From barrier materials to biosourced packaging

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Borregaard – world’s most advanced biorefinery

From barrier materials to biosourced packaging/ L.Crowther-Alwyn & A. Karppinen / 31.05.18
Exilva - A new product from Borregaard

- Microfibrillated Cellulose (MFC)
- High available surface area with functional OH groups – new, exciting properties

Source: Harrington (1996)
Univ. Of Canterbury
Exilva - Properties

- 3D network of flexible microfibril aggregates
- Interesting rheological properties
  - Highly shear thinning
  - High viscosity at rest
  - Fast viscosity recovery
- Very high water holding capacity
- Good film forming and barrier properties
- Non-toxic, environmentally friendly and a 100% bio-based product
The Exilva industrial plant

• New production facility
  – Capex 23 M€
  – Initial capacity 50 000 tons (as 2%), designed for easy expanding
  – Production started in Q3-16
  – Location: Sarpsborg, Norway

• Received grant from BBIJU (EU H2020) as a flagship project
  – 25 M€ over 3 years (May 2016-April 2019)
  – Aiding on commercialization phase of Exilva
Main objectives of Work Package 2

- Liquid water, Water vapour barrier
- \(O_2\), Contaminants barrier
- Heat sealable
- Recyclable, Compostable
- High Stiffness for a lower basis weight
- Grip improvement

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Barrier properties

- MFC has better oxygen and oil barrier properties than many common packaging materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Relative humidity (%)</th>
<th>Oxygen permeability (cm³·μm)/(m²·d·kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFC</td>
<td>0</td>
<td>0.011</td>
</tr>
<tr>
<td>MFC</td>
<td>50</td>
<td>3.52-5.03</td>
</tr>
<tr>
<td>PET</td>
<td>50</td>
<td>10 - 50</td>
</tr>
<tr>
<td>PLA</td>
<td>0</td>
<td>184</td>
</tr>
<tr>
<td>LDPE</td>
<td>50</td>
<td>1900</td>
</tr>
</tbody>
</table>

Influence of MFC grade

• 1 reference from CTP
  – MFC-CTP KB3P

• 4 Exilva products:
  – Exilva 1
  – Exilva 2
  – Exilva 3
  – Exilva 4

Increasing degree of fibrillation
MFC characterization

MFC-CTP KB3P

Exilva 1

Exilva 2

Exilva 3

Exilva 4
# Barrier properties of the MFC films

<table>
<thead>
<tr>
<th>Sample</th>
<th>Grammage (g/m²)</th>
<th>Thickness (µm)</th>
<th>density (calculated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFC-CTP KB3P</td>
<td>51 ±1</td>
<td>47</td>
<td>1.09</td>
</tr>
<tr>
<td>Exilva 1</td>
<td>50 ±1</td>
<td>50</td>
<td>1.00</td>
</tr>
<tr>
<td>Exilva 2</td>
<td>52 ±1</td>
<td>51</td>
<td>1.01</td>
</tr>
<tr>
<td>Exilva 3</td>
<td>51 ±1</td>
<td>48</td>
<td>1.06</td>
</tr>
<tr>
<td>Exilva 4</td>
<td>52 ±1</td>
<td>45</td>
<td>1.14</td>
</tr>
</tbody>
</table>

Increasing degree of fibrillation

**Cobb, oil, 60s**

- MFC-CTP KB3P: 0.3 g/m²
- Exilva 1: 0.4 g/m²
- Exilva 2: 0.5 g/m²
- Exilva 3: 0.2 g/m²
- Exilva 4: 0.1 g/m²

**OTR, 23°C 50%RH**

- MFC-CTP: 2.5 cm³/m².d.bar
- Exilva 1: 1.5 cm³/m².d.bar
- Exilva 2: 1.0 cm³/m².d.bar
- Exilva 3: 2.0 cm³/m².d.bar
- Exilva 4: 1.5 cm³/m².d.bar
Self-standing MFC films

MFC-CTP KB3P

Exilva 1

Exilva 2

Exilva 3

Exilva 4
Mechanical properties of the MFC films

- Stress at break (MPa)
- Strain (%)

- MFC-CTP KB3P
- Exilva 1
- Exilva 2
- Exilva 3
- Exilva 4
Conclusions

- Exilva, commercially produced MFC, can form films with outstanding barrier to oxygen and oil and probably to mineral oil.

- The SHERPACK project will demonstrate the possibility to produce packaging materials that are biobased, recyclable, biodegradable, high barrier, including to mineral oils.