SuCoHS

SUSTAINABLE & COST EFFICIENT
HIGH-PERFORMANCE COMPOSITE STRUCTURES
DEMANDING TEMPERATURE
AND FIRE RESISTANCE

SuCoHS Project

Sustainable Cost Efficient High Performance Composite Structures demanding Temperature and Fire Resistance

Date: 05 September 2019

Tobias Wille (DLR), Project Coordinator

SuCoHS project, Grant Agreement N° 769118

Outline

- Background
- Objectives
- Concept and Methodology
- Consortium
- First results
- Outlook

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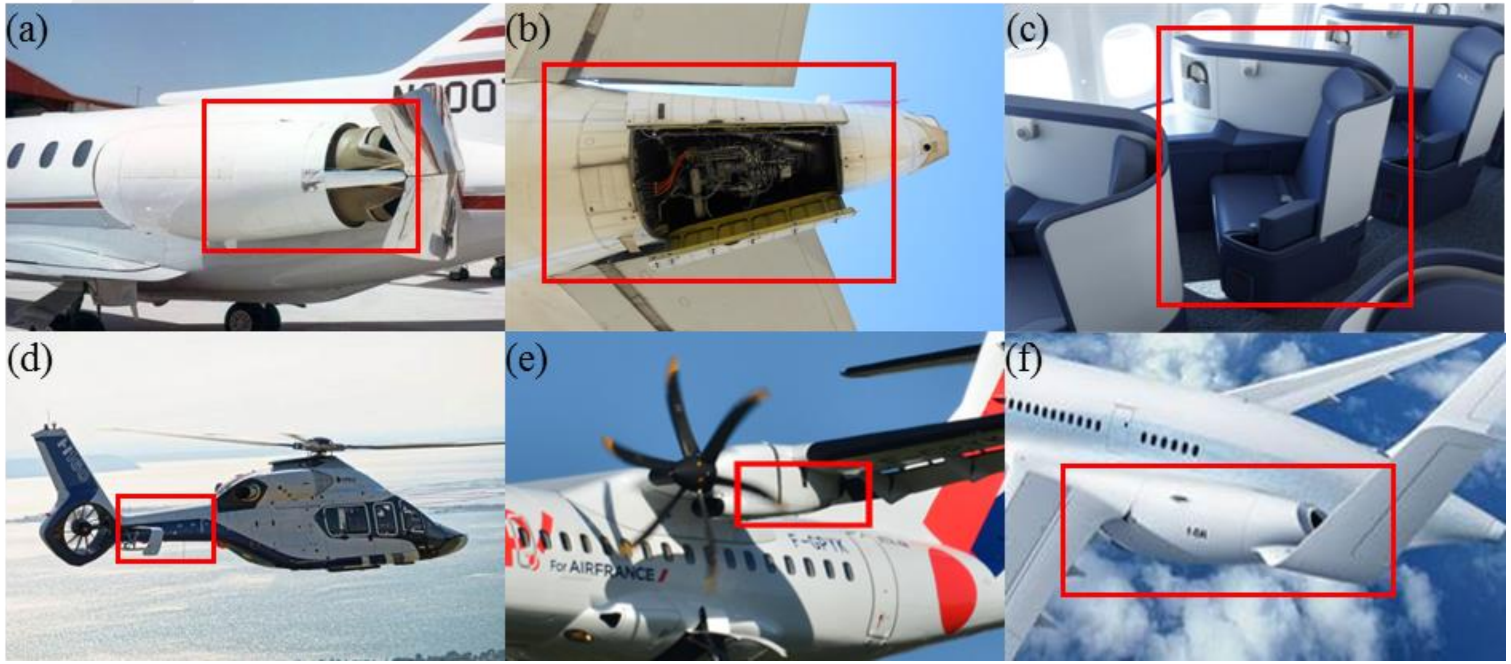
Background

- Several aeronautical applications demanding high thermal conditions
    - Temperature
    - Fire



