THE ECO-COMPASS PROJECT EU/CHINA COOPERATION: INTRODUCTION AND STATUS AFTER 18 MONTHS

INTRODUCTION TO THE ICCS20 SPECIAL SESSION

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ICCS20 Special Session

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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

Growing market for aviation [1]:

- Air traffic more than doubles in the next 20 years
- 4.5 % growth of passenger traffic p.a. until 2035
- 32.425 passenger aircraft required over the next 20 years

Environmental challenges [2]:

- Climate change
- Loss of biosphere integrity (biodiversity loss and extinctions)
- Nitrogen and phosphorus flows to the biosphere and oceans
- Landsystem change
- …

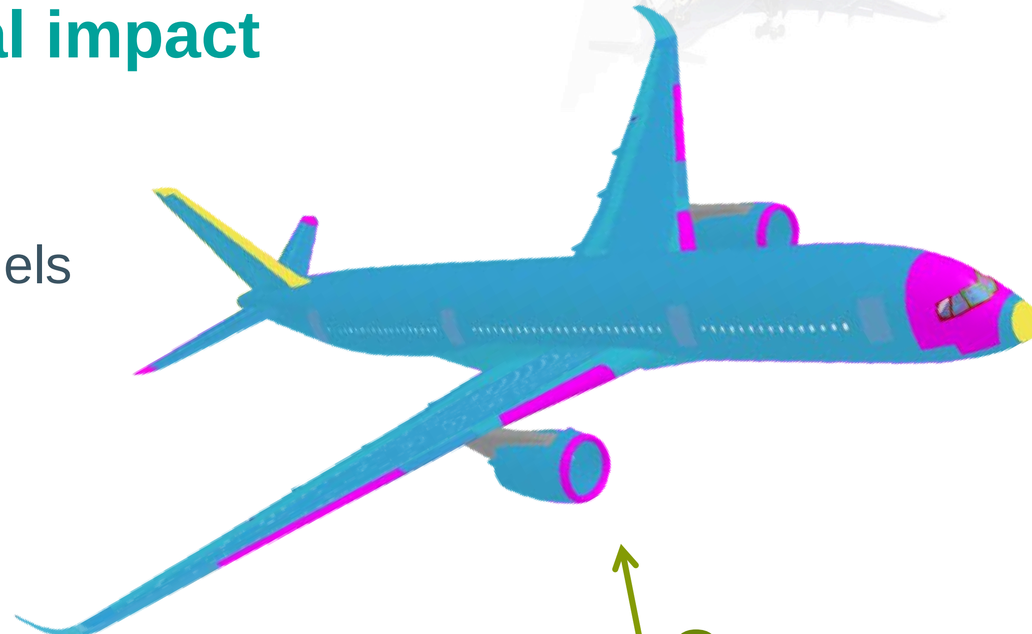
[1] Airbus Global Market Forecast 2016-2035

[2] Stockholm Resilience Institute: The nine planetary boundaries

Measures with potential to reduce aviations environmental impact

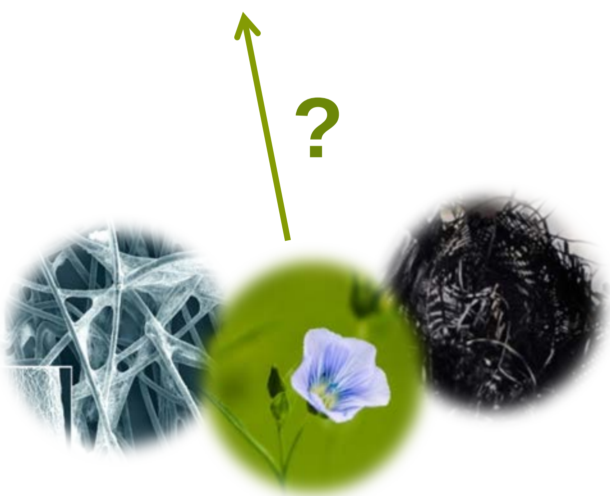
- Aircraft configuration
- Propulsion / alternative fuels
- Aerodynamics
- Trajectory / flight path
- Energy management
- …
- **Lightweight design**
  - **Fibre Reinforced Composites**
    - **CFRP, GFRP, GLARE, …**

