, is used for 3D printing. However many challenges remain:

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Many researches has been conducted to **3D print composites** yet:

- the thermoplastic used have poor thermal and mechanical performances;
- photo-cured resins are costly.
- the material is petro-sourced.

Bio-based thermosetting resin with cellulose ➔ Bio-based and cost-effective material with good performances.

1 Håkansson et al., « Solidification of 3D Printed Nanofibril Hydrogels into Functional 3D Cellulose Structures ».

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Methods

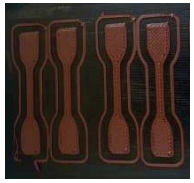
Materials characterization

- Oligomer analysis with RMN and FTIR.
- Size distribution and morphology of the cellulose.

Ink formulation

- Thermosetting bio-based resin
- Cellulose powder or Nanofibers
- Solvent and catalyst

3D-Printing by extrusion



Material and paste characterization

Rheology

DMA

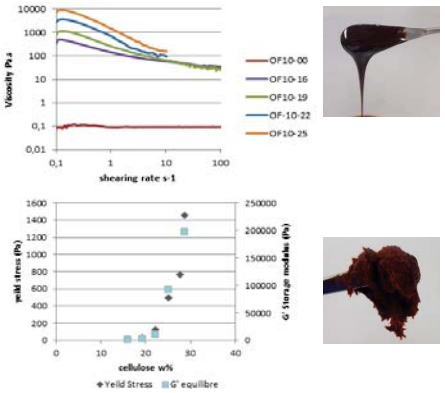
Microscopy

TGA

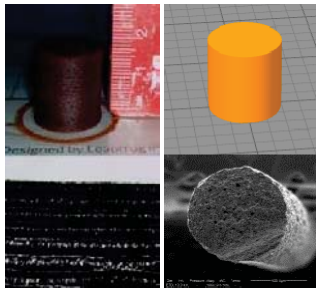
- Printability assessments
- Thermal and mechanical performances
- Morphology and printing quality

Results

Rheology of pastes



Shape fidelity and shrinkage



- Shape fidelity.
- Shrinkage < 5%.
- Porosity.

- Printable and extrudable.
- Porosity and printing limitations.

Thermal performances

- Good thermal properties.
- Possibility of carbonisation.