Project LEVIS - Enabling the industry to shift to sustainable mobility: Methods to make lightweight automotive components a reality

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LEVIS
LIGHT MATERIALS FOR ELECTRIC VEHICLES

6th
June
23

EUROPEAN YEAR OF SKILLS

ENLIGHT EVs
FATIGUE 4LIGHT
LEVIS LIGHT MATERIALS FOR ELECTRIC VEHICLES
REVOLUTION
Alma ADVANCED LIGHT MATERIALS
FLAMINGo

3-11 June 2023
#EUGreenWeek
PARTNER EVENT

LEVIS overview

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Grant agreement ID: 101006888

Topic: LC-GV-06-2020 - Advanced light materials and their production processes for automotive applications

Timing: 02/2021-01/2024 (36 months)

EU contribution: € 4 990 113,63

Coordinator: ITAINNOVA

13 partners: 8 RTOs & 5 INDs
7 countries

The Enlight EVs cluster is formed by FATIGUE4LIGHT (GA N. 101006844), FLAMINGO (GA N. 101007011), REVOLUTION (GA N. 101006631), LEVIS (GA N. 101006888), and ALMA (GA N. 101006675).

LEVIS Main skills for lightweighting

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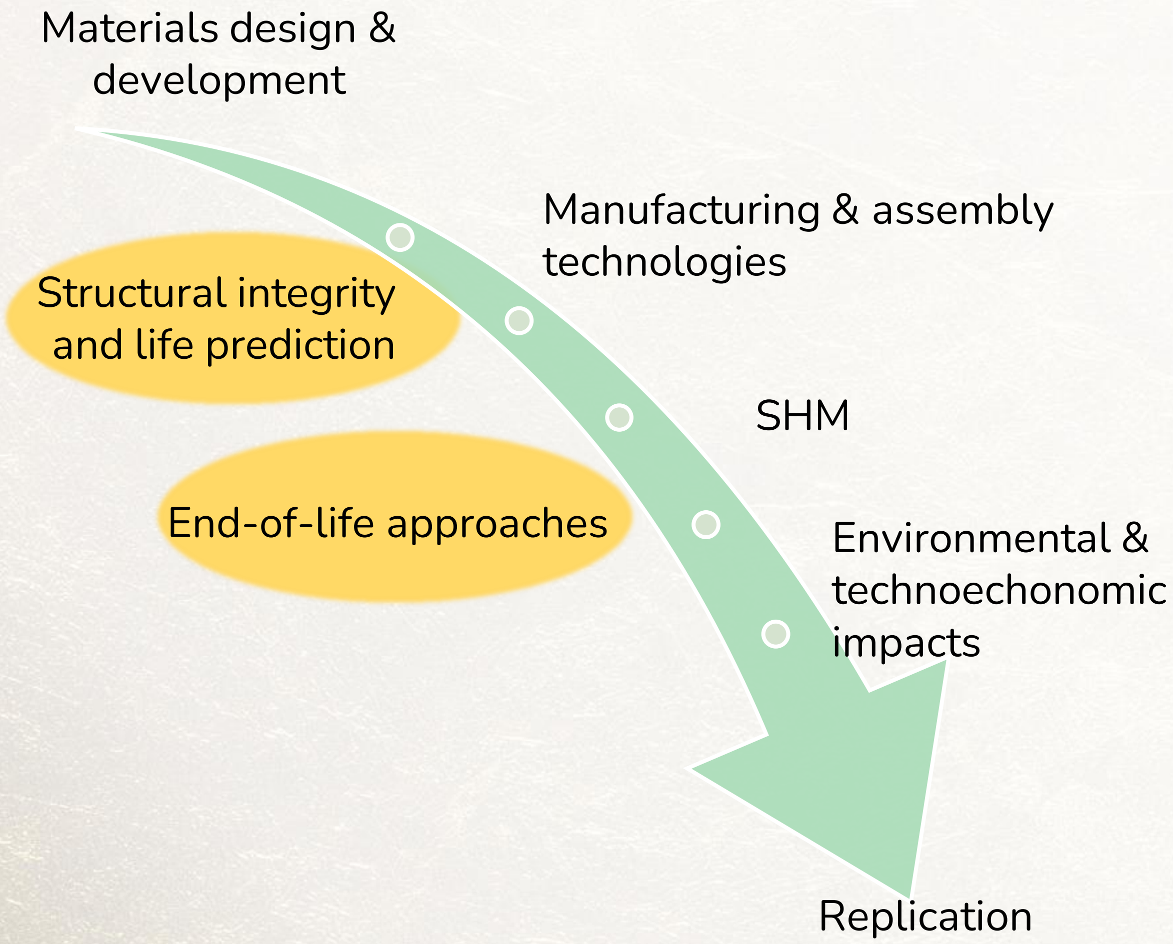
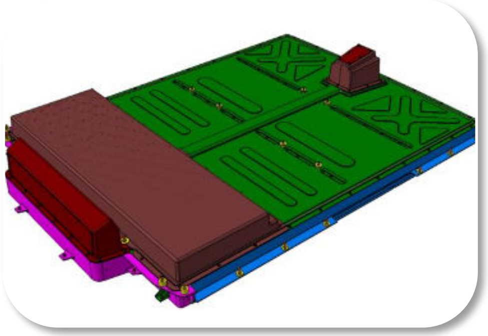
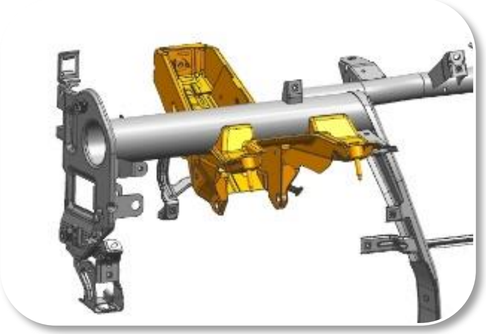


