

Nanocellulose : applications in food?

Bernard Cathala

French National Research Institute
INRA, Nantes, France

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Nanocelluloses and food

Nanocellulose research and applications are almost exclusively dedicated to non-food applications

However, to be fully enlarge, the market of NC should be extended to all kind applications

What applications in food sector for nanocellulose?

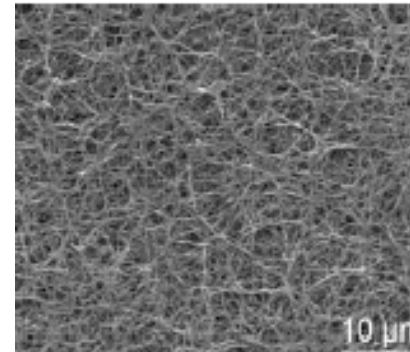
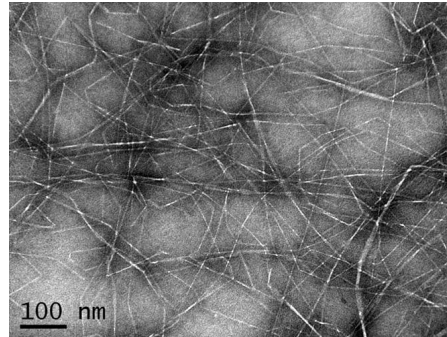
- Already existing uses of nanocellulose in food : bacterial cellulose
- Tehchnological properties of NC : thickening, gelling and water binding agent, emulsions.
- New applications ?

What are the limitations?

Nanocelluloses

- 1) TEMPO oxidation or enzymatic pretreatment
- 2) Mechanical treatment

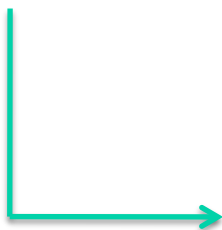
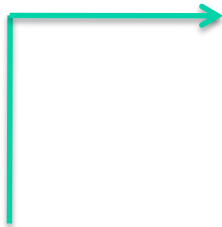
Cellulose nanofibrils (CNF)



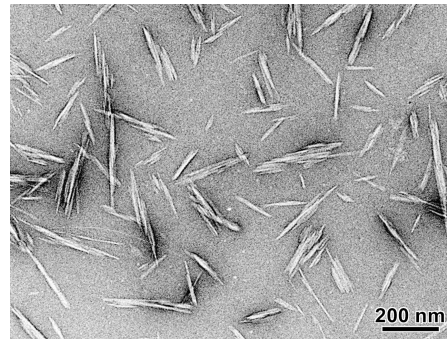
Bacterial cellulose (BC)

Low molecular weight sugars, alcohol, ...
← Fermentation

Cellulose :
wood, cotton,
alga,



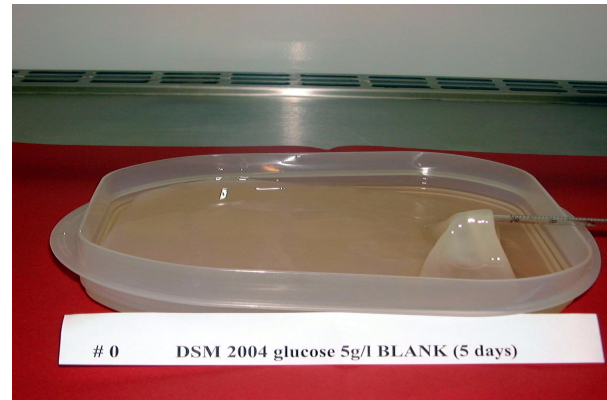
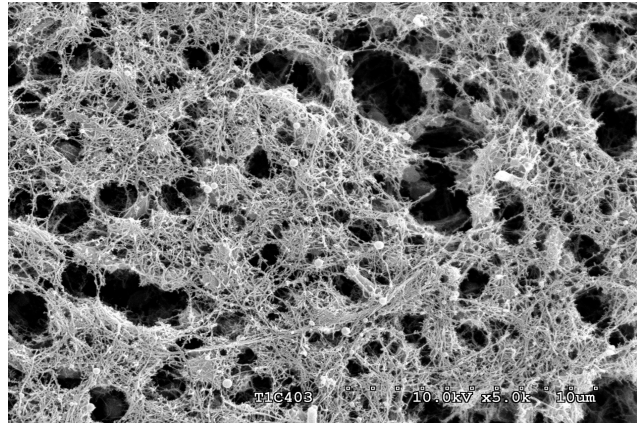
Acid hydrolysis