→ All synthetic / man-made materials



- Further reduction of ecological footprint by:

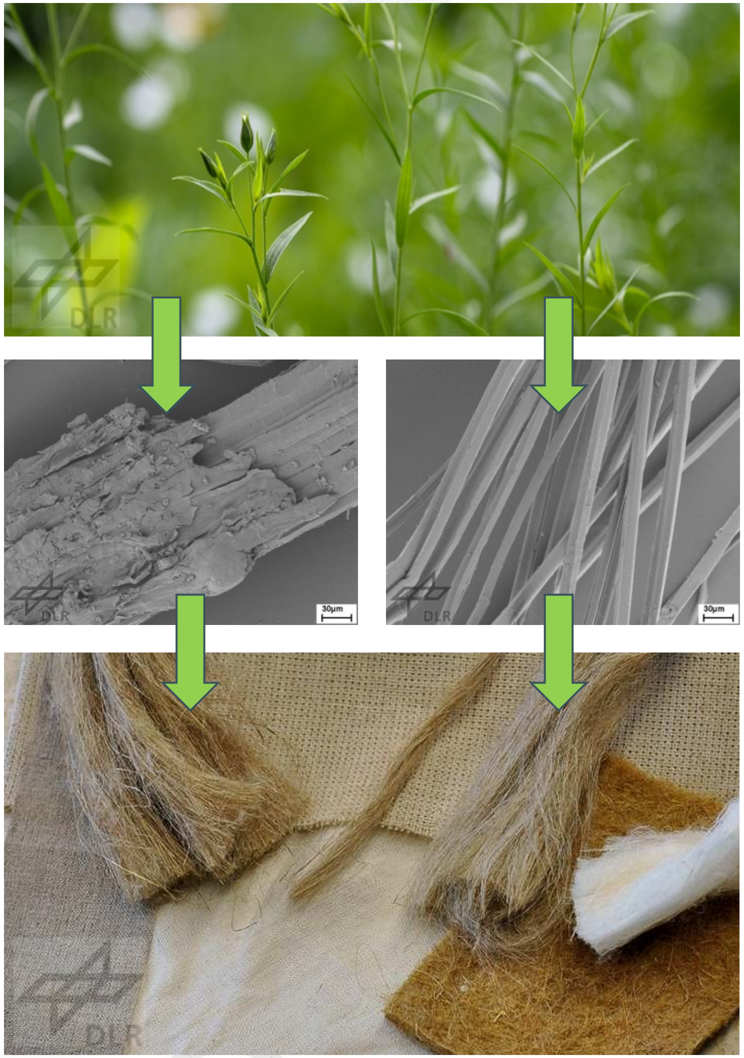
→ Bio-based materials?
→ Recycled materials?
→ Function Integration?



ECO COMPASS

Bio-Composites: Challenges

- Fulfillment of demanding requirements in aviation
  - Mechanical properties
  - Fire properties
    - Heat Release
    - Flammability
    - Smoke Density & Toxicity
    - Flame penetration resistance (Cargo)
- Variable fibre properties
- Durability (Resistance to climate, UV, cleaning agents)
- Modifications and their effects on environmental impacts
- Prediction of material behaviour by modelling and simulation