LEVIS DEMONSTRATORS


Suspension control arm


Battery box


Module box


Steering column carrier group of cross car beam

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Simulation methods for accurate failure/service life predictions and optimized designs

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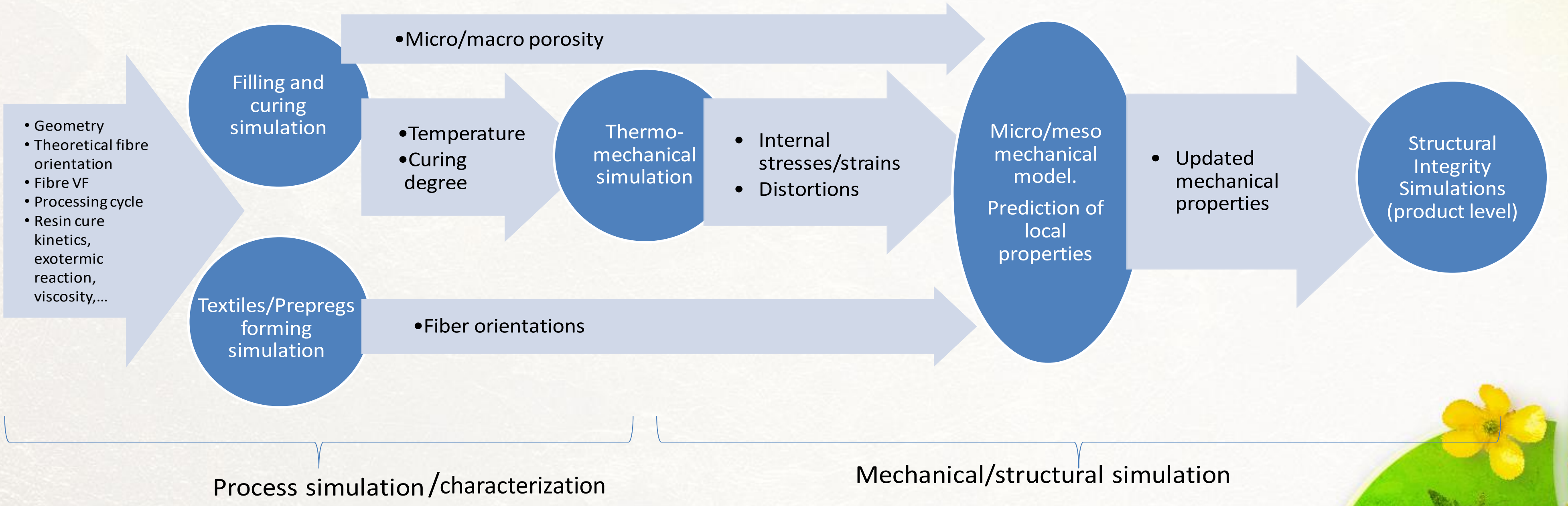