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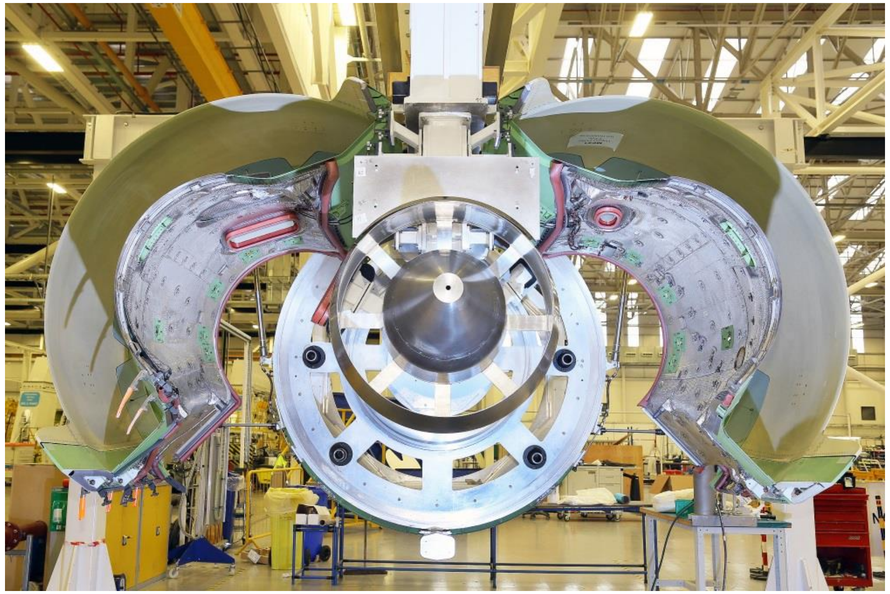
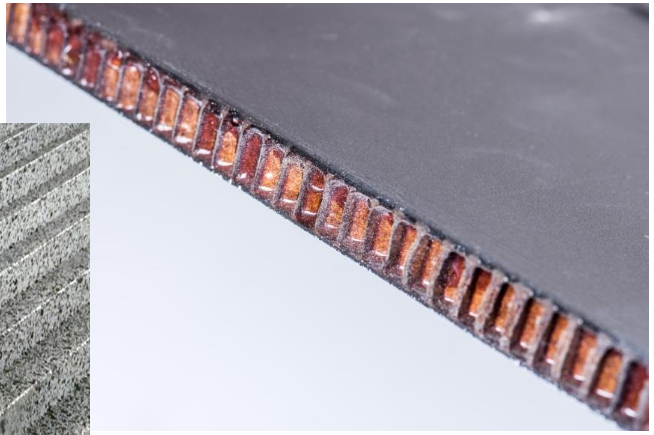
Background

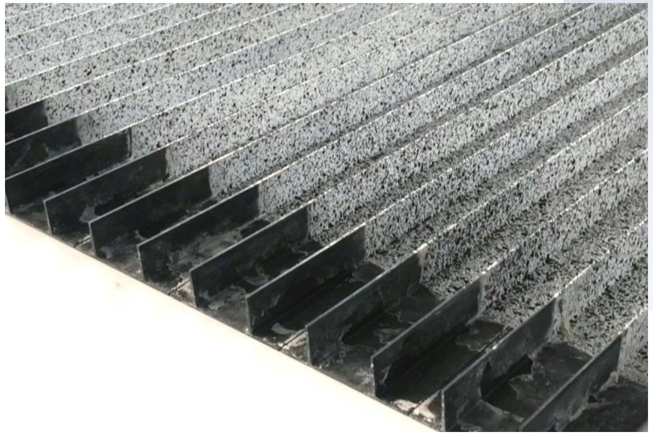
- Current metal designs could be replaced to reduce weight or improve performance



[Bombardier]

- Current composite designs could be improved to increase efficiency for multidisciplinary requirments or to reduce manufacturing costs





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Objectives

- Overall objective of EC
  - Maintain European leadership through weight and cost savings in expanding the use of composite materials in areas of demanding high thermal conditions (temperature and fire)
- Technological objectives of SuCoHS project
  1. Multi-material systems/ structures to increase mech. performance, fire and thermal resistance up to 350°C, reduce weight 12-15% and costs up to 17%
  2. Systems for multiple sensing during production and operation to increase safety and aircraft availability and decrease maintenance costs by up to 15%
  3. Tailored composite manufacturing with in-situ structural assessment to reduce time and costs for individual production steps by up to 30%
  4. Multi-disciplinary analysis methods and allowables to reduce weight and cost of selected parts by additional 3-8%
  5. Building block for designing multifunctional structures validated by representative prototypes with integrated systems
  6. Pilot demonstration of future composite part development with horizontal & vertical integration of disciplines, methods and requirements

