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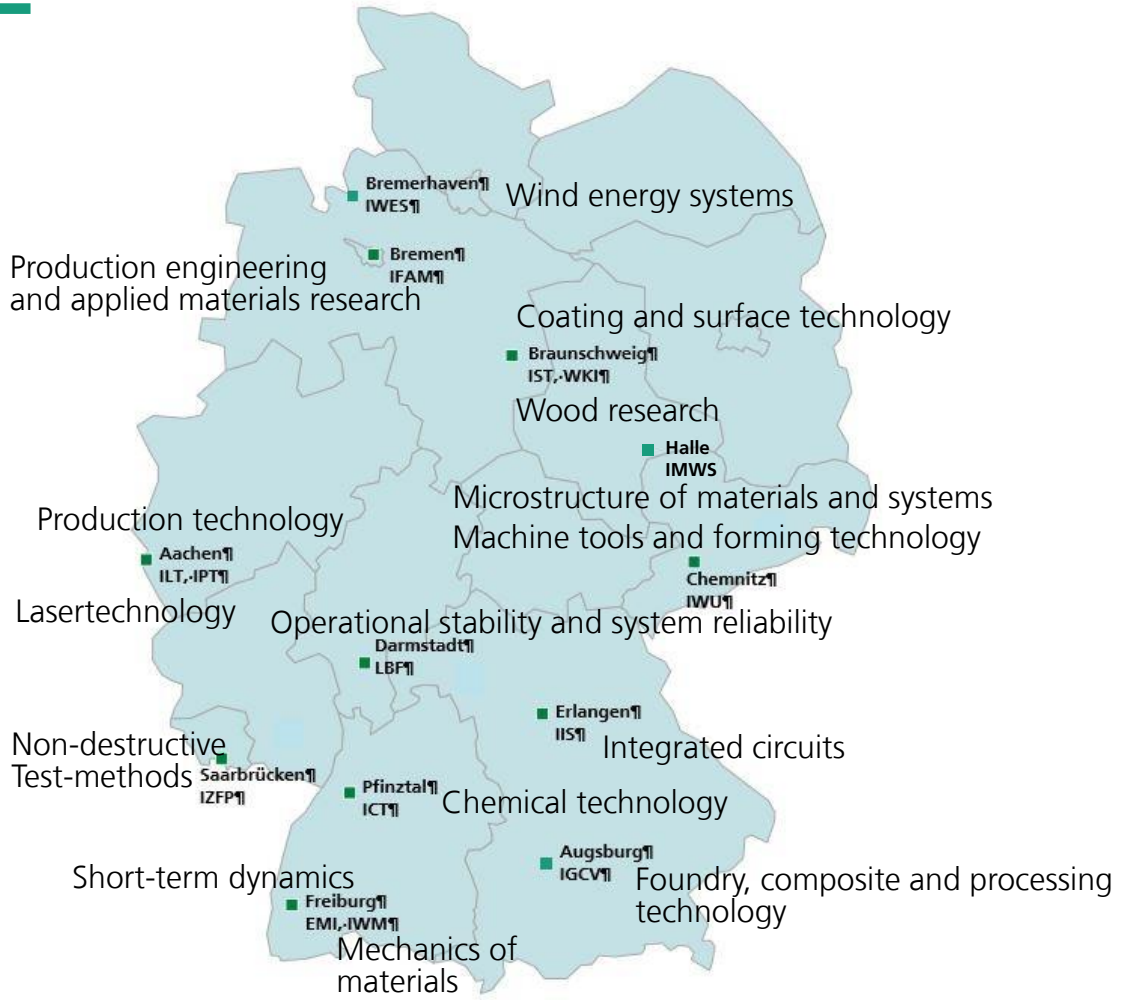
Fraunhofer Research Field Lightweight Construction

FROM CONCEPT TO PRODUCT

» CUSTOMISED EXPERTISE FROM 15 INSTITUTES«

Fraunhofer Research Field Lightweight Construction

A consortium of 15 cooperating Fraunhofer Institutes



Co-operating Fraunhofer Institutes

Short-Term Dynamics, Ernst-Mach-Institut, EMI | Chemical Technology, ICT | Production Engineering and Applied Materials Research, IFAM | Foundry, composite and processing technology, IGCV | Integrated circuits, IIS | Lasertechnology, ILT | Microstructure of materials and systems, IMWS | Production technology, IPT | Coating and surface technology, IST | Wind energy systems, IWES | Mechanics of materials, IWM | Machine tools and forming technology, IWU | Non-Destructive Test-methods, IZFP | Structural Durability and System Reliability, LBF | Wood research, WKI

Fraunhofer Research Field Lightweight Construction

Why and how do I get in touch?

