ECO-COMPOSITES

Jens Bachmann (DLR)

EU-China Week on Aviation Research
Brussels, 18-20 April 2016

GRAIN 2

DLR

Content

- Background
- Possible applications of eco-composites in aviation
- Properties of eco-materials
- Conclusions

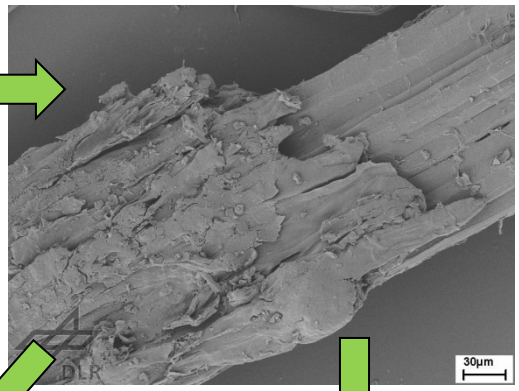
Background

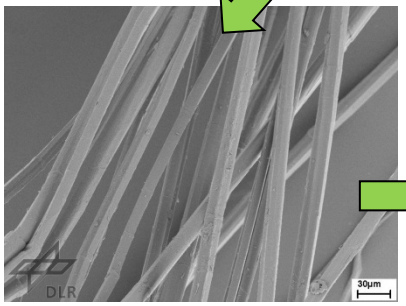
- Composite materials with reduced ecological impact
- „Definition“ of Eco-Composites for this presentation
  - Natural Fibre Reinforced Plastics (with petrol based matrix)
  - Bio-resins combined with man-made fibres
  - Bio-Composites (resin and fibre renewable, not necessarily 100%...)
  - Recycled Materials

- What is the motivation to use eco-materials in aviation?
  - Improved ecological footprint -> „green“ image
  - Good specific properties
  - Multifunctional aspects