Levis Methodology: simulation workflow including process simulation and structural integrity simulations (using FEM).

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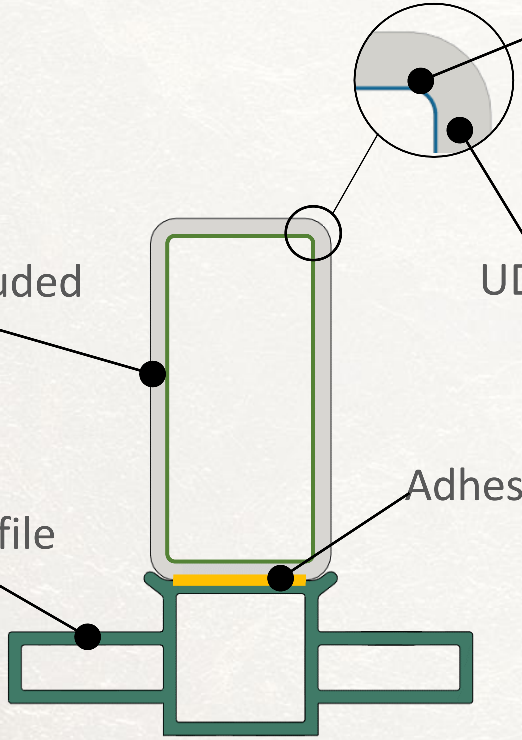
Simulation methods for accurate failure/service life predictions and optimized designs

Case example: Internal Beam of a battery box
Proposed solution: Multimaterial beam: Aluminum + CFRP + Adhesive



ASPECTS TO BE CONSIDERED

- Accurate definition of the geometry regarding the interactions with other components
- Proper material definition based on experimental characterization and micromechanics models
- Definition of Finite element simulations needed to confirm structural stability
- Definition of failure criteria for each material

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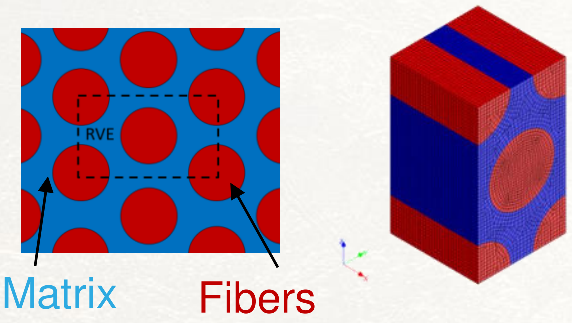
- **Proper material definition** (mechanical and thermal)
- Based on experimental methods of characterization (ideally)
- Complemented with computational methods: Homogenized properties of composites from individual material properties
- Possibility to introduce processing effects (fibre fraction, orientations, …)

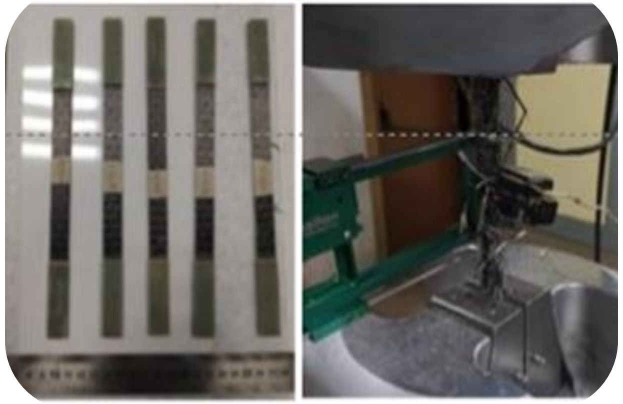
VF
Fibre size & properties
Matrix properties



