Manon LE GARS
Ph.D. thesis (2017-2020)
LGP2 (J. Bras, N. Belgacem)
ICMMO (P. Roger)

Biobased High Gas and Vapor Barrier Polymers for Packaging

Polymères biosourcés hautement barrières aux gaz et vapeurs pour l'emballage

Context

Cellulose Nanocrystals (CNC)

- **Cellulose**: most abundant renewable material in the biosphere.
- **CNC**: obtained by **acid degradation** of amorphous part of NFC (obtained by mechanical defibrillation of the cellulose)
- High **mechanical** and **barrier** properties, **fillers** in polymers matrix

Packaging materials

- Nowadays, major innovations : **biobased** / **biodegradable** polymers and **high performance** nanocomposites
- Need of replacing non-renewable petrol-based materials
- **Polylactide Acid (PLA)** : research aims to enhance its barrier properties

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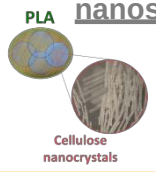
But : Low compatibility of CNC with PLA

Developpement of PLA based films including cellulose nanostructures with designed properties

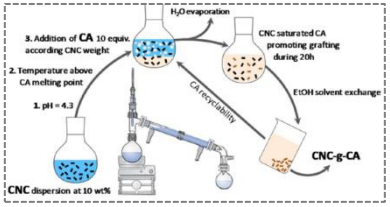


Funded by Agence Nationale de la Recherche ANR

Methods

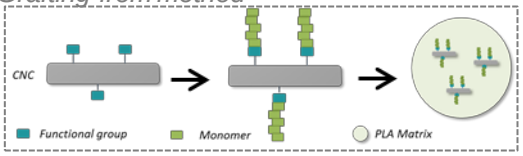
Chemical modifications of CNCs

SolReact method



Etzael Espino-Pérez et al., « Green Process for Chemical Functionalization of Nanocellulose with Carboxylic Acids », Biomacromolecules, 2014,

Grafting-from method



Antioxidant activity / Nanoadsorber

- DPPH test
- O_2/H_2O sorption

Nanocomposites

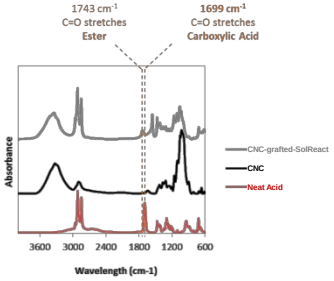
- Lab scale / Pilote scale
- Respect of industrial constraints
- Packaging design
- Barrier properties

Collaborations

- GENIAL (INRA)
- IMP (LYON 1)
- PIMM (CNAM)
- ICMMO (Univ. Paris Sud)
- WIPAK
- CGL PACK
- PBS (Univ. Rouen)

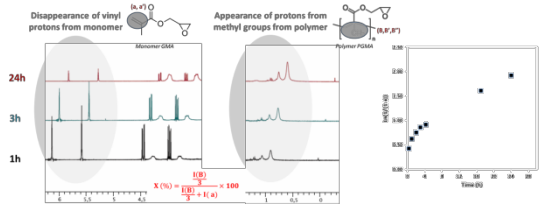
Results

Grafting of fatty acid on CNCs

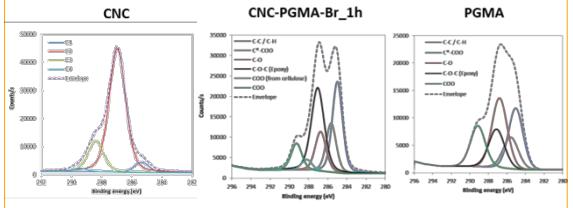


FTIR spectra of grafted CNCs → proof of grafting

SI-ATRP of GMA on CNCs



Kinetic study by ^{1}H-liquid NMR → proof of the polymerization



XPS → Presence of PGMA at the surface

Conferences:

Le Gars, M & al., ACS National Meeting & Exposition, New Orleans, LA, United States, March 2018 *(Oral Presentation)*