Kunde

R&D services &
Products
(Reports, Contracts)
From a single source

R&D Services & Products

Material and component evaluation
Production and processing of structural and functional components
Further training »Composite Engineer«

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Consortium formation

Fraunhofer Research Field Lightweight Construction

Contend

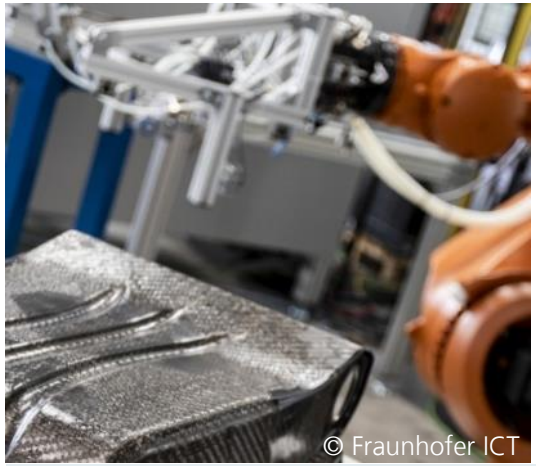
1. Exptertise at a glance
   - Manufacturing technologies
   - Evaluation
   - Component testing, valdiation
2. Key topics
   - Circular economy
   - Lightweight construction of battery-powered vehicels
   - Lightweight contruction for hydogen technologies
   - LCA for lightweight solutions
3. Further training programme »Composite Engineer«

01

Expertise at a glance

Manufacturing technologies

Process chains, automation

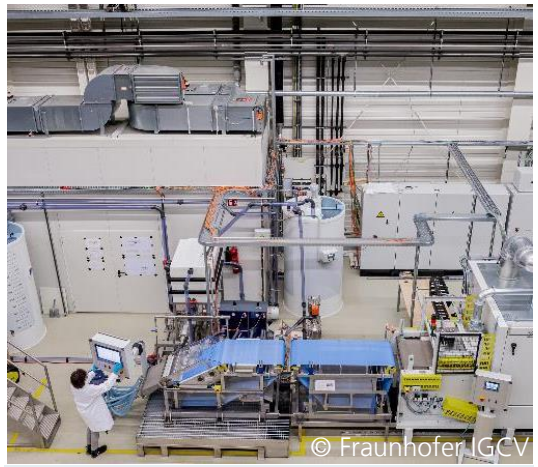


Hybrid thermoplastic structural components

RTM and high-pressure RTM wet pressing processes
Pultrusion Tape laying, consolidation and compression moulding

Tape laying and prepreg processing

Systems and processes for automated tape and prepreg processing
Thermoplastic tape laying
Thermoset prepreg and towpreg processing



Wetlaid nonwoven line on a pilot plant scale

Processing of any fibre materials - especially recycled carbon fibres - into innovative and novel nonwovens

Aluminium-foam sandwich structures

Rail vehicle drive head 18 % weight reduction to 1402 kg
High rigidity
High Energy absorption

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Manufacturing technologies

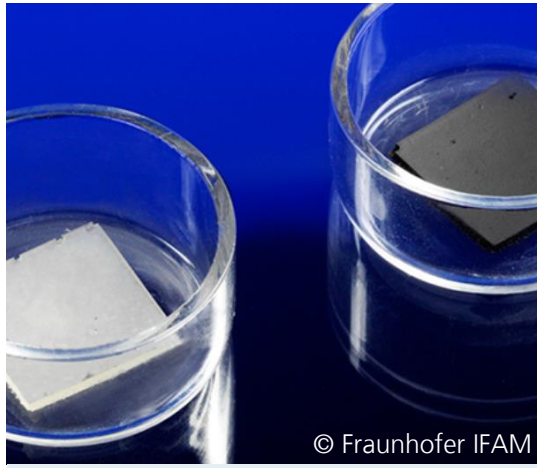
Processing/finishing, joining technology, surfaces