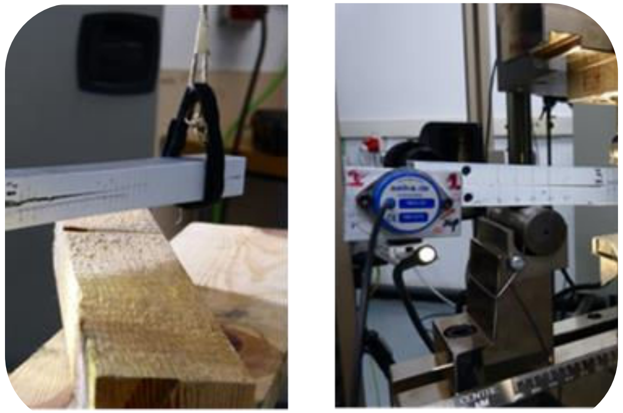
Homogeneouos UD CFRP and RVE considered in the properties analysis

Homogenized properties:

- Linear elastic
- Strength
- Thermal



Mechanical characterization of the CFRP



Characterization of the fracture toughness of the adhesive

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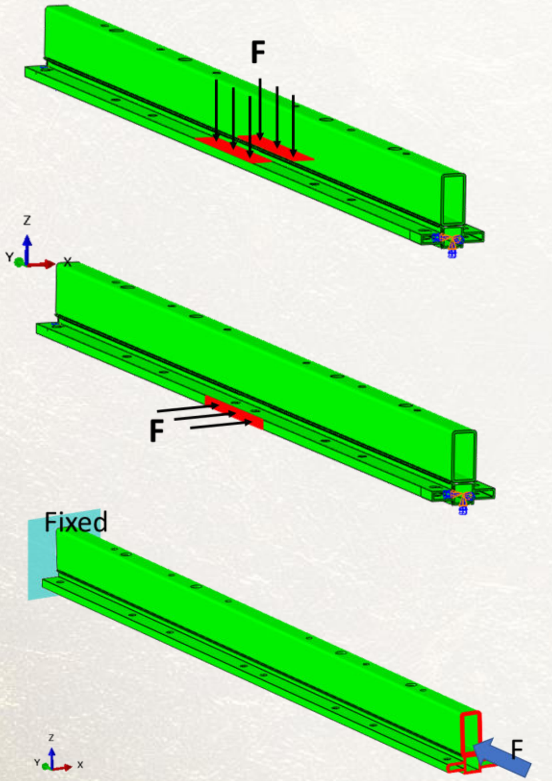
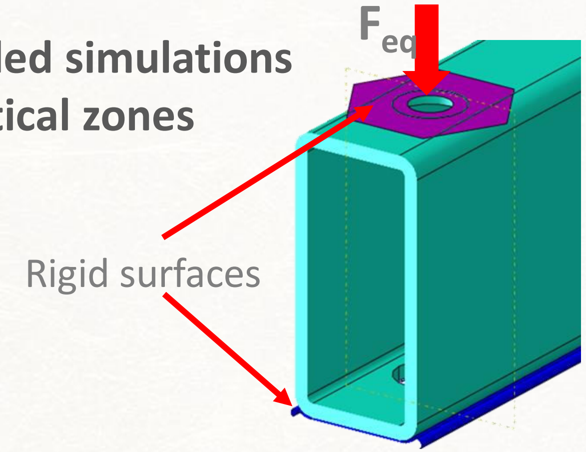
Simulation methods for accurate failure/service life predictions and optimized designs

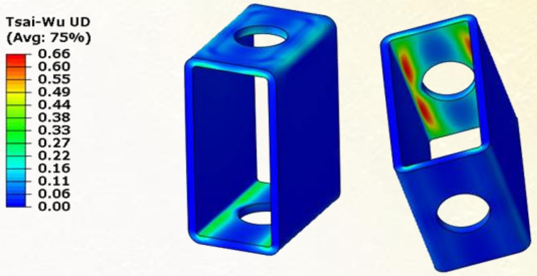
- **Definition of FE simulations** needed to assess failure prediction