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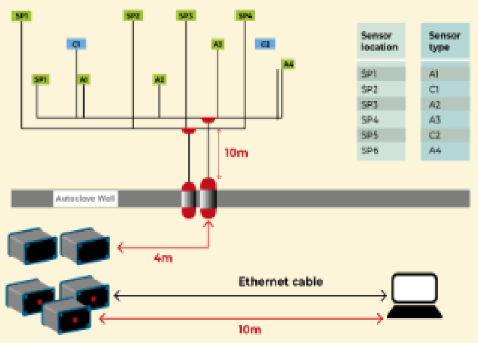
Concept and Methodology

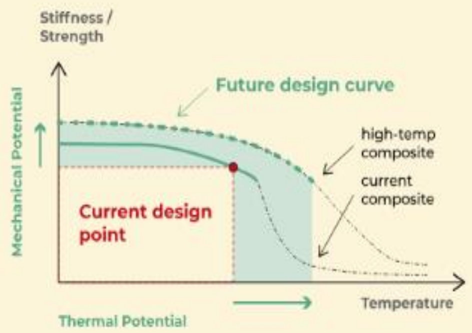
- Concept providing key technologies for
  - Design
  - Manufacturing
  - Operation

Manufacturing



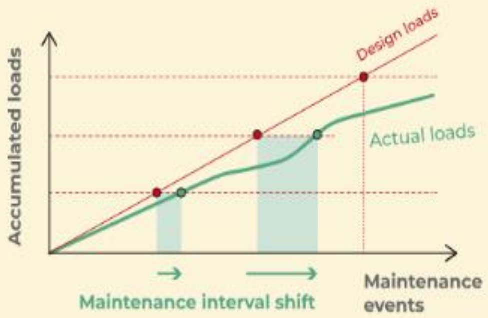
- Tailored multifunctional preforms
- Advanced hybrid manufacturing technologies
- Zero-defect manufacturing

Design



- New composites materials
- Reliable multidisciplinary analysis tools and allowable
- Robust multifunctional structural concepts

Operation



- Reliable multifunctional sensors
- Efficient tools for structural usage evaluation
- Enhanced maintenance scheduling

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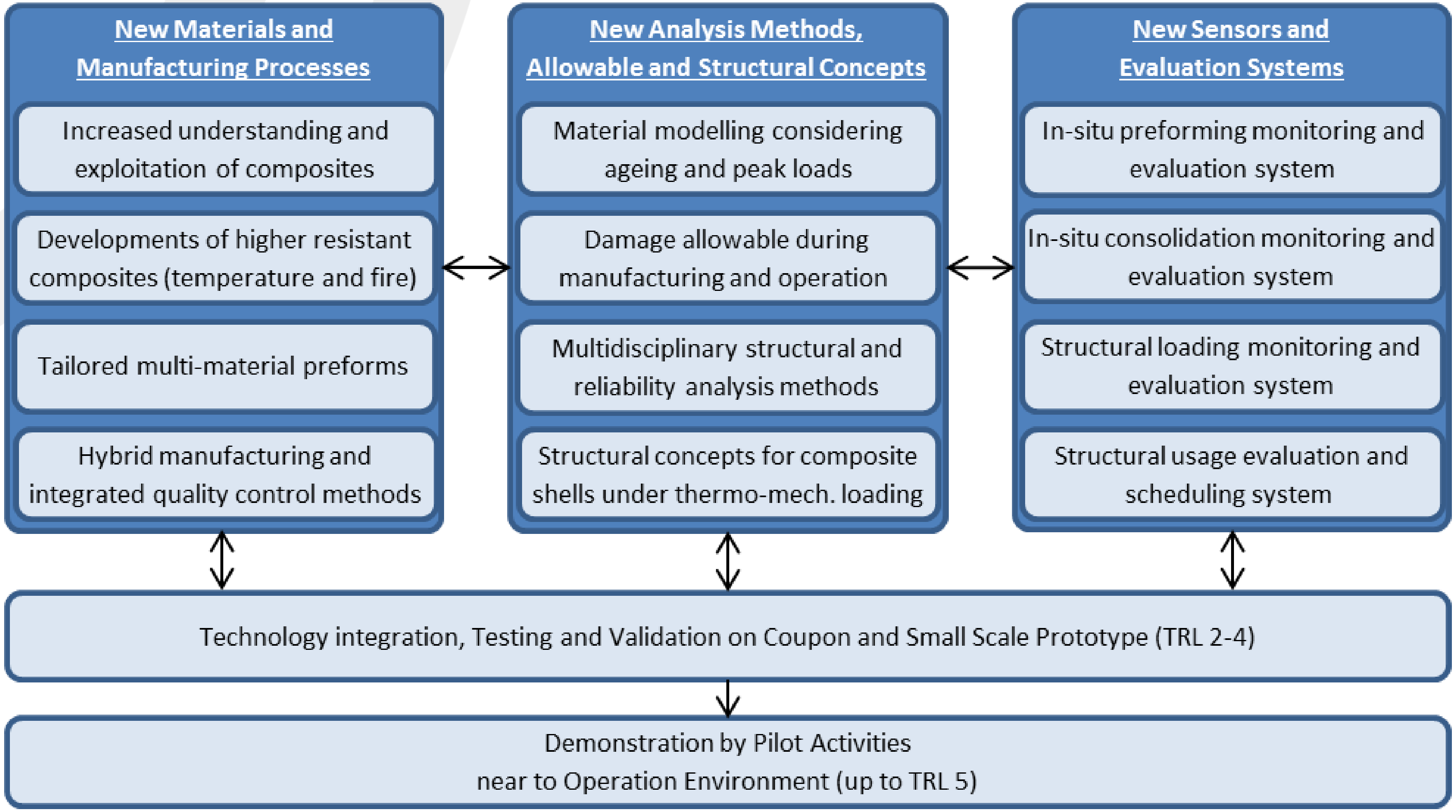
Concept and Methodology