Fibre properties

Fibre type		Density	Price	Young's modulus	Tensile Strength	Elongation	Length	Diameter	Moisture content	Cellulose content
		[g/cm³]	[USD/kg]	[GPa]	[MPa]	[%]	[mm]	[µm]	[wt-%]	[wt-%]
Synthetic	Carbon HS	1.7-1.8	66-110	200-250	3500-4900	1.4-2.1	-	5-10	-	-
	Carbon HM	1.9	200	350-550	2700-4400	0.7-1.2	-	5-10	-	-
	Carbon IM	1.8	100	250-350	5400-6300	1.9-2.2	-	5-10	-	-
	Aramid meta	1.38	15-33	12-20	700-850	15-30	-	10-20	< 8	-
	Aramid para	1.44	n/a	58-124	2500-4100	2.4-3.3	-	~12	< 8	-
	S/R-glass	2.46-2.49	20-37	85-87	3000-3600	4.0-5.0	-	9-11	-	-
	E-glass	**2.55-2.6**	**1.63-3.26**	**72-85**	**1900-2050**	**1.8-4.5**	**-**	**5-24**	**-**	**-**
Fruit	Coir	1.15-1.22	0.25-0.5	4-6	135-240	15-35	20-150	10-460	8	32-43.8
	Cotton	1.52-1.56	2.1-4.2	7-12	350-800	5-12	10-60	10-45	7.85-8.5	82.7-90
Bast	**Flax**	**1.42-1.52**	**2.1-4.2**	**75-90**	**750-940**	**1.2-1.8**	**5-900**	**12-600**	**8-12**	**62-72**
	Hemp	1.47-1.52	1.0-2.1	55-70	550-920	1.4-1.7	5-55	25-500	6.2-12	68-74.4
	Jute	1.44-1.52	0.35-1.5	35-60	400-860	1.7-2.0	1.5-120	20-200	12.5-13.7	59-71.5
	Ramie	**1.45-1.55**	**1.5-2.5**	**38-44**	**500-680**	**2.0-2.2**	**900-1200**	**20-80**	**7.5-17**	**68.6-85**
Leaf	Sisal	1.4-1.45	0.6-0.7	10-25	550-790	4.0-6.0	900	8-200	10-22	60-78
Grass	Bamboo	0.6-1.1	0.5	11-32	140-800	2.5-3.7	1.5-4	25-40	-	26-65

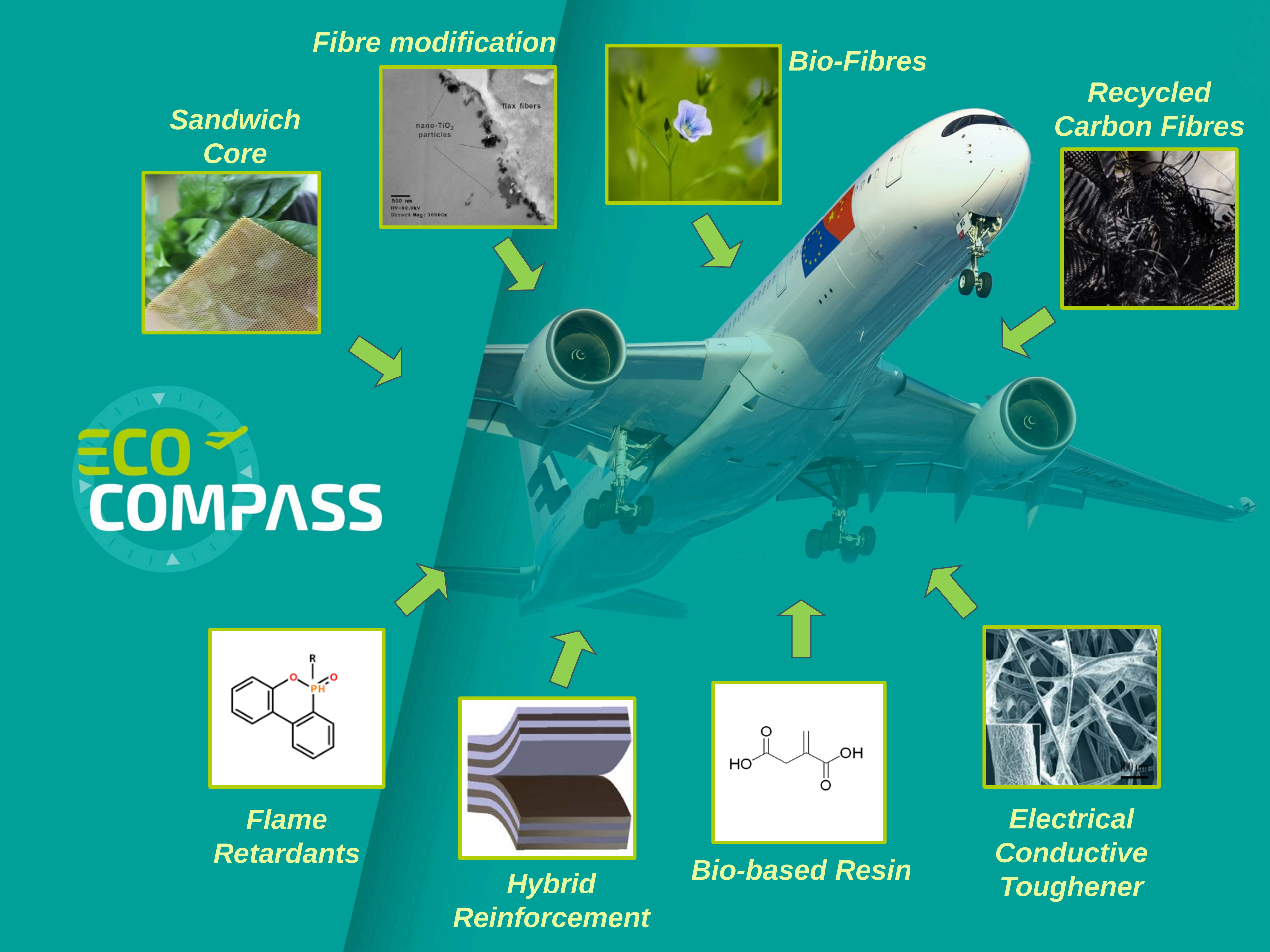
based on [Dicker et al. / Composites: Part A 56 (2014) 280-289]