Bending and compression

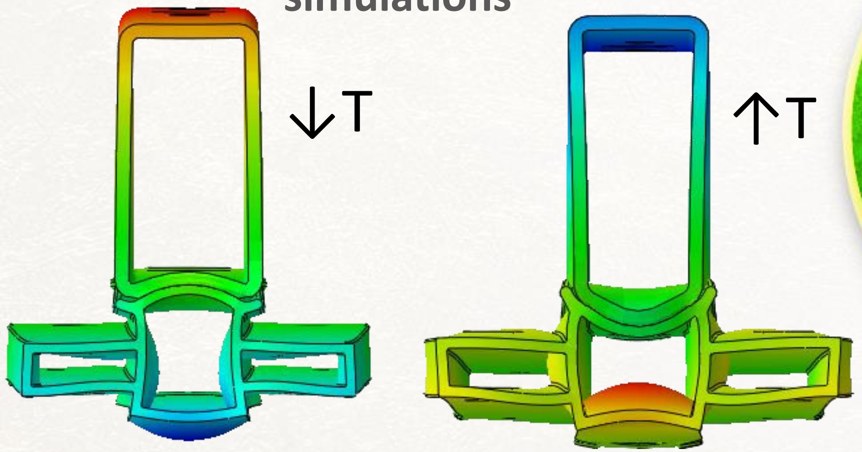


Detailed simulations of critical zones





Thermal expansion simulations



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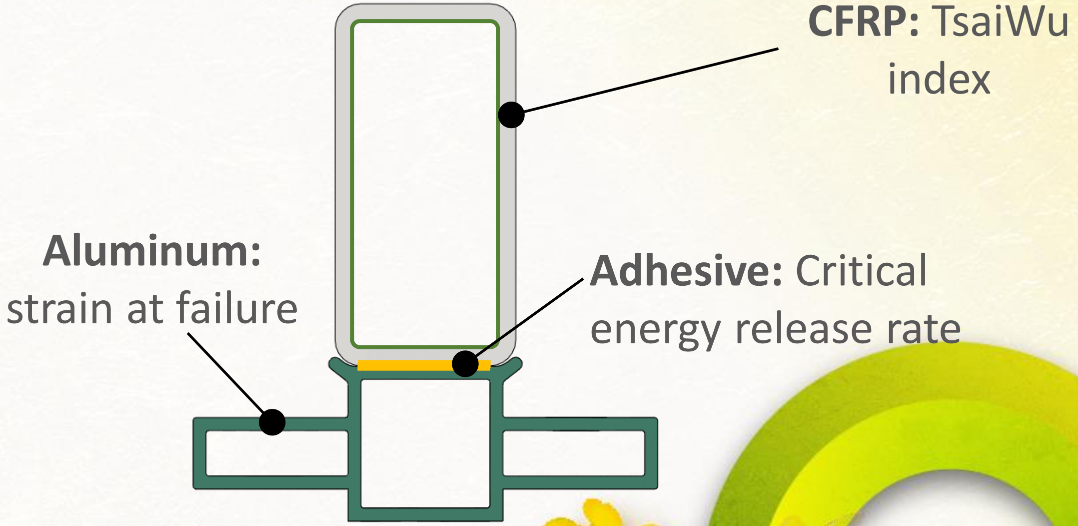
Simulation methods for accurate failure/service life predictions and optimized designs

- **Definition of proper failure criteria** for each material attending to its behavior/definition in the models
- Allows to detect the weakest link and modify materials/geometry if needed
- The component fails when any of the materials fails



Summary:

- Combination of process simulations and structural integrity simulations adapted to each component to accurately analyze its failure
- Combination of experimental and computational information to create accurate models
- Possibility of investigate easily different materials, geometries, etc

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Closed-loop recyclabe CFRTP & relative recycling process