Laser cutting of lightweight structures

Fibre-reinforced materials

Metallic materials

Optimisation of cutting speed, efficiency, quality and robustness



Adhesive technology

Adhesive selection

Dosing and application technology

Creation of predictions of ageing behaviour based on kinetic models

Rotor blade production

Design for recycling

Sustainable production

Efficient use of adhesives

Condition monitoring

Multifunctional and smart surface finishes

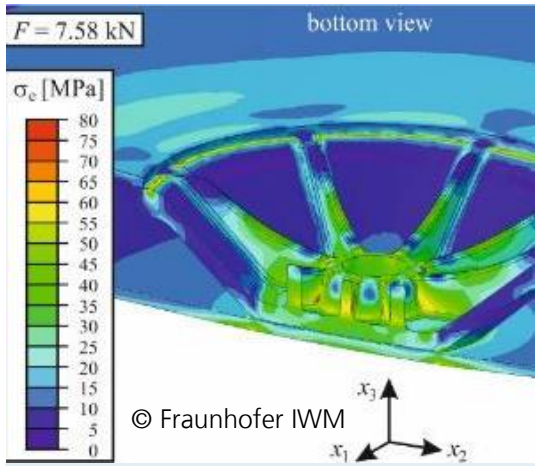
Tribological and optical functions

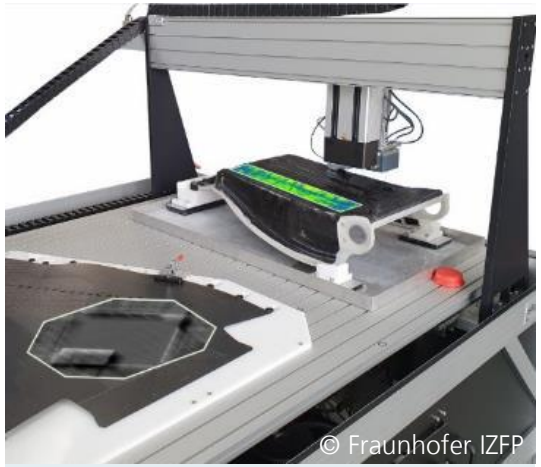
Non-stick or antibacterial properties

Thin-film sensor technology

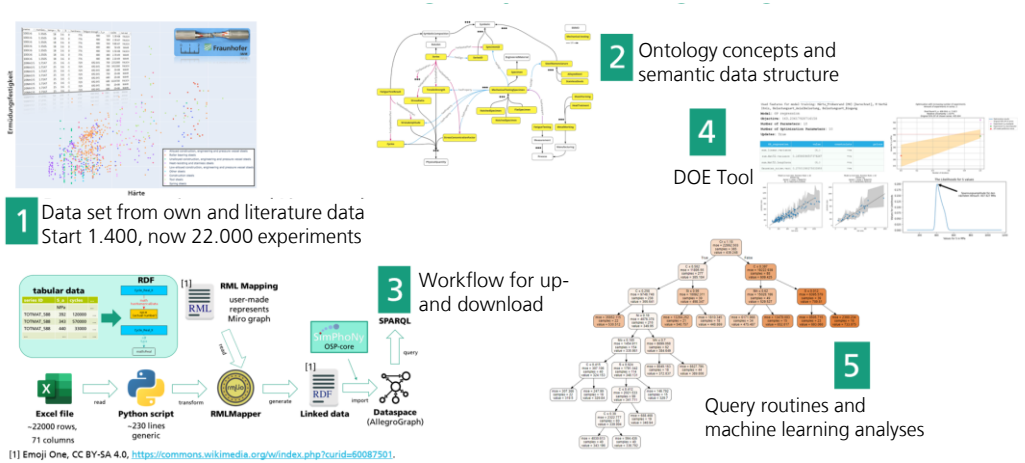
Assessment

Component simulation, quality control and digitalisation





Example: Fatigue behaviour of high-strength steels



Numerical simulation

Exampel: load transfer elements, detailed analyses for concept phase and operation

Stiffness, Structural robustness; creep rupture properties, service life, ageing

Sensor systems for inline quality control

Development and implementation of hardware and software solutions

Diconde server for data archiving

Material digitalisation along the value chain

Consolidation of scattered and unstructured data into a well-founded knowledge database

Curating data sets for machine learning analyses

Enabling traceability

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Component testing
Validation


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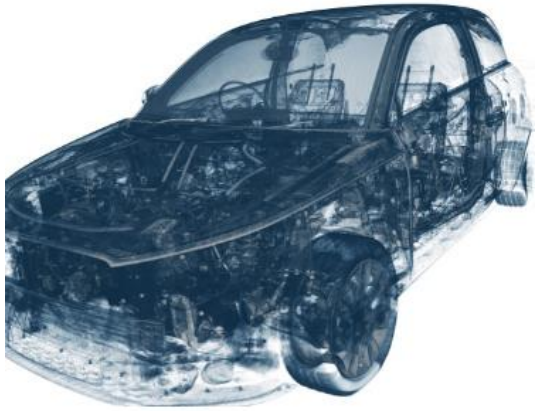
Wood-based material and natural fibre technologies
Load-bearing behaviour, quality testing and evaluation, fire protection
Recycling of waste wood and biocomposites (WPC)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XXL-CT / high-energy CT
which can be used to examine large objects, e.g. entire vehicles. Measurement data acquisition, correction procedures, reconstruction and X-ray image processing.


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X-ray Car Crash
Use of X-ray diagnostics enables observation of the dynamic behaviour of hidden vehicle structures under crash load


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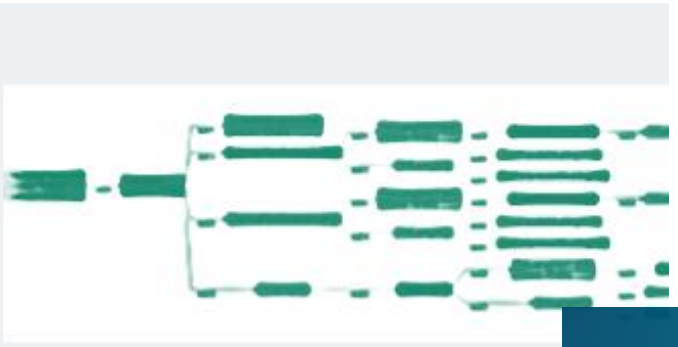
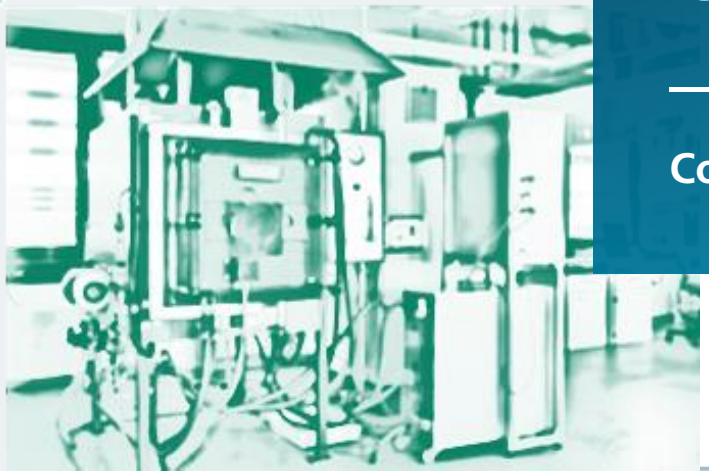
Full scale vehicle test bench
Introduction of vertical, longitudinal and lateral forces as well as steering and braking torques
For vehicles weighing up to six tonnes

