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Ph.D. thesis (2017-2021)

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Biomimicry for Tissue Engineering via 3D-Printing of Nanocellulose-Collagen Bioink

Biomimétisme pour la conception de tissus organiques par impression 3D de bio-encres de nanocellulose et collagène

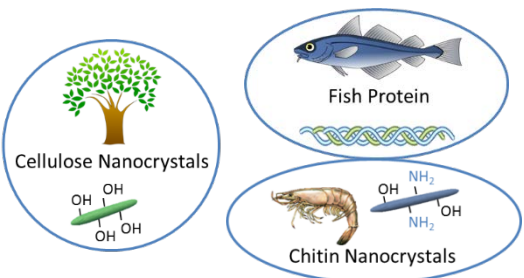
Context

Biomedical 3D-printing

An evolving ground-breaking technology

- Growing community
- High demanded potential applications
- Great diversity of materials and processes

Advantages of collagen and nano-cellulose/chitin



- Bio based and bio mimicking materials
- High surface area
- Surface chemistry
- Mechanical properties

Characterizing printability

- Numerous softwares, hardwares, inks
- Lack of standards
- Need for comparison tools

Methods

3D-printing Processes

Screen-printing

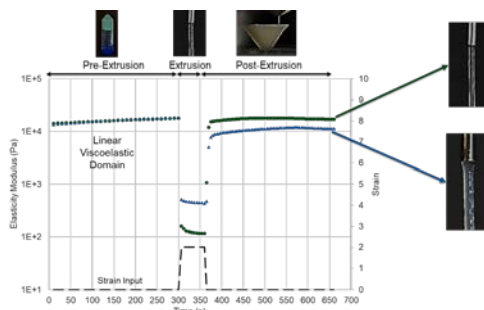
Speed: 20 mm/s
Resolution \approx 100 μ m
Inks with >80 wt%



Commercial 3D-printers + prototype (PFR)

Rheology

- Classic rheology (amplitude, frequency sweeps and flow curves)
- Recovery rheology (recovery after shear/strain impulsion)
- Temperature sweeps



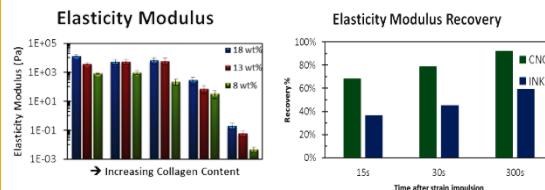
Printability Tools

- TAXT
- Photography
- Line Printing

Results

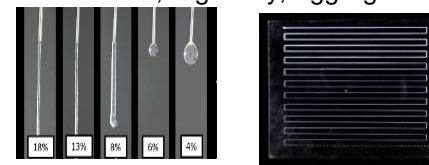
Synergy Study

- Difference diluted/concentrated
- No phase separation at high concentration
- Interpenetrating networks



Printability Assessment

- Filament quality, opacity, roughness
- Pressure, speed, stabilization time
- Line width, regularity, aggregates



Formulation and 3D-printing

- Challenging shapes printing
- Multimaterial printing
- Post-processing cross-linking