- Methodology



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Consortium

- In a Nutshell

40 Researchers and engineers

14 Partners

36 Months

7 European Countries

571.5 person-months

EU contribution 6 638 939 €

Project name:
Sustainable and Cost Efficient High Performance Composite Structures demanding Temperature and Fire Resistance

Project acronym: SuCoHS

Funding scheme: Research and Innovation Action (RIA)

Project Coordinator: Dr. Tobias Wille (DLR)

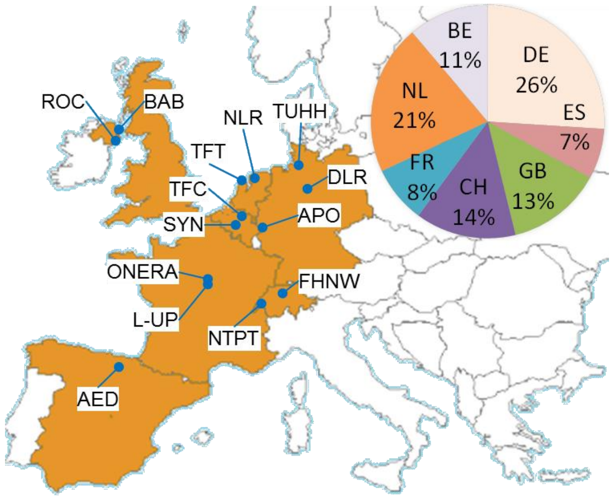
Contact: tobias.wille@dlr.de

Project start date: 01/09/2018

Project end date: 31/08/2021

Consortium

- Universities
  - Material toughening
  - Process simulation
  - Probabilistic analysis
- Research Centers
  - Material testing and modeling
  - Manufacturing technologies
  - Structural analysis and testing methods
- SME and industrial facilitators
  - Material development
  - Sensor system development
  - Data base
- Industrial End users
  - Structural concepts and simulation methods
  - Production verification
  - Pilot demonstration



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Pilot Demonstrators

- Reduce part complexity
- Multidisciplinary loading
- Reduce number of subparts
- Use of composites Tg<335°C

- Avoid titanium APU housing
- Use of composites Tg<300°C
- Ensure fire resistance
- Ensure damage tolerance

- New structural concepts and materials for improved performance at reduced costs
- Flammability and FST requ.