02

Main topics





Circular economy

Concepts | Methods | Components

Development of recycled plastics with a focus on their operational stability and service life for a sustainable circular economy

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Fraunhofer LBF - Plastics research area - YouTube

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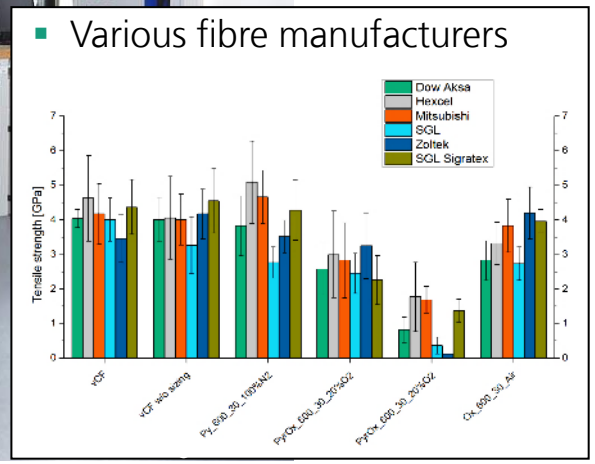
Recycling of Composites

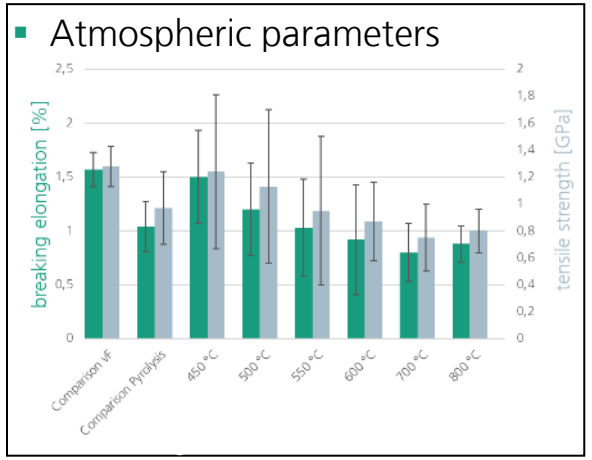
Separation of fibres and matrix using pyrolysis

© Fraunhofer IGCV

Pyrolytic oven on IGCV

- 440 x 700 x 540mm³ (WxLxH)
- Maximum Temperature: 800 °C
- Adjustable atmosphere (Ar, N_2, O_2)
- Heating rate: 6K/min
- Oxidation and partial oxidation possible





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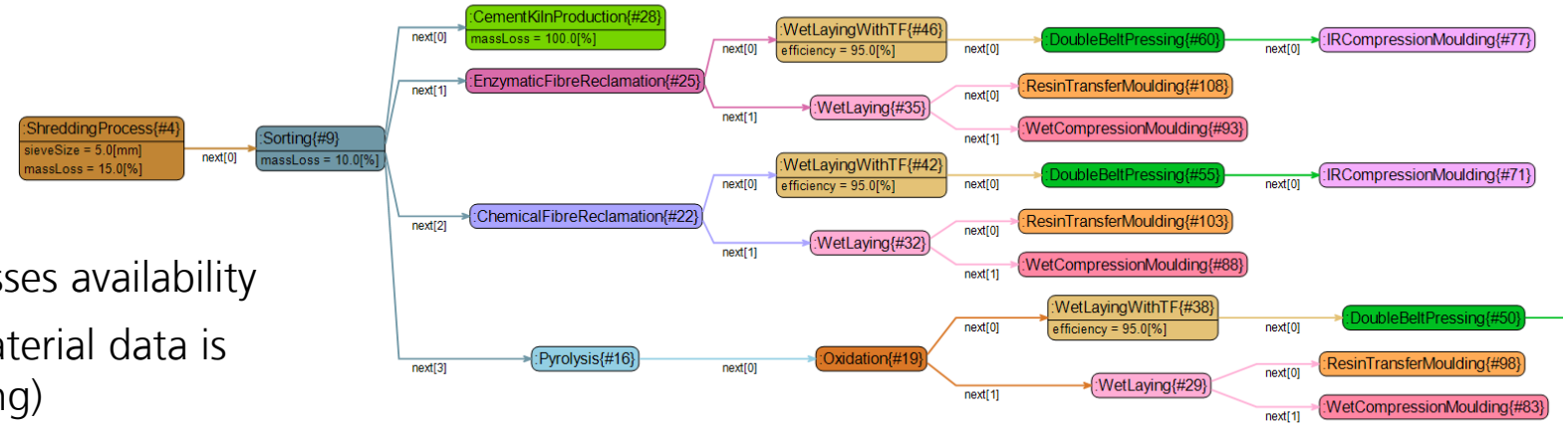
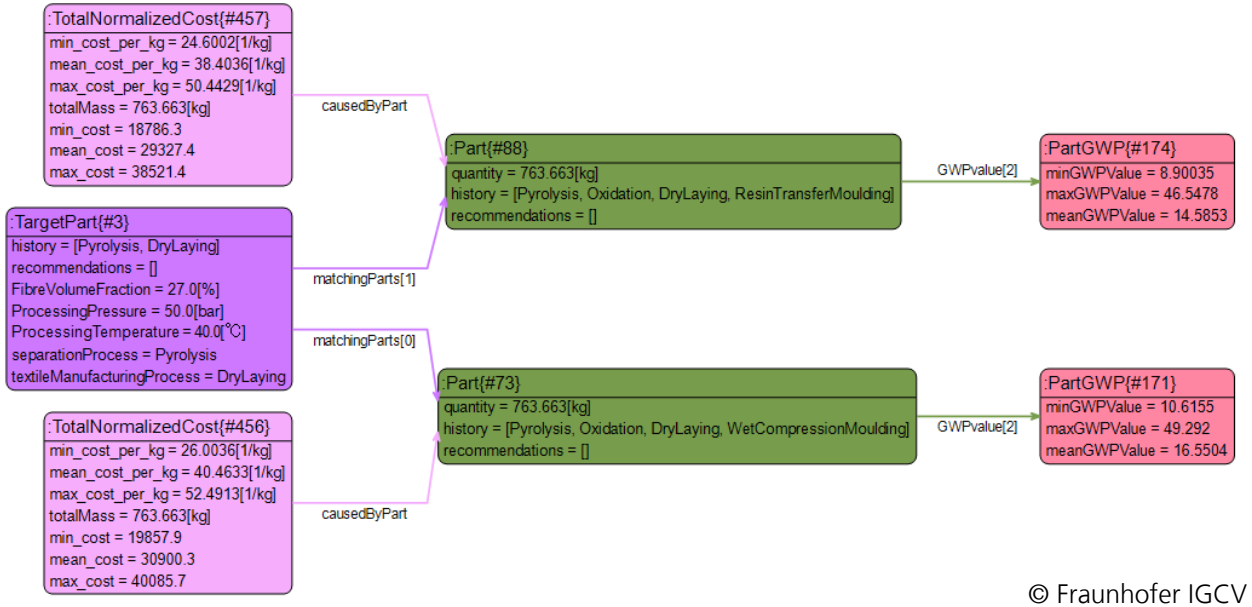
Digital circular economy