ECO-COMPASS

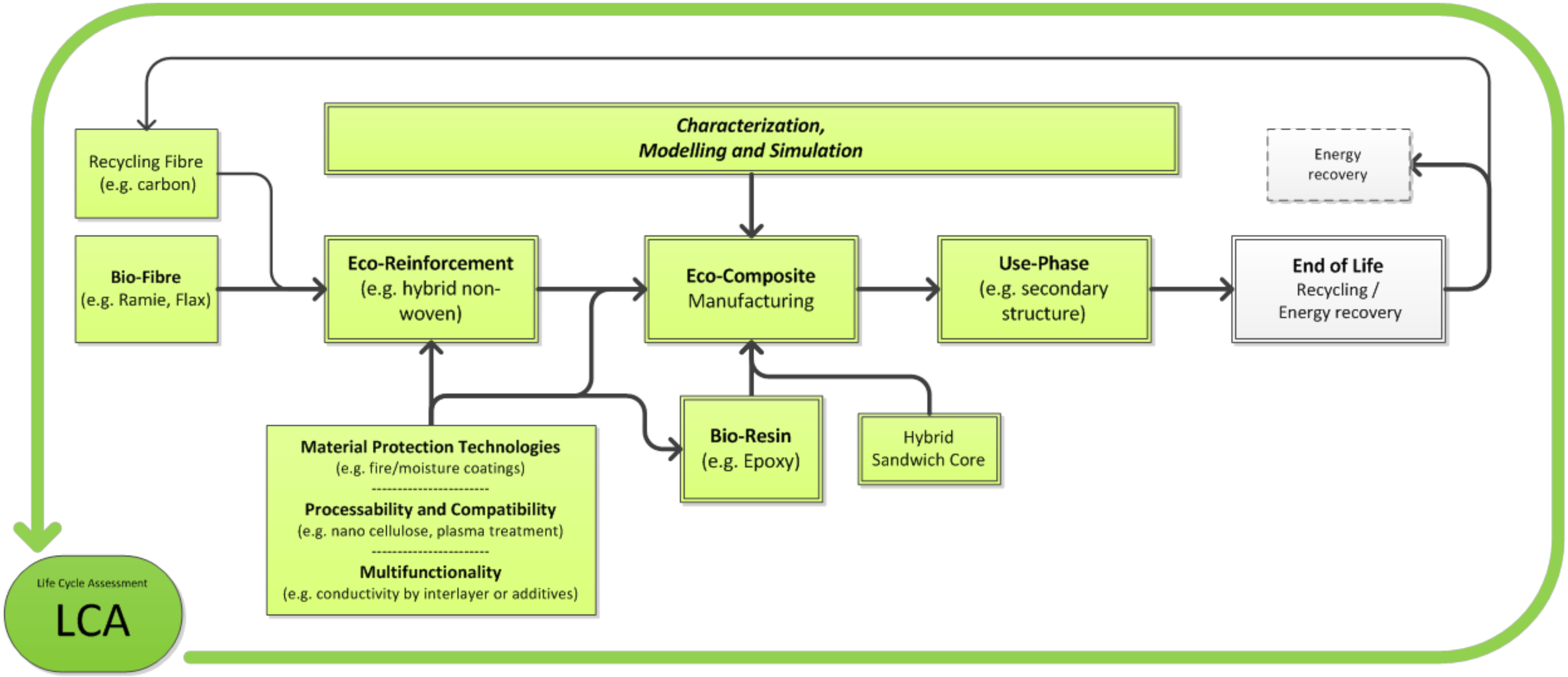
Ecological and Multifunctional Composites for Application in Aircraft Interior and Secondary Structures