Bio-fibres & bio-resins

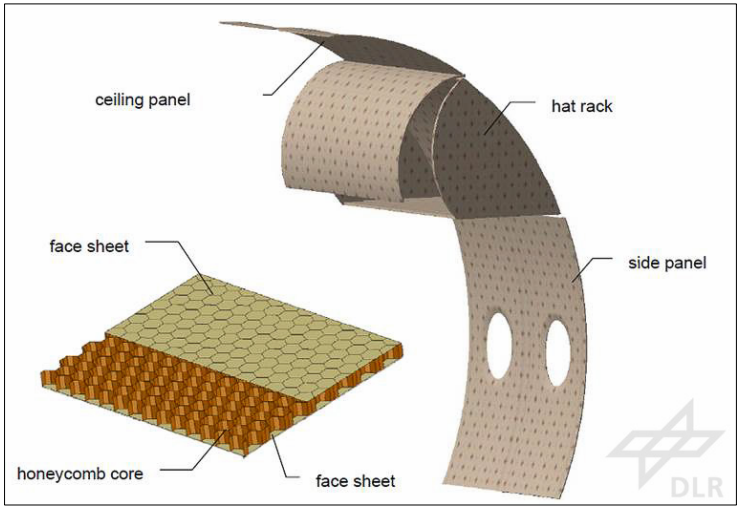
Linum usitatissimum





Possible applications of eco-materials in aviation: Interior

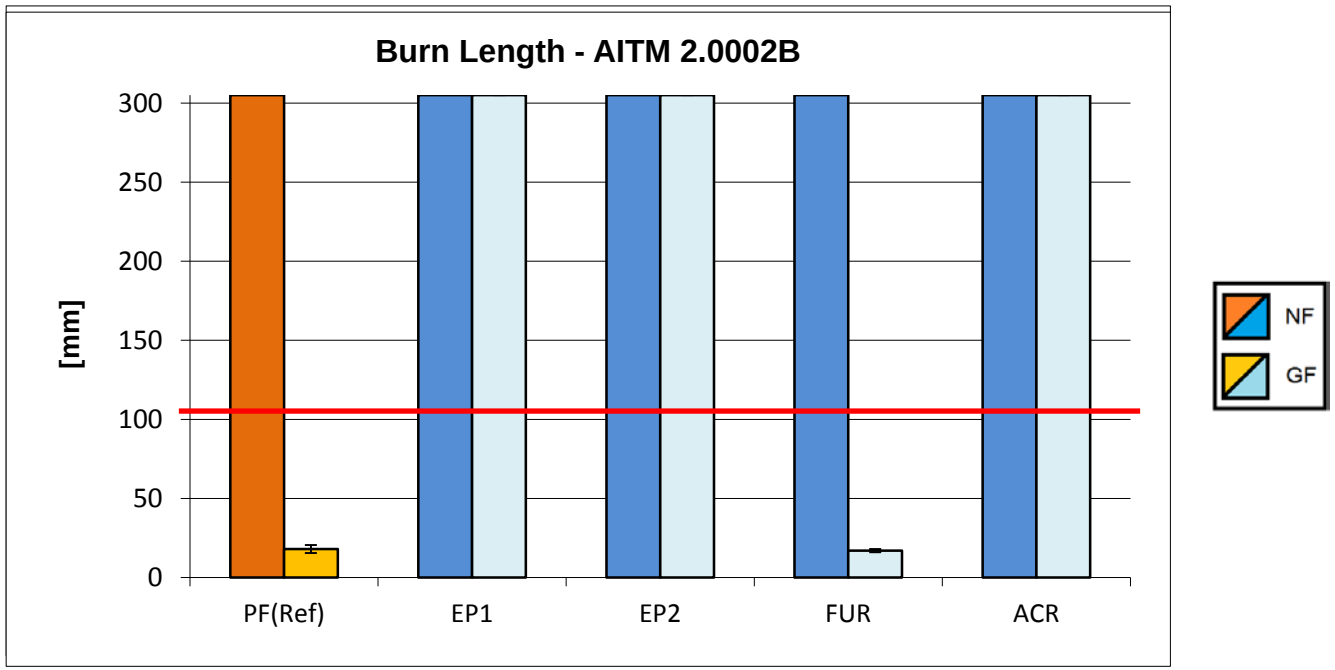
- Challenges
  - Fire properties (FST + HR)
  - Weight compared to currently used sandwich panels
  - Sensitivity for liquids and humidity



GRAIN 2

Properties of eco-materials

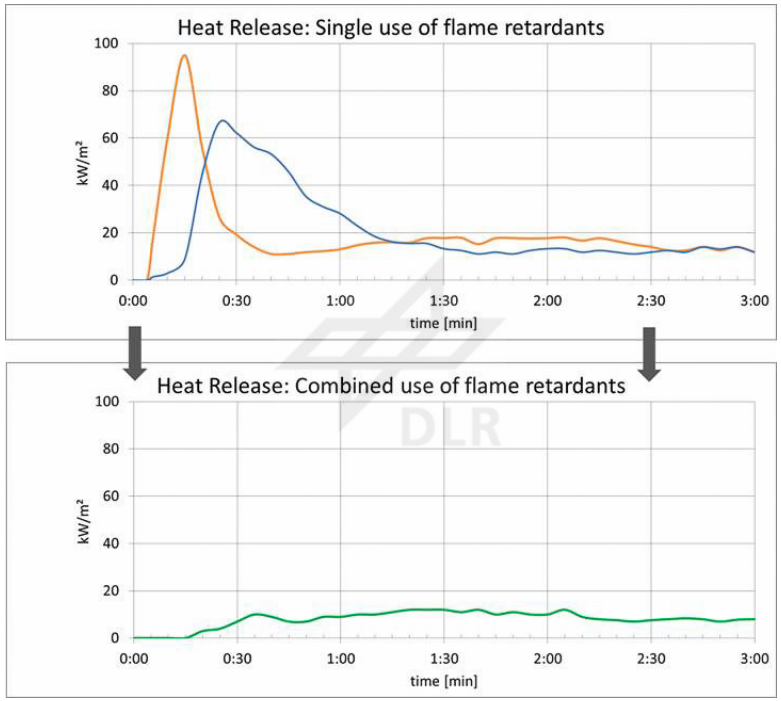
- Comparison of “bio”-resins with standard phenolic resins
- Natural fibre (NF) and glass fibre (GF) reinforcement



[Bachmann, J., Fischer, H. – Bioharze und flammgeschützte Naturfasern: Nachhaltige Materialien für das Flugzeuginterieur? – AVK-Flammschutz bei Composites-Anwendungen, Frankfurt, 10.12.2013]

