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Ph.D. thesis (2018-2021)

LGP2 (N. Belgacem)

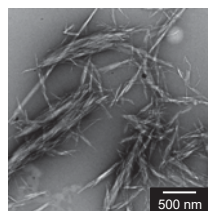
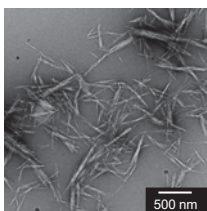
Green chemistry to produce modified nanocellulose with new high-added value functions.

Modification de la cellulose par des voies de chimie verte pour obtenir des nanocellulose à haute valeur ajoutée.

Context

Nanocellulose

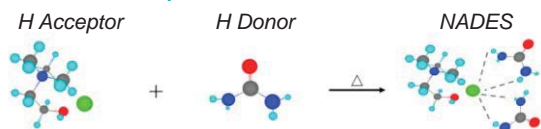
- Polymer from biomass
- Surface chemistry reactivity
- High surface area
- Cellulose Nanofibrils & Nanocrystals



Cellulose nanocrystals obtain by ChCl:OAD treatment

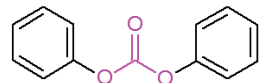
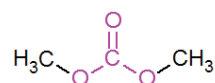
Green reactive solvents

Natural Deep Eutectic Solvents: NADES



- ChCl : Citric Acid Monohydrate 1:1
- ChCl : Oxalic Acid Dihydrate 1:1
- ChCl : Urea 1:2

Carbonate Ester



Objectives

Green Chemistry

12 principles including:

- Safer solvents & reaction conditions
- Safer chemicals & products
- Use of renewable feedstocks
- Use of catalysts



Easy obtention of nanocellulose

- Less energy consumption
- Fast processes
- Efficient pretreatment with reactive solvents

High added value nanocellulose

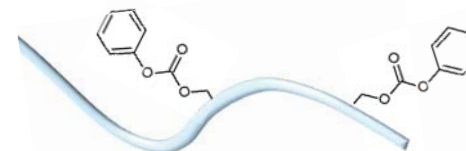
- *Hydrophobic nanocellulose*
- *Stimuli responsive polymers grafting*
- *Antimicrobial effect*
- *Flame retardant properties*



Methods

Grafting of new functions

- Flame retardant properties
- Stimuli responsive
- Hydrophobic nanocellulose

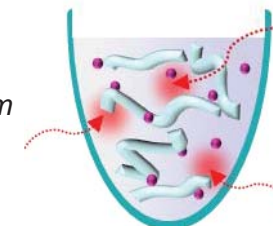


Grafting with intensive processes

- *In situ microwave chemistry*
- Reducing of reaction time
- Improving reactivity

$$2 \text{ mm} < \lambda < 30 \text{ cm}$$

$$E = h \cdot \nu$$



- *Use of catalyst*
- Selective reaction
- Reduction of reaction time
- *Plasma-assisted surface grafting*