Challenges and potential

- Lack of information for recycling processes availability
  - Quality and quantity of recycled material data is missing (digital know-how modelling)
  - Transparence in available recycling processes
- Ontologies for recycling processes help to find the best suited and price effective recycling routes
- Digital Twins will help to disassemble parts, shred and sort multi-materials
- Including Design2Recycling within the design process of parts
- Adaptive and intelligent process control help with more fluctuating material input

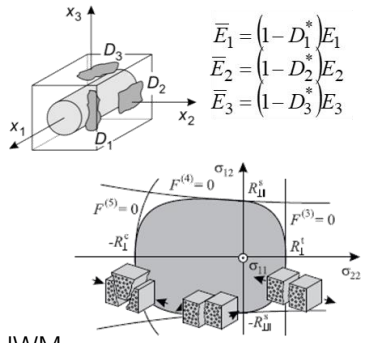


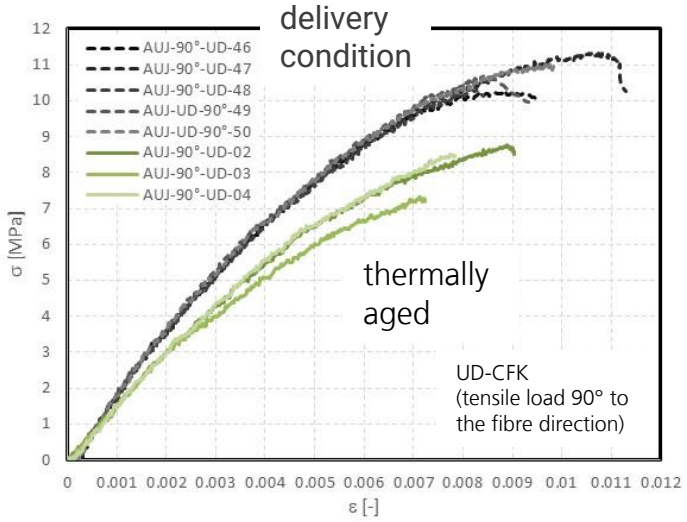


Prediction of the degradation behaviour

Characterisation and modelling of the ageing of reinforced and unreinforced plastics

- Ageing due to
  - UV exposure and condensation
  - Constant or cyclical (long-term) temperature exposure
  - Constant or cyclical (long-term) moisture exposure
- Determination of resulting material characteristics
- Modelling for the prediction of ageing effects