Cellulose nanocrystals (CNC)

Bacterial cellulose

Bacterial cellulose is a microbial polysaccharide at high purity level.
Recognized as GRAS food ingredient by FDA



- Already used in commercial products : Nata de coco
- Various shapes can be obtained from different carbon sources
- BC dispersions have pseudoplastic viscosity
- BC is a biodegradable, dimensionally stable thickener (stable against temperature and salt addition)
- Low-calorie and cholesterol lowering effect

For review : Shi Z et al., Food Hydrocolloids 35, p 539 (2014) / Omoto and al., handbook of hydrocolloids p321, CRC Ed

Nanocelluloses as food additives

BC and NFC due to the three-dimensionnal structure display thickening, gelling and water binding properties

- Theses properties can be successfully used in various food products¹:

- Adding nata to meat paste has been proposed as a viable replacement for fat in Chinese-style meatballs²

- NFC addition to hamburger reduce the weight loss after frying whitout any side effect on taste.³

- NFC have a favourable effect on baked bread (softer texture and better appearance). Lower content of NFC compared to starch for similar effect. ³

(1) Suspensions containing microfrillated cellulose US Patent 4,487,634 D11, 1984.

(2) Lin, K. W., & Lin, H. Y. Quality characteristics of Chinese-style meatballcontaining bacterial cellulose (Nata). Journal of Food Science, 69(3), Q107 Q111, 2004

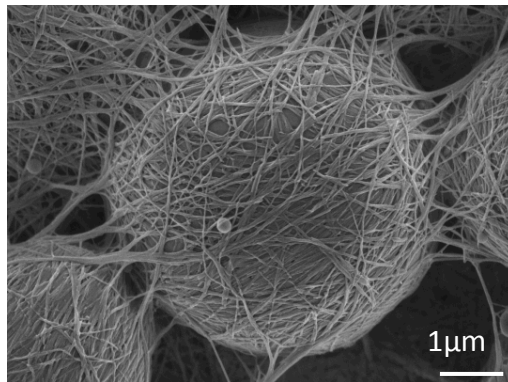
(3) Innventia report 403 : Nanocellulose as an additive in foodstuff, June 2013

Nanocelluloses in food application

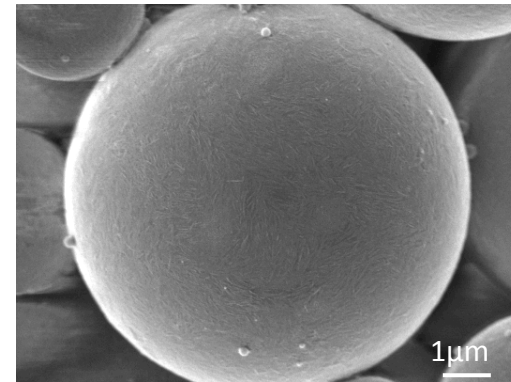
BC, NFC and CNC can stabilize emulsions

- Stable over long period, pH 2-10, T°, ..
- Low amount of NC are required due to irreversible adsorption

BC and NFC yield 3D network¹



CNC based Pickering emulsions²



(1) Suspensions containing microfibrillated cellulose US Patent 4,487,634 D11, 1984. Lightweight and Strong Cellulose Materials Made from Aqueous Foams Stabilized by Nanofibrillated Cellulose, Wågberg et al., Biomacromolecules, 14, 503-511, 2013

(2) New Pickering Emulsions Stabilized by Bacterial Cellulose Nanocrystals (BCN). Kalashnikova, I., et al Langmuir, 27, 7471-7479, 2011; Cathala, B. et al, Patent WO2012/017160, 2010.

Nanocelluloses new development

-High internal phase emulsions : up 95% of oil with tunable texture

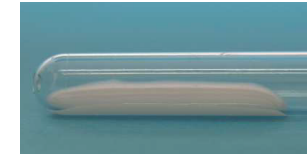
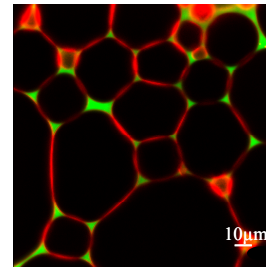
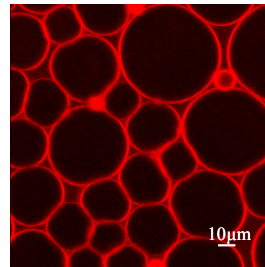
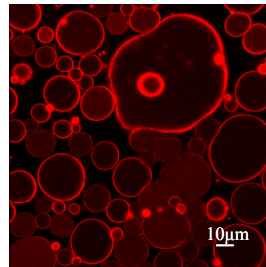
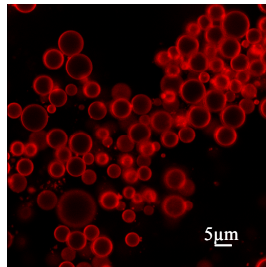
Increasing the oil content

