INFLUENCE OF NATURAL FIBRE TYPE IN ECO-COMPOSITES

Bordeaux, 27 March 2007

Dr. Míriam García
ECO-COMPOSITES

INTRODUCTION

BIOPOLYMER
PETROLEUM DERIVED POLYMER

WOOD
ANNUALLY GROWN PLANTS (PRODUCTS OR SUBPRODUCTS)
INTRODUCTION

Wood fibre

Rice husks

kenaf
### Competitors

- **Wood Fibre Composites**
  - Talc or mica composites

- **Long natural fibre composites**
  - Glass fibre composites

### Natural Fibres vs Glass Fibres

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower specific weight (1.25-1.50 vs 2.6 g/cc)</td>
<td>Lower impact strength</td>
</tr>
<tr>
<td>Price</td>
<td></td>
</tr>
</tbody>
</table>
Advantages of eco-composites vs typical composites

- Biodegradability
- Price

Advantages of eco-composites vs wood

- Dimensional stability
- Durability against fungi and insects
- Processability like plastics
Kenaf eco-composites: fibres increase stiffness of the polymer

Rice husks eco-composites: rice acts as a filler
BIOPOLYMER + RICE HUSKS OR KENAF

KENAF

L/D = 50

RICE HUSKS

L/D = 3.5
## CHARPY IMPACT STRENGTH

<table>
<thead>
<tr>
<th>Fibre content (%)</th>
<th>Unnotched impact strength (J/m)</th>
<th>Notched impact strength (J/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kenaf</td>
<td>RS</td>
</tr>
<tr>
<td>0</td>
<td>76±6</td>
<td>76±6</td>
</tr>
<tr>
<td>20</td>
<td>47±4</td>
<td>33±7</td>
</tr>
<tr>
<td>30</td>
<td>52±3</td>
<td>36±4</td>
</tr>
</tbody>
</table>
BIOPOLYMER+RICE HUSKS OR KENAF

FIRE TESTS

Burning Time (s)

0 5 10 15 20 25
PLA KENAF:KENAF/FR 10% RS RS/FR 10%

10% FR

DURABILITY

Eco-composites without pigment
500h QUV
Chalking, bleaching and cracking

Eco-composites with 4% pigment
1500h QUV

Eco-composites without pigment
500h QUV
Chalking, bleaching and cracking
<table>
<thead>
<tr>
<th>Ageing Time (h)</th>
<th>E (MPa)</th>
<th>σ (MPa)</th>
<th>ε (%)</th>
<th>Ageing Time (h)</th>
<th>E (MPa)</th>
<th>σ (MPa)</th>
<th>ε (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 h</td>
<td>5800±250</td>
<td>87.8 ±11.3</td>
<td>2.4 ±0.2</td>
<td>0 h</td>
<td>4100±150</td>
<td>77.9 ±8.8</td>
<td>3.3 ±0.3</td>
</tr>
<tr>
<td>500 h</td>
<td>5900±250</td>
<td>69.1 ±6.6</td>
<td>1.5 ±0.2</td>
<td>500 h</td>
<td>4600±300</td>
<td>54.1 ±11.9</td>
<td>1.6 ±0.2</td>
</tr>
<tr>
<td>1000 h</td>
<td>5200±250</td>
<td>32.0 ±7.5</td>
<td>1.0 ±0.1</td>
<td>1000 h</td>
<td>4200±550</td>
<td>29.5 ±8.1</td>
<td>1.0 ±0.5</td>
</tr>
<tr>
<td>1500 h</td>
<td>4900±540</td>
<td>29.6 ±14.6</td>
<td>1.0 ±0.2</td>
<td>1500 h</td>
<td>4000±200</td>
<td>14.8 ±9.0</td>
<td>1.0 ±0.5</td>
</tr>
</tbody>
</table>

Retaining of flexural properties: stiffness at low deformation levels is maintained.
CONCLUSIONS

Kenaf eco-composites give rise to better mechanical performance than rice husk eco-composites.

In non load-bearing applications, the low price of rice husks can compensate for the lack of mechanical improvement.
WPC
HDPE+WOOD
WPC
PROCESSING
DIRECT INJECTION

VARIABLES

WOOD FIBRES
Fibre A L=300-500 µm
Fibre B L=100 µm

INJECTION PRESSURE

FIBRE CONTENT

DIRECT INJECTION
Increases in the stiffness and the strength with fibre content
Injection pressure has no effect
B fibre: results independent of fibre content
Results for 30% A fibre ≅ 20% B fibre

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>MICA 25%</th>
<th>TALC 30%</th>
<th>TALC 40%</th>
<th>GLASS FIBRE 30%</th>
<th>WOOD FIBRE 20%</th>
<th>WOOD FIBRE 40%</th>
<th>FIBRE A 30%</th>
<th>FIBRE B 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile modulus (MPa)</td>
<td></td>
<td></td>
<td>3100</td>
<td>3510</td>
<td>1700</td>
<td>2700</td>
<td>1635</td>
<td>1700</td>
</tr>
<tr>
<td>Tensile strength (MPa)</td>
<td></td>
<td></td>
<td>34.5</td>
<td>32.4</td>
<td>20.7</td>
<td>23.4</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Flexural modulus (MPa)</td>
<td></td>
<td></td>
<td>2000</td>
<td>2137</td>
<td>2410</td>
<td>3020</td>
<td>1400</td>
<td>2400</td>
</tr>
<tr>
<td>Flexural strength (Mpa)</td>
<td></td>
<td></td>
<td>44.8</td>
<td>46.9</td>
<td>37</td>
<td>26.2</td>
<td>31</td>
<td>35</td>
</tr>
</tbody>
</table>
CONCLUSIONS

Stiffness of the injected eco-composites is comparable to commercially available filler filled composites, while strength is comparable to both filler and glass fibre filled commercial composites but with much innocuous environmental performance.
CONCLUSIONS

Annually grown plants
Aspect ratio of the fibres plays a key role: the higher the aspect ratio the higher the mechanical properties.
Price of the materials can be easily reduced with the addition of agricultural subproducts for i.e. decorative appliances.

WPC
Composites can be easily obtained by direct injection moulding up to almost 70% in volume.
Mechanical performance is fibre content dependant but not injection parameters dependant.
Mechanical properties comparable to talc filled composites.
Thanks for your attention