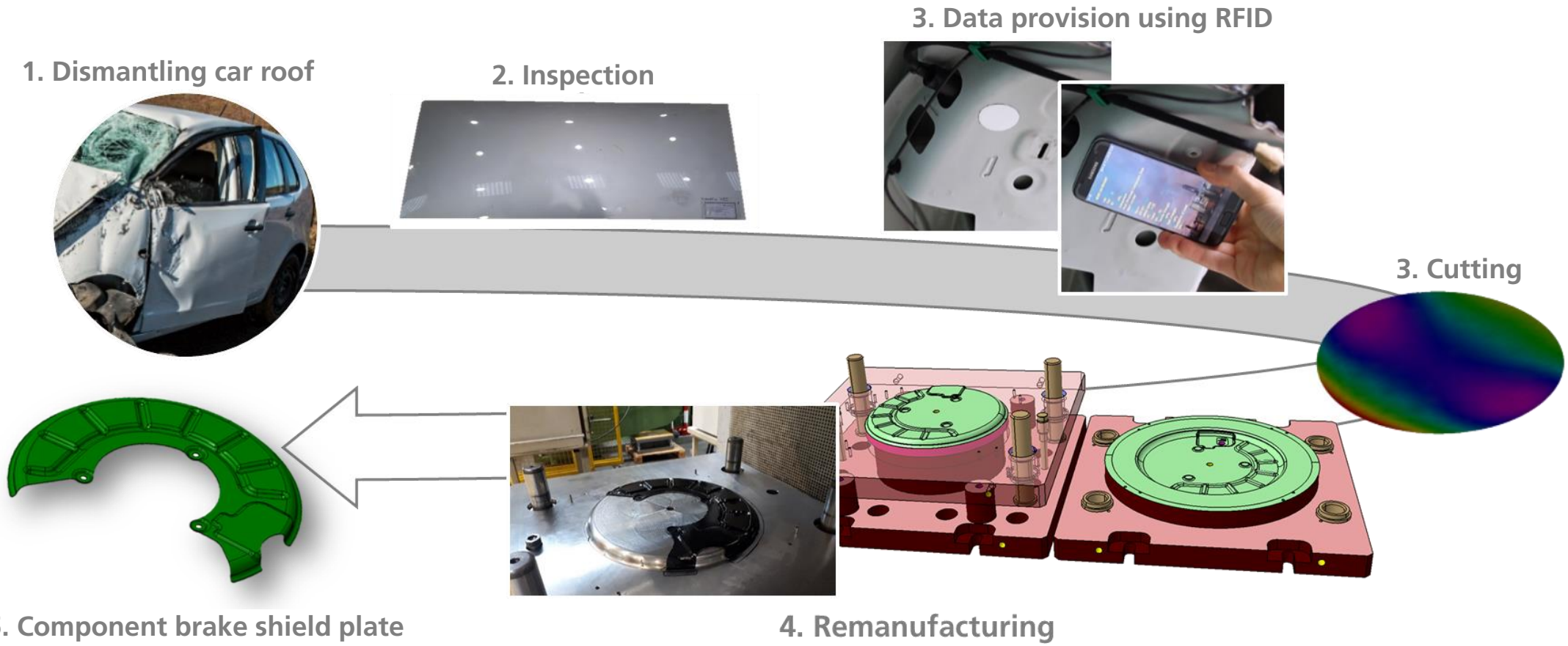


Climate chamber

Weathering system

Circular products and resource-conserving (re)fabrication

reProd® - Example: From car roof to brake shield plate



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Lightweight construction of battery-powered vehicles

Design | Production | Suitability for use

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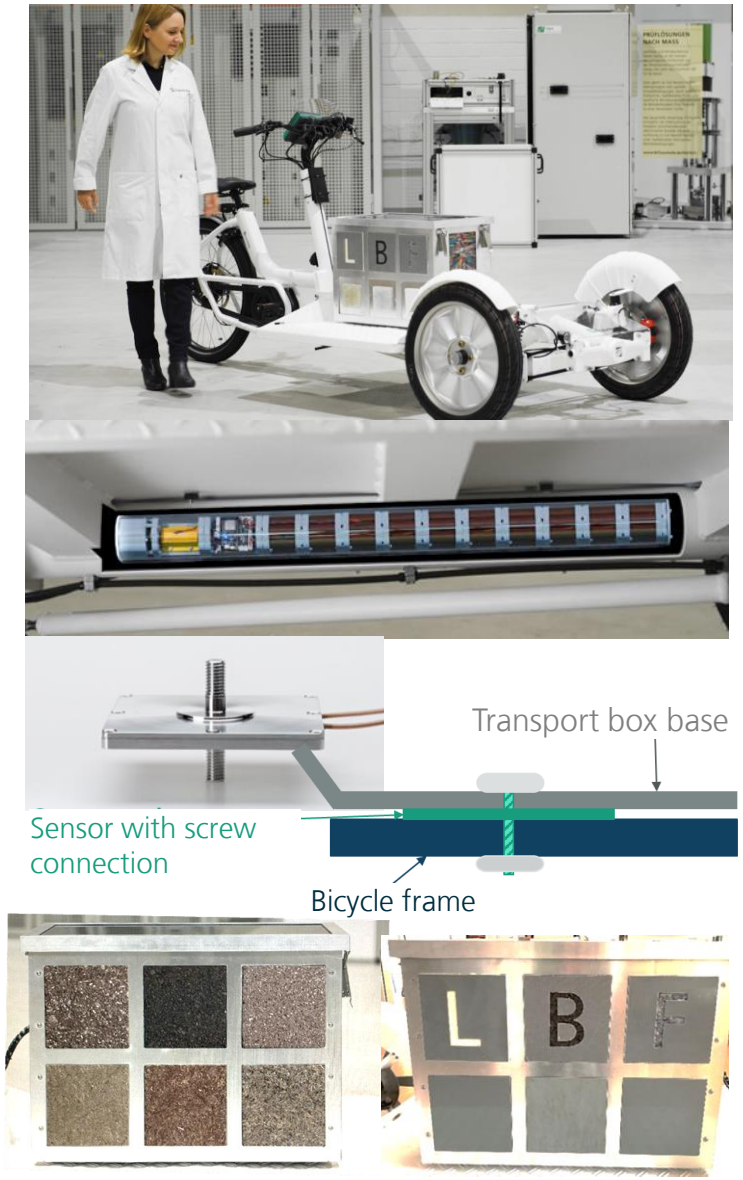
Functionally integrated lightweight construction