Properties of eco-materials

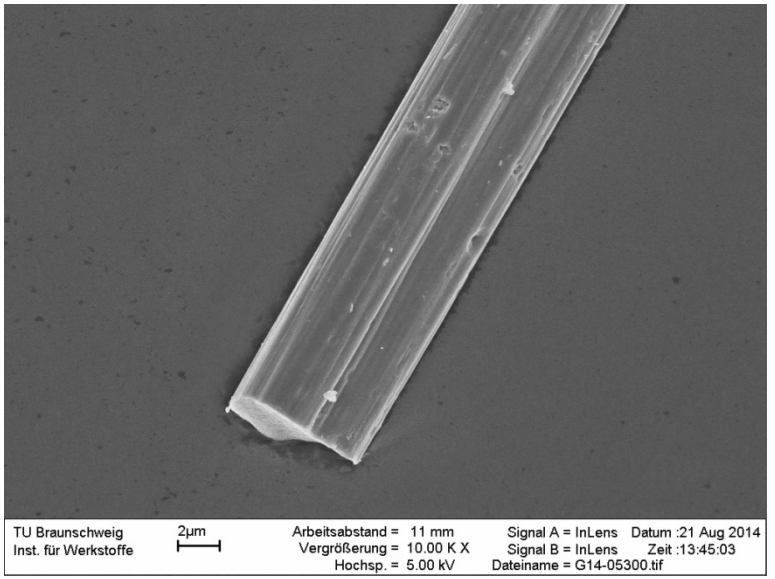
- Fire properties of natural fibre reinforced plastics (Interior, Sandwich)
- Fibre: Flax (plain weave, non-woven)
- Resin: Phenolic (standard for cabin use)
- Core: Nomex® Honeycomb (standard)



[Bachmann, J., Michelis, B. – Verbesserung der Brandeigentschaften von NFK im Hinblick auf den Luftfahrt-Kabineneinsatz – Köln 2011]

Recycled carbon fibres

- Pyrolysis process industrially available
- Less energy consumption
- Elimination of fibre sizing
- Resin residue and „craters“ on rCF
- Strength of rCF comparable to vCF
- Restricted fibre length



[DLR]

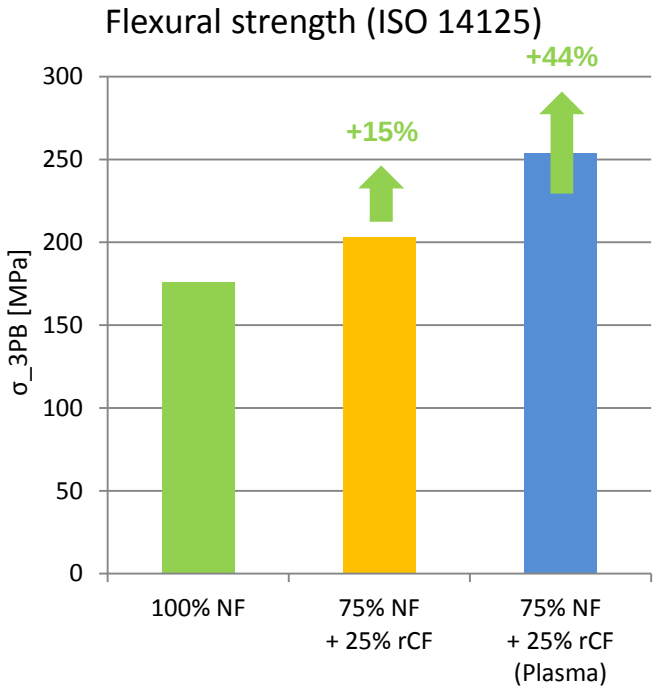
vCF = Virgin Carbon Fibre
rCF = Recycled Carbon Fibre

GRAIN 2

Possible applications of eco-materials in aviation: Secondary Structures

- Challenges
  - Mechanical properties compared to current structural materials
  - Quality of reinforcements
  - Robustnes
  - Sensitivity for environmental influences
  - Cellulose: Additional calorific potential during post crash fire

Properties of eco-materials



- Mixing rCF and NF
- „Hand-made“ non-woven
- Epoxy resin
- Fibre volume fraction ~ 30%

→ Plasma activation (trial) reveals potential of rCF

GRAIN 2

DLR Demonstrators

Conclusions

- Bio-fibres are able to substitute glass fibres with their good specific properties
- Safety requirements (FST) could be fulfilled, but the mechanical properties, weight and impact on LCA must be considered
- Resins based on renewable materials are available, some offer comparable fire properties compared to petrol-based phenolics
- Recycled fibres are available and their quantity will rise in the future while the prise is expected to decrease, offering a “greener” alternative to virgin fibres with some restrictions (e.g. length)
- Hybrid composites based on renewable and recycled fibres offer the potential to use more ecological improved materials in aviation

→ Eco-materials offer the potential to decrease ecological footprint of aviation when the total weight of the parts does not increase, but every case should be validated with Life Cycle Assessment

谢谢大家的关注。

Thank you for your attention.