OUTLOOK ON THE POTENTIAL OF HYBRID NONWOVEN FROM FLAX FIBRES AND RECYCLED CARBON FIBRES

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- The Ministry for Industry and Information of the People’s Republic of China under grant agreement No [2016]92
Motivation
ECO-COMPASS

Recycling?

Composite 53%

Al/Al-Li 19%

Titanium 14%

Steel 6%

miscellaneous 8%

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Hybrid nonwoven from rCF and NF

Interlayer

Intralayer
Nonwoven processes

- Airlay Process: 5–120 mm
- Paper Process: <6–18 mm
- Wetlaid Process: <30 mm
- Mechanical Processes (Carding): 5–100 mm

Fibre length [mm] vs. Increasing isotropic material properties
Mixing and nonwoven production

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## Nonwoven configuration

<table>
<thead>
<tr>
<th>Laminate</th>
<th>Stacking Sequence and Volumetric Distribution of Fibres</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>30Flax</td>
<td></td>
<td>30 vol.-% Flax</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70 vol.-% Epoxy</td>
</tr>
<tr>
<td>30rCF</td>
<td></td>
<td>30 vol.-% rCF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70 vol.-% Epoxy</td>
</tr>
<tr>
<td>22.5Flax-7.5rCF</td>
<td></td>
<td>22.5 vol.-% Flax</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 vol.-% rCF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70 vol.-% Epoxy</td>
</tr>
<tr>
<td>Gr-22.5Flax-7.5rCF</td>
<td></td>
<td>22.5 vol.-% Flax</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

Legend: Flax, rCF

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Fibre distribution
Flexural Characterisation

3PB Flexural Stress-Strain (ISO14125)
(typical results in 0° composite direction).

- 30rCF
- "Gr"-22.5Flax-7.5rCF
- E-Glass Mat
- 22.5Flax-25rCF
- Flax UD Fabric
- 30Flax
- Flax Balanced Fabric

Stress [MPa] vs. Strain [%]

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Flexural Characterisation

3PB Specific Flexural Stiffness [ISO14125]

<table>
<thead>
<tr>
<th>Material</th>
<th>Specific Flexural Stiffness [MPa/g/cm³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>30Flax</td>
<td>6000 ± 100</td>
</tr>
<tr>
<td>30rCF</td>
<td>7500 ± 200</td>
</tr>
<tr>
<td>22.5Flax-7.5rCF</td>
<td>10000 ± 300</td>
</tr>
<tr>
<td>Gr-22.5Flax-7.5rCF</td>
<td>12500 ± 400</td>
</tr>
<tr>
<td>E-Glass Mat (30%)</td>
<td>5000 ± 150</td>
</tr>
<tr>
<td>Flax balanced fabric (EP, Prepreg, 42%)</td>
<td>5000 ± 150</td>
</tr>
<tr>
<td>Flax UD fabric (EP, Prepreg, 51%)</td>
<td>5000 ± 150</td>
</tr>
</tbody>
</table>

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Summary & Outlook

• Recycled carbon fibres (rCF) retain their good mechanical properties
• Restricted length comparable to natural fibres (NF)
• rCF an flax fibres were combined in a hybrid nonwoven as a way to improve mechanical properties compared to pure NFRP.
• Flexural characterisation (3PB) shows potential improvement of hybrid nonwoven configurations compared to pure flax reinforced composite. However, pure rCF reinforcement was not reached.

Outlook

• A full characterisation with TEN, COM, etc.
• Improvement of fibre-matrix adhesion for pyrolysed rCF without sizing
• Upscaling of fibre mixing and distribution process
• Adaptation of mixing ratio, fibre distribution and fibre alignment (e.g. by cross-laying)
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谢谢大家的关注。
THANK YOU FOR YOUR ATTENTION.