THE ECO-COMPASS EU-CHINA PROJECT

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EMUS 2019
Jens Bachmann* (DLR)
YI Xiaosu* (AVIC BIAM)
*) Coordinators of the ECO-COMPASS project

This project has received funding from:
- The European Union’s Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information of the People’s Republic of China under grant agreement No [2016]92
Background

- Natural Fibres?
- Bio-based resins?
- Recycled fibres?
- Multifunction?
ECO-COMPASS

Ecological and Multifunctional Composites for Application in Aircraft Interior and Secondary Structures

‣ Cooperation of Chinese and European partners
‣ 2016 – 2019

‣ Identification of applications for eco- and multifunctional composites
‣ Development, characterization and simulation of eco-materials to give a broad overview of the possibilities in aviation with leverage to other transport sectors like automotive and railway.
‣ Application / Demonstrators
‣ Life Cycle Assessment (LCA)
ECO-COMPASS

8 EUROPEAN PARTNERS FROM 6 COUNTRIES

11 CHINESE PARTNERS

www.ECO-COMPASS.eu
ECO-COMPASS RESULTS

EU & China
ECO-COMPASS Results

• Improvement of fibre properties

Modification of sisal fiber with CNC by (a) electrophoresis, (b) electrostatic adsorption

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Diameter (μm)</th>
<th>Tensile strength (MPa)</th>
<th>Young’s Modulus (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>173.3 (31)</td>
<td>529.9 (102)</td>
<td>13.6 (2.9)</td>
</tr>
<tr>
<td>CNC-treated</td>
<td>175.3 (32)</td>
<td>511.5 (97)</td>
<td>14.4 (3.3)</td>
</tr>
<tr>
<td>Alkali-treated</td>
<td>142.6 (18)</td>
<td>692.8 (92)</td>
<td>18.8 (3.0)</td>
</tr>
<tr>
<td>Alkali-CNC-EPD</td>
<td>156.4 (23)</td>
<td>614.9 (73)</td>
<td>22.0 (3.1)</td>
</tr>
<tr>
<td>Alkali-CNC-ESA</td>
<td>150.2 (20)</td>
<td>716.6 (110)</td>
<td>21.0 (2.6)</td>
</tr>
</tbody>
</table>

dynamic interface fatigue pull-out test
ECO-COMPASS
Results

Plasma treatment (rCF, flax)

Hybrid nonwoven (rCF, flax)

Flexural Strength, 0° [MPa]

Flexural Modulus in 0° [GPa]

Fibre volume content

R Garcia, LEITAT

Aerospace 2018, 5(4), 107; https://doi.org/10.3390/aerospace5040107
Aerospace 2018, 5(4), 120; https://doi.org/10.3390/aerospace5040120
ECO-COMPASS
bio-bases resins

- Rosin
- Epoxidized natural oils
- Saccharides
- Natural polyphenols

June 2019
## ECO-COMPASS Results

Rosin-based curing agent epoxy resin

<table>
<thead>
<tr>
<th>Property and test condition</th>
<th>Unit</th>
<th>Reference ¹</th>
<th>Test result</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength warp</td>
<td>RT/dry</td>
<td>MPa</td>
<td>≥500</td>
<td>707</td>
</tr>
<tr>
<td>Tensile modulus warp</td>
<td>RT/dry</td>
<td>GPa</td>
<td>65±8</td>
<td>62.3</td>
</tr>
<tr>
<td>Tensile strength weft</td>
<td>RT/dry</td>
<td>MPa</td>
<td>≥500</td>
<td>557</td>
</tr>
<tr>
<td>Tensile modulus weft</td>
<td>RT/dry</td>
<td>GPa</td>
<td>65±8</td>
<td>60.9</td>
</tr>
<tr>
<td>Compression strength warp</td>
<td>RT/dry</td>
<td>MPa</td>
<td>≥300</td>
<td>509</td>
</tr>
<tr>
<td>Compression modulus Warp</td>
<td>RT/dry</td>
<td>GPa</td>
<td>58±8</td>
<td>61.2</td>
</tr>
<tr>
<td>Compression strength Weft</td>
<td>RT/dry</td>
<td>MPa</td>
<td>≥280</td>
<td>362</td>
</tr>
<tr>
<td>Compression modulus weft</td>
<td>RT/dry</td>
<td>GPa</td>
<td>57±8</td>
<td>57.7</td>
</tr>
<tr>
<td>Bending strength warp</td>
<td>RT/dry</td>
<td>MPa</td>
<td>≥650</td>
<td>883</td>
</tr>
<tr>
<td>Bending modulus warp</td>
<td>RT/dry</td>
<td>GPa</td>
<td>58±8</td>
<td>56.8</td>
</tr>
<tr>
<td>Short beam shear strength</td>
<td>RT/dry</td>
<td>MPa</td>
<td>≥50</td>
<td>55.7</td>
</tr>
<tr>
<td>In plane shear strength</td>
<td>RT/dry</td>
<td>MPa</td>
<td>≥45</td>
<td>72.6</td>
</tr>
<tr>
<td>In plane shear modulus</td>
<td>RT/dry</td>
<td>GPa</td>
<td>3.5±1</td>
<td>3.84</td>
</tr>
</tbody>
</table>

