POSSIBLE APPLICATIONS FOR NANOCHELULOSE IN PACKAGING

2013-11-18 | Mikael Ankerfors
NOMENCLATURE

Microfibrillated cellulose (MFC) - Original name since the 1980’s

Nanocellulose = Collective name for all types of nanocellulose. Used for this material the last 7 years.
  - Other nanocelluloses are NanoCrystalline Cellulose (NCC) and Bacterial NanoCellulose (BNC)

Nanofibrillated cellulose (NFC) = new name started to be used 5-6 years ago

Cellulose nanofibrils (CNF) = has been around for over 15 years, but poorly used. This is however now the suggested standardized name for the material.
  - In the same standardization NCC is coild cellulose nanocrystals (CNC)
Elementary fibril aggregates in wood-fibres

ORGANISATION OF CELLULOSE IN FIBRES

Adapted from: Rowland and Roberts 1972

Fibril/fibril aggregate Ø~20±10nm ~3^2-7^2 microfibrils

Microfibril/Elementary fibril Ø~4nm ~30-40 cellulose chains

A) Coalesced high order surface
B) Readily accessible slightly disordered surface
C) Readily accessible surfaces of strain-distorted tilt and twist regions
WHY IS IT INTERESTING?

MFC IN THE 1980’S
Energy consumption = 30000 kWh/tonne


MAJOR PROBLEMS

- Extensive clogging
- High energy consumption (over 30000 kWh/tonne)
ENZYME-BASED PRE-TREATMENT

Energy consumption = 1000-2000 kWh/tonne
Energy reduction = 93-97 %
ENZYME-BASED MFC

MFC gel
2 w-%
ANOTHER PRE-TREATMENT

Energy consumption = 500-2000 kWh/tonne
Energy reduction = 93-98 %
MFC gel
2 w-%

MFC gel
7 w-%
CRYO-TEM IMAGE OF CHARGED MFC

SHEAR THINNING BEHAVIOUR OF MFC – EFFECT OF CONCENTRATION

FILM OF CHARGED MFC

STRESS-STRAIN CURVES FOR FILMS OF DIFFERENT MFCS

<table>
<thead>
<tr>
<th>Pulp</th>
<th>Stress at brake [MPa]</th>
<th>Young’s Modulus [GPa]</th>
<th>Strain at break [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanopaper</td>
<td>~200</td>
<td>10-20</td>
<td>6-12</td>
</tr>
<tr>
<td>Unbl. kraft</td>
<td>64</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Bl. kraft SW</td>
<td>54</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Bl. kraft HW</td>
<td>34</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Newsprint</td>
<td>16</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ground wood</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

"Nanopaper": Strongest cellulose-based material made by man


MFC USED AS DRY STRENGTH AGENT – OLD NEWS

MFC wet-end *addition* to CTMP

MFC IS INTERESTING FOR PAPER APPLICATIONS

- As a dry strength agent
- As an oxygen barrier material for packaging
- As an additive in coatings
- As a surface strength agent to reduce linting and dusting
NFC COATINGS ON BOARD

Reference

1 g/m² NFC

1.8 g/m² NFC

Renewables have low impact
Board is 75% of weight but only 20% of CO₂ impact
COMPARISON OXYGEN AND WATER VAPOUR PERMEABILITY FOR DIFFERENT MATERIALS

STARCH/GLYCEROL/MFC NANOCOMPOSITE

Source: Svagan, A.J., Azizi Samir, M.A.S., Berglund, L.A. Biomimetic Polysaccharide Nanocomposites of High Cellulose Content and High Toughness. Biomacromolecules (2007); 8(8); 2556-2563.
MECHANICAL PROPERTIES PLA-MFC NANOCOMPOSITE

![Stress-Strain Curve](image)

25 wt% MFC
40 wt% MFC
60 wt% MFC
100 wt% MFC

POTENTIAL USES FOR MFC IN PACKAGING

- Bio-nanocomposites in screw cap and/or top
- NanobARRIER inside the bottle
- Dry strength agent in board
- Rheology modifier in the food product
THANK YOU

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