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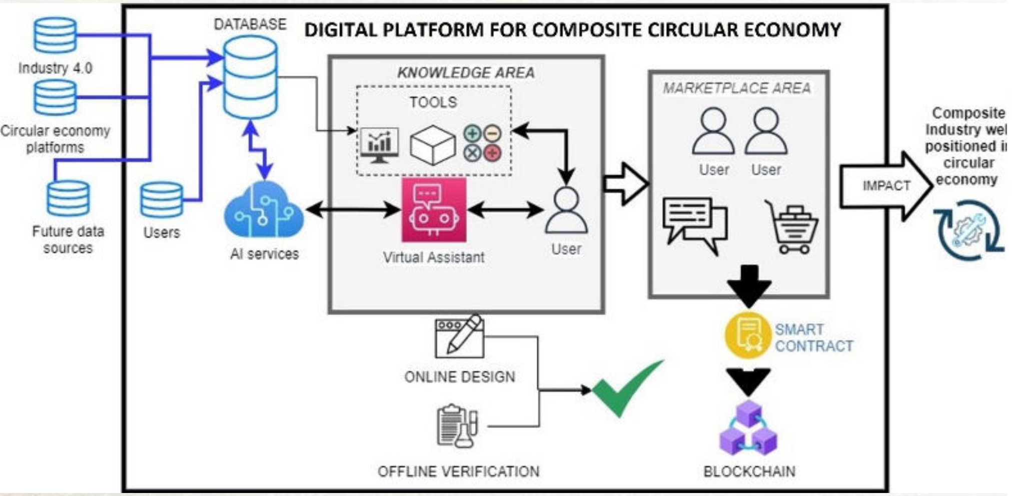
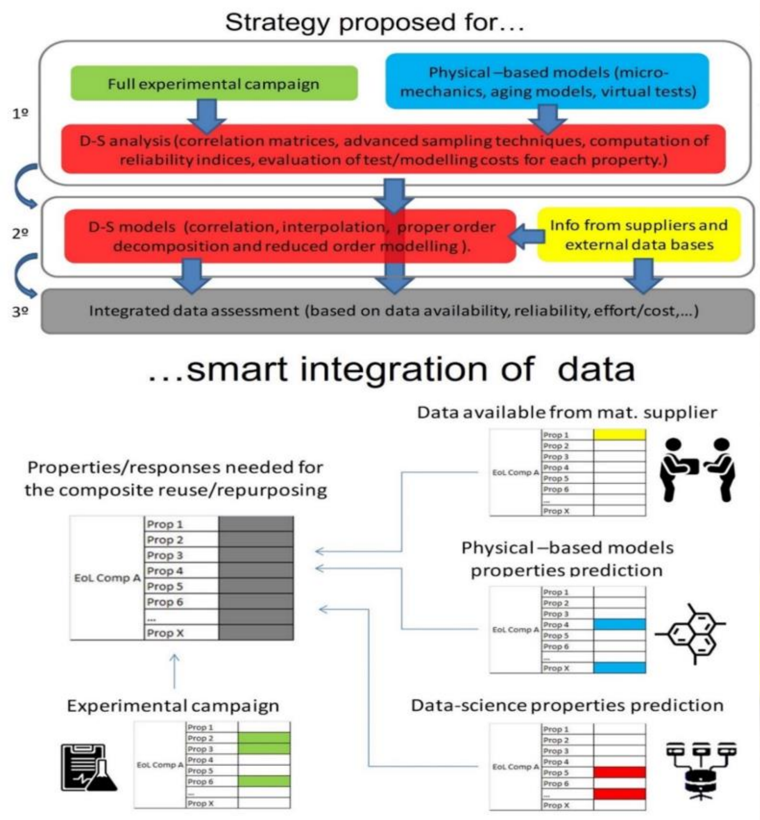
- **Prerequisite**: the composite EoL must be harvested with the maximum retained value, which can only be achieved by a systemic approach for sorting, inspection, characterization and dismantling



An advanced digital ecosystem to implement materials market, design, on-line & off-line testing, sustainability evaluation