- Cooperation of Chinese and European partners
- 04/2016 – 03/2019

- 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)


Fibre modification
flax fibers
nano-TiO2 particles
500 nm
Bio-Fibres
Recycled Carbon Fibres
Sandwich Core
ECO COMPASS
Flame Retardants
Hybrid Reinforcement
Bio-based Resin
Electrical Conductive Toughener

Approach



Recycling Fibre
(e.g. carbon)
Characterization,
Modelling and Simulation
Energy
recovery
Bio-Fibre
(e.g. Ramie, Flax)
Eco-Reinforcement
(e.g. hybrid non-woven)
Eco-Composite
Manufacturing
Use-Phase
(e.g. secondary structure)
End of Life
Recycling /
Energy recovery
Bio-Resin
(e.g. Epoxy)
Hybrid
Sandwich Core
Material Protection Technologies
(e.g. fire/moisture coatings)
Processability and Compatibility
(e.g. nano cellulose, plasma treatment)
Multifunctionality
(e.g. conductivity by interlayer or additives)
Life Cycle Assessment
LCA

Consortium

8 EUROPEAN PARTNERS FROM 6 COUNTRIES

11 CHINESE PARTNERS

AIRBUS GROUP INNOVATIONS

CENTRE INTERNACIONAL DE METODES NUMERICS EN ENGINYERIA

DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV

INSTITUTO DE CIENCIA E INOVACAO EM ENGENHARIA MECANICA E ENGENHARIA INDUSTRIAL

ACONDICIONAMIENTO TARRASENSE ASSOCIACION

L-UP

UNIVERSITY OF MANCHESTER

UNIVERSITY OF PATRAS

AVIC COMPOSITE CORPORATION, LTD

CHINA AVIATION INDUSTRY GENERAL AIRCRAFT CO.,LTD

AVIC BEJING INSTITUTE OF AERONAUTICAL MATERIALS

AVIC HARBIN AIRCRAFT INDUSTRY (GROUP) CO. LTD

HARBIN INSTITUTE OF TECHNOLOGY

AVIC HEFEI HANGTAI ELECTROPHYSICS CO.,LTD

NINGBO INSTITUTE OF INDUSTRIAL TECHNOLOGY,CHINESE ACADEMY OF SCIENCES.

SHANGHAI AIRCAFT MANUFACTURING CO.,LTD

SHANDONG UNIVERSITY

TONGJI UNIVERSITY

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Summary & Outlook

- Interior and Secondary Structures are possible application scenarios for eco-composites, e.g. fairings and linings.
- Demanding safety requirements (e.g. FST) have to be fulfilled without adverse effects on mechanical properties and weight
- Bio-fibres (e.g. flax, ramie) offer promising specific properties. Modifications of fibres to enhance their properties will be investigated.
- Hybrid composites based on bio-fibres and recycled carbon fibres could increase the mechanical properties and application range of eco-composites
- Bio-resins to substitute petrol-based resins
- Multifunctional aspects of high-performance composites like CFRP could lead to a better ecological footprint.
- Modelling & simulation helps to predict the behaviour of eco-composites in demanding applications like aviation.
- Life Cycle Assessment (LCA) to calculate the environmental impact from cradle to grave is important to compare „eco-composites“ with state of the art materials

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谢谢大家的关注。
THANK YOU FOR YOUR ATTENTION.

WWW.ECO-COMPASS.EU