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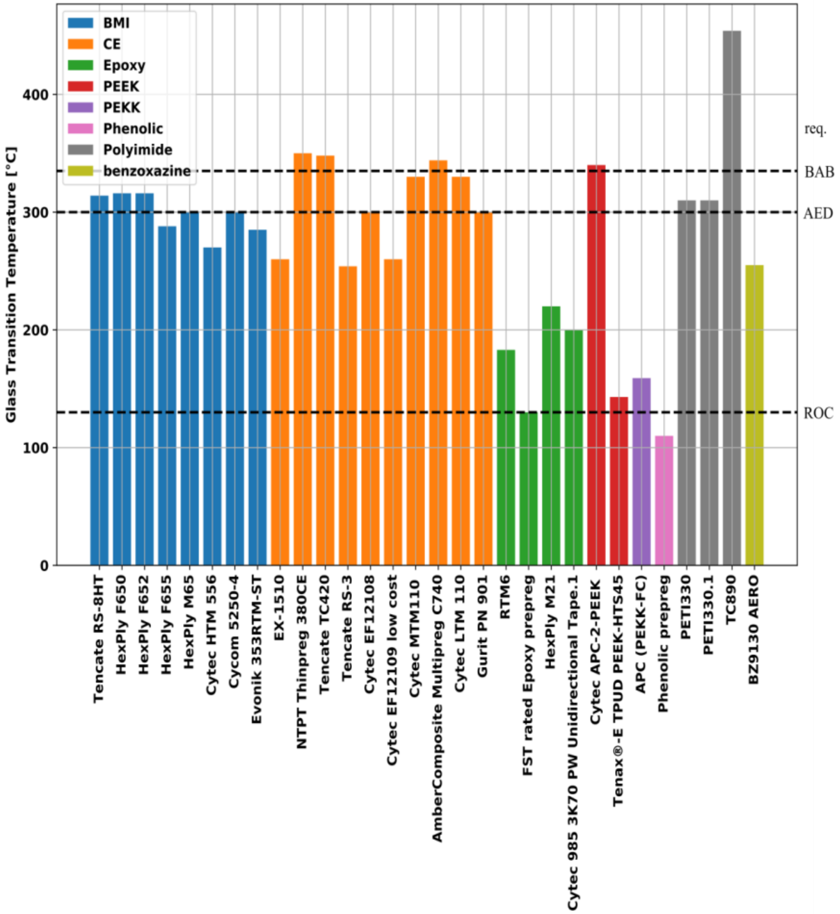
First selected results

- Material development
  - Material screening compared to requirements (mechanical, curing, fire and other parameters)

	Parameter	Unit	BAB		ROC		AED	
			Prio	Limit	Prio	Limit	Prio	Limit
Material Parameters	T_g, dry	°C	1	> 335	2	>130	1	>300
	Stiffness, compressive	GPa	2	>REF[2]	1	>REF[2]	1	>700[1]
	Stiffness, tensile	GPa	2	>REF[2]	2	>REF[2]	1	>700[1]
	Strength, compressive	MPa	2	>REF[2]	1	>REF[2]	1	>800[1]
	Strength, tensile	MPa	2	>REF[2]	2	>REF[2]	1	>800[1]
	Toughness K_{1C}	$MPa/m^{1/2}$	1	>0.85	-	-	-	-
	AFP processability	-	1	-	1	-	1	-
Curing parameters	Cure Temperature	°C	1	<185	2	<140	1	<210
	Cure Time	min	2	-	2	<100	2	<REF[2]
	Postcure time	min	1	MIN[3]	1	NOT[4]	1	NOT[4]
Fire Parameters	Vertical Burn		-	-	1	FAR 25.853 (a), (d)	2	-
	Smoke density		-	-	2		2	-
	Heat Release		-	-	2		2	-
	Burn through resistance	min	-	-	-	-	1	15
Other parameters	Material lead time				1	-	2	
	costs	€			1	MIN[3]	1	MIN[3]
	Acoustic		1		n.a.[5]		n.a.[5]	

[1] the values are referring to fabric values [1]
[2] the values are referring to the reference material,
[3] the values is minimized target value,
[4] the values is not accepted,
[5] the values is not applicable,



[C. Huchette et al.: Review and evaluation of material candidates compared to industrial requirements, SuCoHS public deliverable D2.1, Aug 2019]

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First selected results

- Material development
  - PFA material system ongoing
    - Peak heat release substantially reduced
    - Resin viscosity modified to manufacture prepreg with good tackiness
    - toughened formulations by incorporating a number of liquid and solid modifiers
  - TGA/DSC as a method for the assessment of the fire behavior