30 %

45 %

72 %

84 %

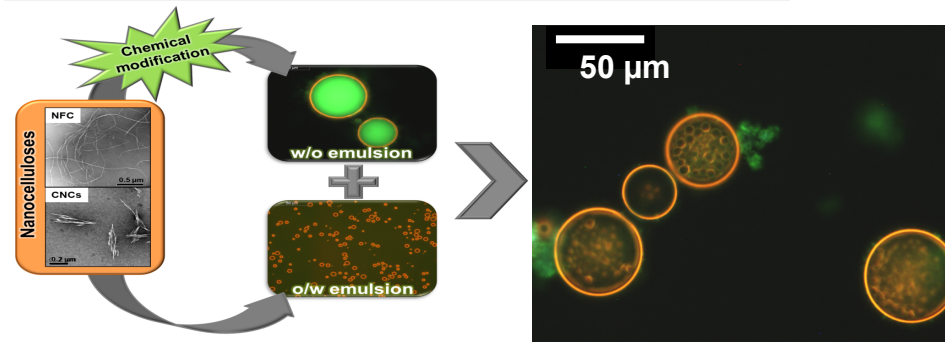


Neutral CNC



Charged CNC

-Double emulsions



(1) Surfactant-free high internal phase emulsions stabilized by cellulose nanocrystals, I. Capron and B. Cathala Biomacromolecules, 14 (2), pp 291–296, 2013; Capron, I., et al patent WO2013/001189

Reglementary status

In US Bacterial Cellulose has been recognized as GRAS since 1992

In EU, cellulose is accepted as food ingredient :

- microcristalline cellulose (E 460) ou cellulose derivatives (E 461-69)

What will be the status of Nanocellulose?

- BC is a microbial polysaccharide
- NFC/CNC : novel food or E 460?

Nano concerns in EU

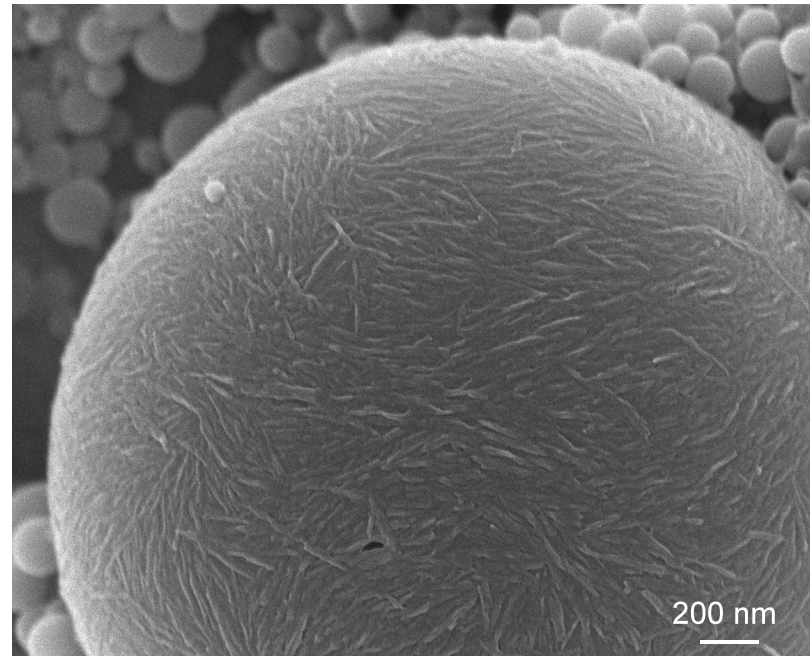
- Declaration requirment in France since one year. Belgium, Italie, Denmark, UK and Germany are on the way. Nancellulose?
- Safety evaluation

Summary and perspectives

NC can be efficient food additives :

- Higher functionalities with lower dose can be expected
 - Mostly dimensionnaly stable (pH, ionic strenght, T°)
 - Thickening, gelling, water binding properties and emulsions stabilizing agent
 - Low-calorie and cholesterol lowering effect
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- Devellop research targets
 - NC fabrication process to food applications
 - Technological and nutritional properties evaluation
 - New products
 - Tacle the question of NC reglementary status in food applications

Thanks for your attention



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