Lightweight cargo bike (L-LBF)

Redesign of the front end to realise the following advantages:

Mass reduction of approx. 40 %

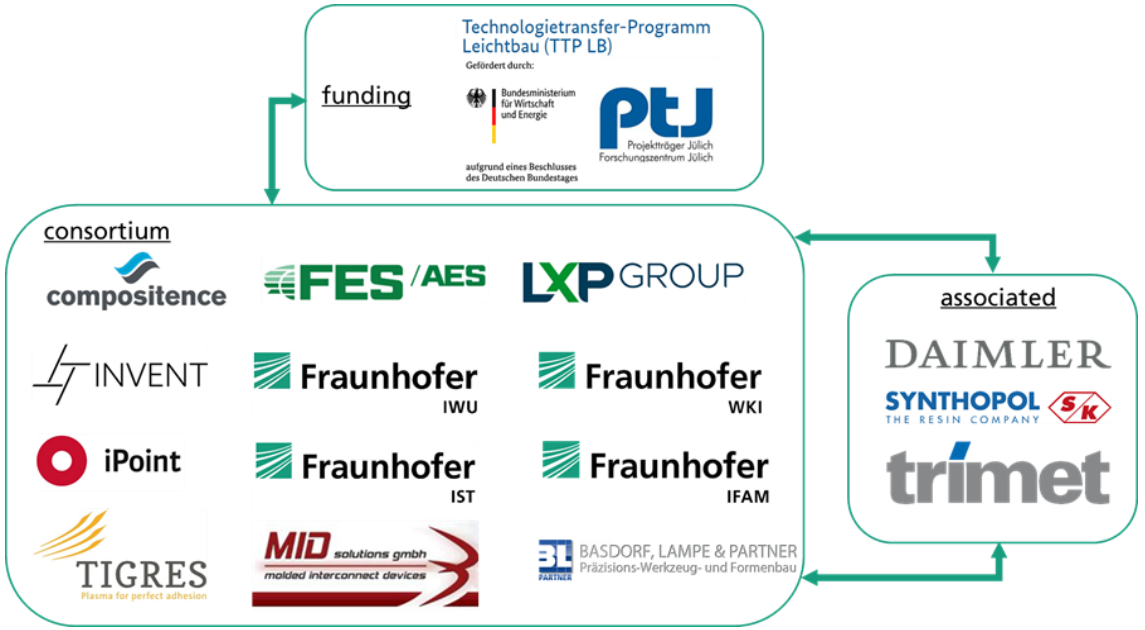
- Integration of a tubular battery system with double the capacity (1000 Wh) compared to the commercial system in the frame structure (weatherproof and theft-proof)
- Integration of sensory connecting elements between the frame and sustainable transport boxes, which are made from 100% organic materials or 100% recycled materials



CoolBat

CO2-SAVING LIGHTWEIGHT SOLUTIONS ON THE DEMONSTRATOR BATTERY HOUSING OF THE NEXT GENERATION

- **Finances**
- **Funding: BMWi: TTP Lightweight Construction Call for Proposals**
- **Total volume: approx. 4,600 T €**
- **Timetable: 01.05.2021 - 30.04.2024**
- **Focal points of the project:**
- **CO2 balancing**
- **LCA and LCC Materials, technologies and systems**
- **Development of internal support structures with integrated temperature control channels**
- **Development of functionally integrated external load-bearing structures**
- **Development of sustainable fire protection materials**
- **Development of load path-optimised covers**
- **Demonstrator development with proof of CO2 reduction**



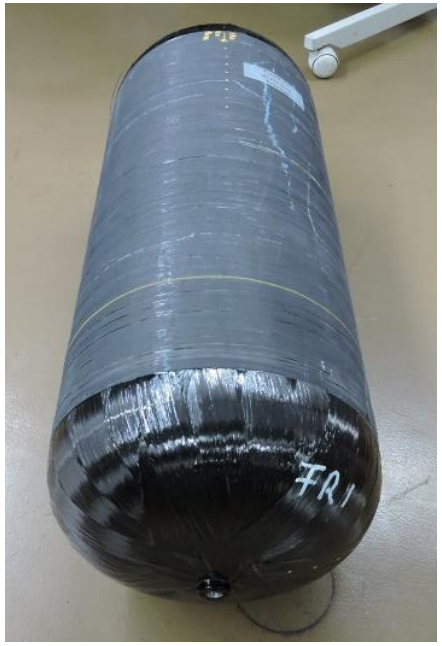
Lightweight construction for Hydrogen technologies

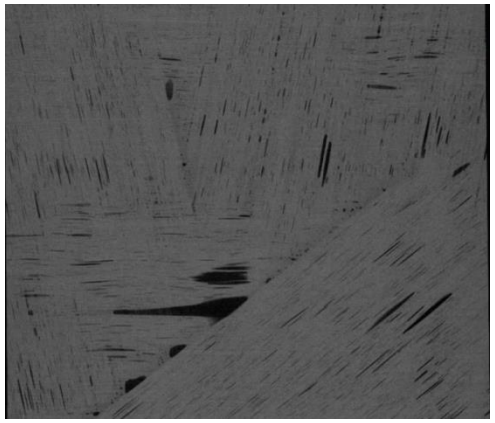
Production | Infrastructure | Material assessment