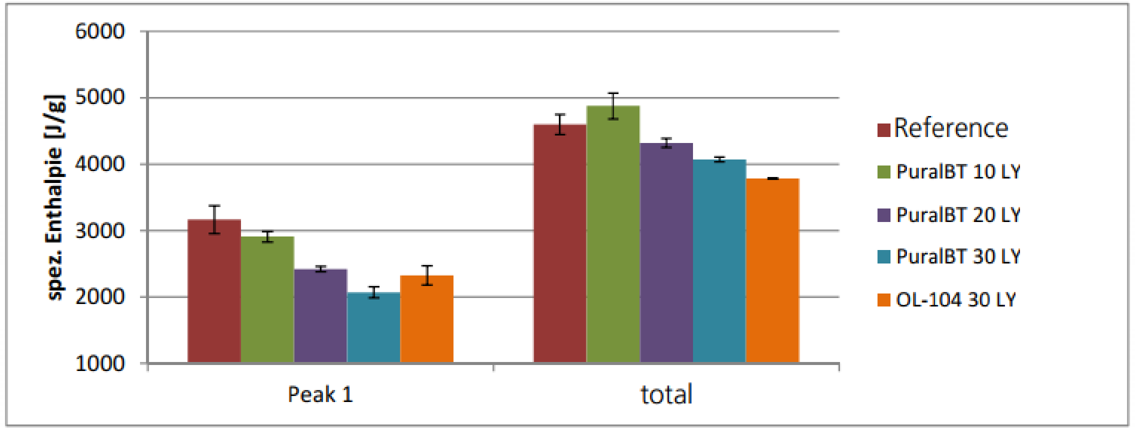

Figure 8: Characteristics of TGA/DSC measurements of ATH-containing resins in air-like atmosphere

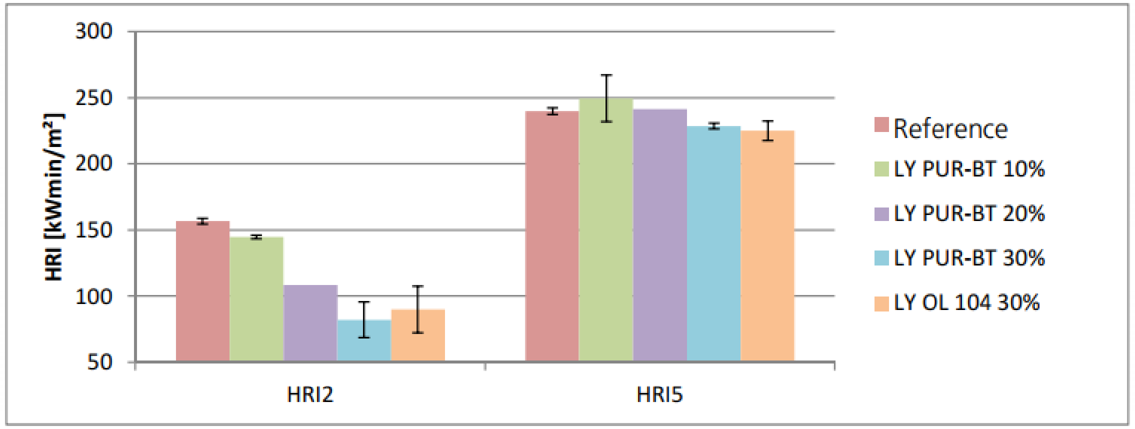

Figure 9: Characteristics of heat release measurements of ATH-containing resins in OSU-calorimeter-measurement

[A. Kühn: "The TGA/DSC as a method for the assessment of the fire behavior", 2019]

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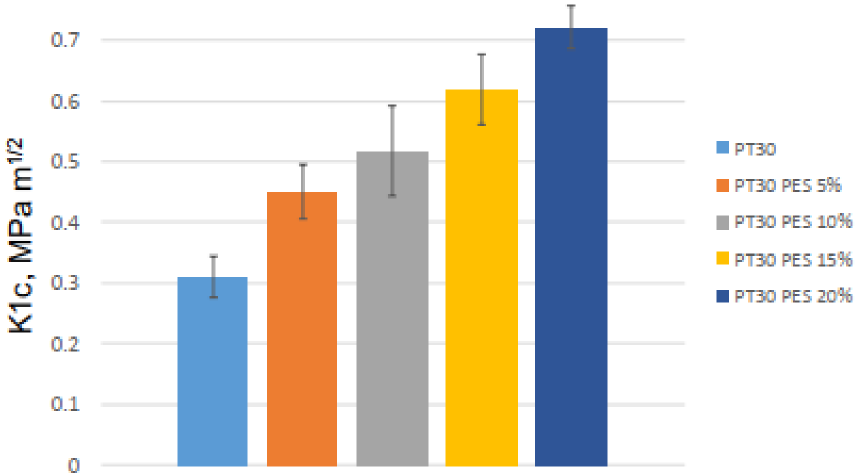
First selected results