¹ A commercial product

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Aerospace 2018, 5(2), 65; [https://doi.org/10.3390/aerospace5020065](https://doi.org/10.3390/aerospace5020065)

Aerospace 2018, 5(4), 110; [https://doi.org/10.3390/aerospace5040110](https://doi.org/10.3390/aerospace5040110)
ECO-COMPASS Results

- Flammability

Ramie + Epoxy
FR Ramie
FR Epoxy

27 sec

Flammability acc. FAR25.853

Requirement: Burn Length < 203 mm

Requirement: After Flame Time < 15 seconds
ECO-COMPASS Results

AGMH-1 “Green Honeycomb” is made of plant fiber hybrid paper containing 20% plant fibers.

<table>
<thead>
<tr>
<th>Items</th>
<th>Compression strength, MPa</th>
<th>Longitudinal shear strength, MPa</th>
<th>Transversal shear strength, MPa</th>
<th>Longitudinal shear modulus, MPa</th>
<th>Transversal shear modulus, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nomex, I</td>
<td>1.24</td>
<td>1.0</td>
<td>0.55</td>
<td>32.5</td>
<td>19.5</td>
</tr>
<tr>
<td>Nomex, II</td>
<td>1.64</td>
<td>1.07</td>
<td>0.58</td>
<td>36</td>
<td>19</td>
</tr>
<tr>
<td>GREEN Honeycomb</td>
<td>1.78</td>
<td>1.16</td>
<td>0.75</td>
<td>43.2</td>
<td>29.3</td>
</tr>
</tbody>
</table>
ECO-COMPASS Results

Composite Structures 131 (2015): 707-719. DOI: 10.1016/j.compstruct.2015.06.006
Damage analysis of carbon fiber composites exposed to combined lightning current components D and C.

Electrical Conductivity Integration via InterWoven Wire Fabrics (IWWF)
ECO-COMPASS Results

1st Natural Frequency from Lineo UD flax prepreg at 109 Hz

Absorption coefficient of the tested samples across the frequency range 500-6400 Hz
Materials Developed and Studied:

Rosin-sourced curing agent EP composites and the structures.

ECO-COMPASS
TRL status

Technology, System Test, Qualification and Operation
TRL 9: Actual Technology system qualified through successful mission operations.
TRL 8: Actual Technology system completed and qualified through test and demonstration.
TRL 7: Technology systems prototype demonstration in an operational environment.
TRL 6: Technology system/subsystem model or prototype demonstration in a relevant environment.
TRL 5: Technology component and/or basic technology subsystem validation in a relevant environment.
TRL 4: Technology component and/or basic technology subsystem validation in a laboratory environment.
TRL 3: Analytical and experimental critical function and/or characteristic proof-of-concept.
TRL 2: Technology concept and/or application formulated.
TRL 1: Basic principles observed and reported.

Technology System/Subsystem Development
TRL 9
TRL 8
TRL 7
TRL 6
TRL 5
TRL 4
TRL 3
TRL 2
TRL 1

Technology Demonstration
TRL 9
TRL 8
TRL 7
TRL 6
TRL 5
TRL 4
TRL 3
TRL 2
TRL 1

Technology Development
TRL 9
TRL 8
TRL 7
TRL 6
TRL 5
TRL 4
TRL 3
TRL 2
TRL 1

Research to prove feasibility
TRL 9
TRL 8
TRL 7
TRL 6
TRL 5
TRL 4
TRL 3
TRL 2
TRL 1

Basic Technology Research
TRL 9
TRL 8
TRL 7
TRL 6
TRL 5
TRL 4
TRL 3
TRL 2
TRL 1
ECO-COMPASS
Potential Gaps and Challenges

• Fire performance, especially the Heat Release of NFRP and (bio-based) epoxy resins.

• Long term behaviour

• Upscaling of fibre modification technologies

• Assessment of potential environmental impacts of treatments and processes to improve properties of eco-composites
ECO-COMPASS Demonstrators

Airbus

AVIC
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THANK YOU FOR YOUR ATTENTION.