A prospective concept & method designed for composite EoL parts evaluation

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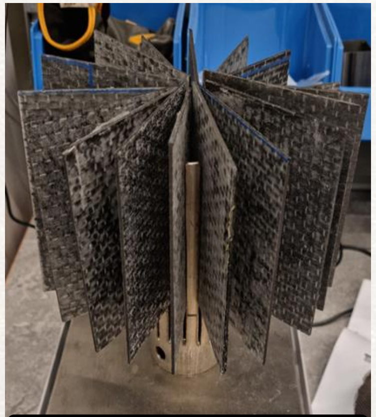
- **Overall rules underpinning the LEVIS EoL strategies**
  - Parts without damage & with good service status to be directly used in structures with identical or similar requirements
  - Parts with minor damages, which occur mostly in resin-rich regions to be repaired and then used for structures with comparable requirements
  - Parts with catastrophic damages, which occur mostly throughout the fibre reinforcement and cannot be repaired, to be recycled by reclamation of constituents (fibres, resins and chemicals, etc.) followed by remanufacturing of structures

- **LEVIS CFRTP demos and EoL strategies & recycling approaches**

LEVIS demos	Elium resin based composites & hybrid structures		PA resin based composites & hybrid structures	
	Side beam & internal profile in the battery casing, hybridized with Al	**Suspension control arm**, neat CF/Elium composite	**Cross car beam**, hybridized with steel	**Upper cover of the battery casing & battery module casing**, neat PA/CF composites
EoL & recycling	Dismantling through controlled heating	Low-temp pyrolysis	Dismantling through controlled heating	1) CL recycling: chemical treatment to fully recover PA & high-degree alignment of discontinuous rCFs 2) Pelletization followed by injection or compression moulding

Closed-loop recyclabe CFRTP & relative recycling process

- **Recycling of CF/Elium composites**
  - Successful low-temperature pyrolysis in N_2 (420°C/4 h)
  - rCF fabrics kept good structural integrity, beneficial for cost-effective manufacturing of secondary composites
  - Low amount of gas (~3%) indicates most materials being preserved instead of being decomposed
  - Strength and modulus of rCF compared with virgin fibre: 85% of tensile strength preserved, modulus not influenced
  - GC/MS spectrum shows almost a sole peak of MMA



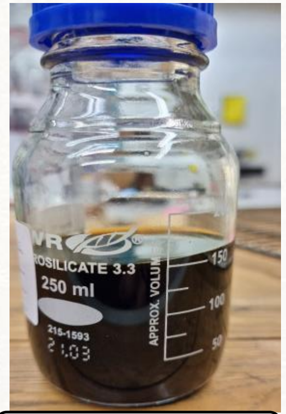
CFRP plates before pyrolysis

N2, 420°C

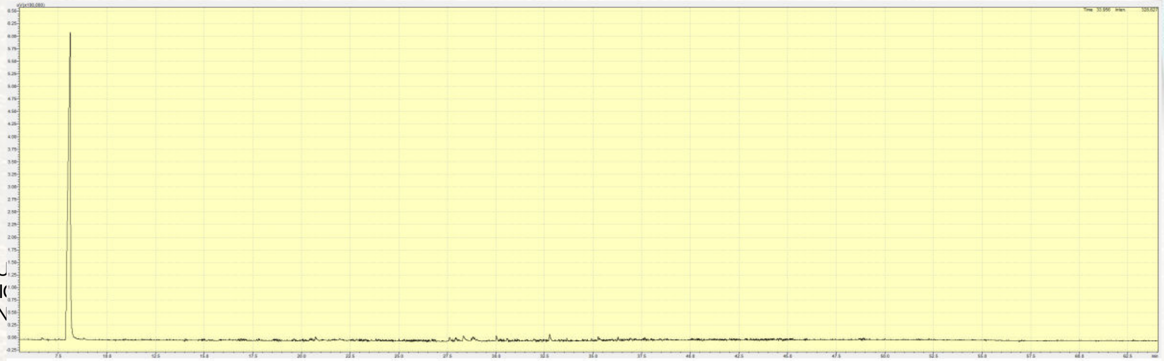
4 h

CF fabrics after pyrolysis

+



Appearance of collected crude oil



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