- Material development
  - Cyanate Ester system modification
    - increasing toughness
    - accelerating curing at 180°C
    - Prepreg development
    - Manufacturing verification



Fracture toghness of PT30 - PES 1 system, [1]

→ **Detailed presentation of results:**

- [1] L. Amirova, F. Schadt, C. Brauner, M. Grob: “**Properties and structure of Cyanate Ester/Polyethersulfone composites**”, 9th EASN, 06.09.2019
- [2] F. Schadt, L. Amirova, C. Brauner, M. Grob: “**Thermoplastic particle toughening of Carbon fiber / Cyanate Ester composites**”, 9th EASN, 06.09.2019

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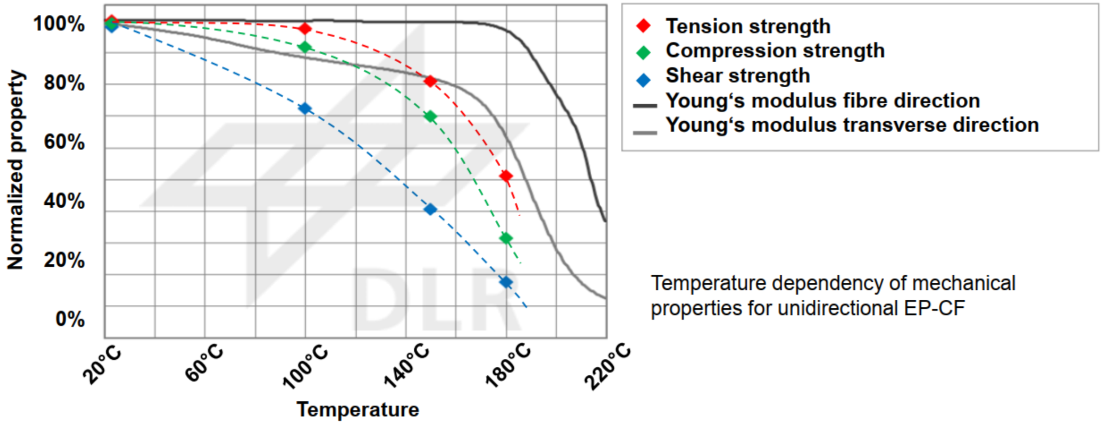
First selected results

- Analysis methods
  - Non-linear material models e.g. close to Tg

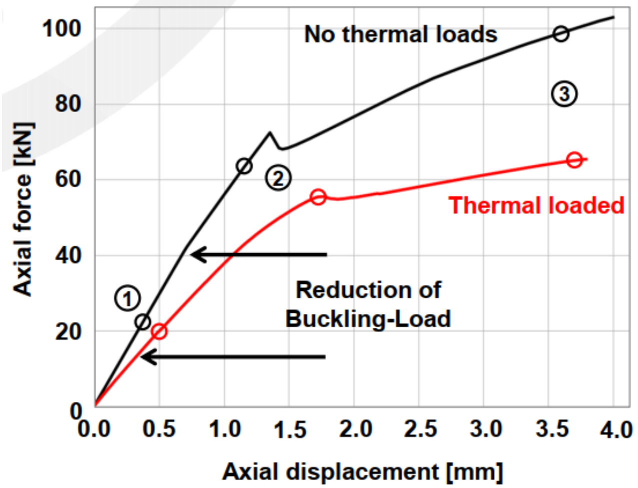


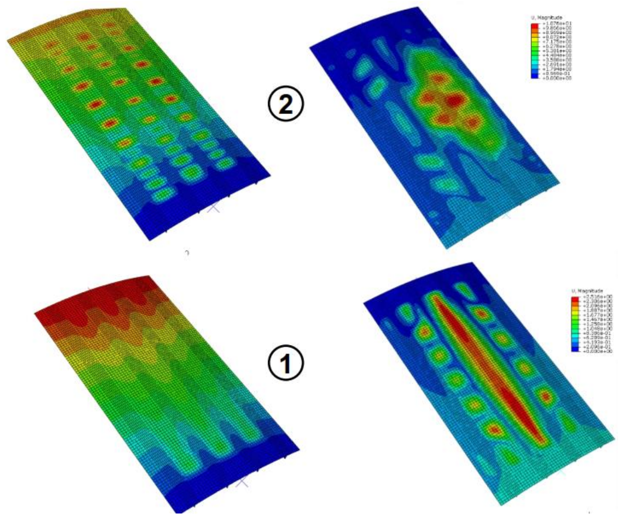
Temperature dependency of mechanical properties for unidirectional EP-CF

  - Robustness analysis procedure taking into account effects-of-defects and load uncertainties

→ **Detailed presentation of results:**

- [3] M. Liebisch, T. Wille, G. Balokas, B. Kriegesmann: "**Robustness analysis of CFRP structures under thermomechanical loading including manufacturing defects**", 9th EASN, 06.09.2019





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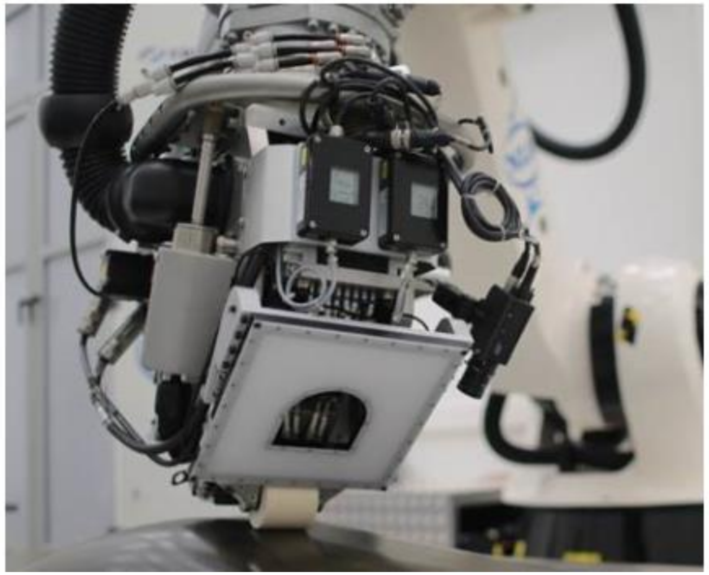
First selected results

- Sensor development
  - Camera based sensor system mounted to AFP robot

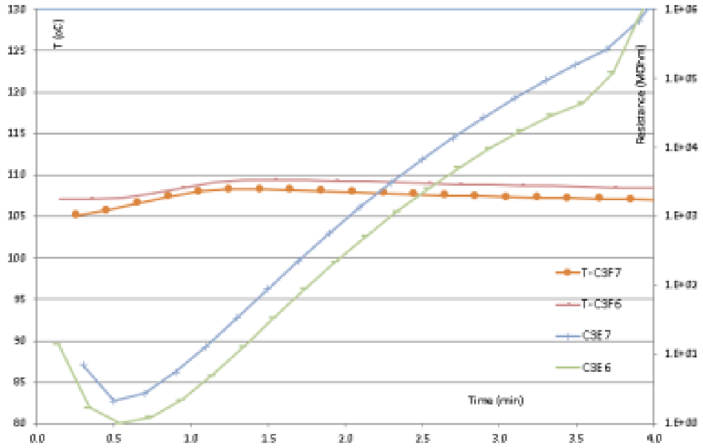


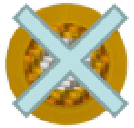
AFP monitoring sensor from Apodius integrated @ NLR

- New durable cure sensors for CFRP
- New disposable cure sensor for higher temperatures up to 250°C

→ **Detailed presentation of results:**

  - [4] N. Pantelelis et al.: “**Cure monitoring of high-temperature resins for enhancing the manufacturing of advanced composites**”, 9th EASN, 06.09.2019





New durable sensor for measuring CFRP without the need of protection developed by Synthesites, [4]

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Outlook

- Detailed coupon testing for down-selected materials
- Material modelling and validation
- Further sensor developments e.g. for FBG integration
- Structural concepts
- Thermo-mechanical tests and fire tests of validation structures
- Demonstrator preparation
  - Design
  - Manufacturing
  - Testing

Get together

- Homepage www.sucohs-project.eu
- Newsletter No 1 released on 07/05/2019, next Newsletter No 2 in October
- Linked In account created for SuCoHS (“company page”) https://www.linkedin.com/company/sucohs-project/
- Conferences
  - EASN Conference, 03-06 September 2019 in Athens
  - SAMPE Europe, 17-19 September 2019 in Nante
  - AEC conference, February 2020 in Bordeaux
  - JEC World, 03-05 March 2020 in Paris
  - ILA, 13-17 May 2020 (tandem with Aerodays 2019) in Berlin
  - ECCOMAS Congress, 19-24 July 2020 in Paris

Contact

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