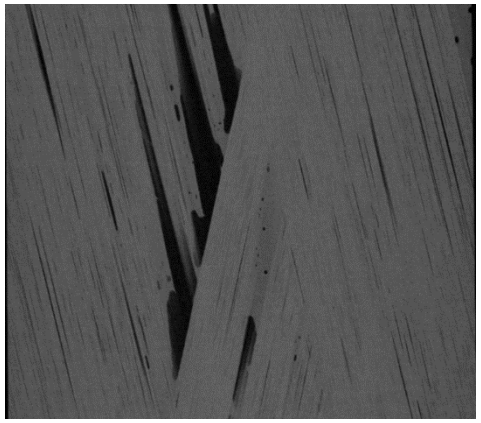
Probabilistic evaluation of high-pressure H2 tanks

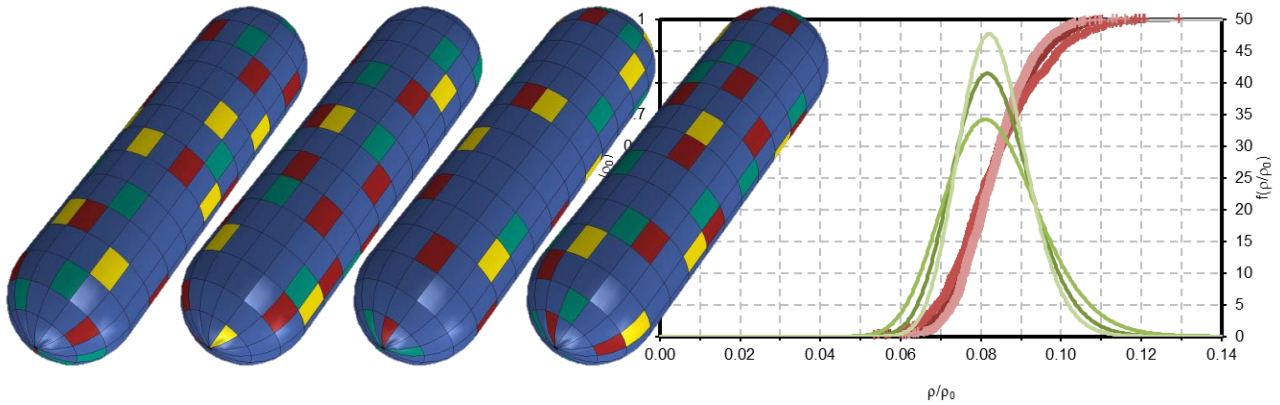
Load limits, service life estimation

- Development of CFRP H2 high-pressure tanks (1000 bar)
- Problem
  - Inherent production-related imperfections in the CFRP shell
  - form starting points for failure
  - discontinuities stochastically distributed
- Solution: probabilistic evaluation concept









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LCA for Lightweight solutions

Resource efficiency | Sustainability assessment

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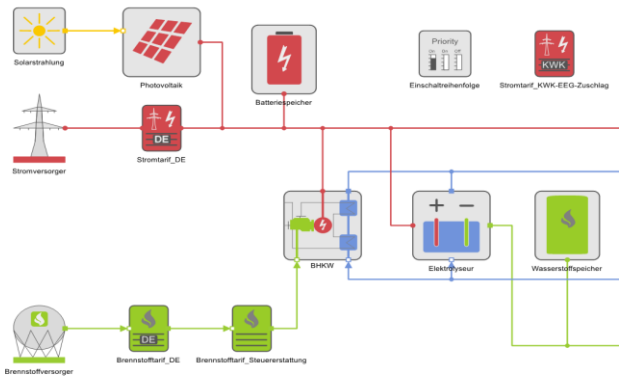
Sustainable production systems

Main topics

Sustainable energy supply concepts

- **Dimensioning of sustainable energy supply conceptse**
- **Energy procurement, generation** and **suitable storage technologies**
- Reliable information basis for **(short, medium and long-term) planning options** for investment decisions

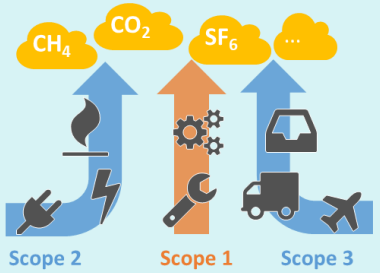


Sustainable production planning and control

- **Sustainability-related value stream analysis**
- **Development of suitable key figure systems** (energy costs, CO2-eqv., etc.) for a multi-criteria PPS
- Development of suitable operating strategies for holistic optimization
- **Integration** of additional control variables in commercially available **PPS software systems**

Product and company-related sustainability assessment

- **Creation of transparency** to identify key emitters, levers and selection of **optimal solutions** (e.g. energy supply, supply chains, use of materials, manufacturing processes)
- **Identification of product- & company-related environmental impacts** (e.g. CO2 footprint)



Activities in the field of LCA with a focus on the composites sector

Transparent data basis for rCFRP process chains from the MAI ÖkoCap and Infinity projects

- Guideline on the technical, economic and ecological potential of recycling and using rCF
- Web application on recycling and the use of rCF

Continuous expansion of the commercial supplementary database „Extension database XXII: carbon composites"

- Current scope of 182 data records, of which:
  - 50 data records Carbon fibre production
  - 20 data records for semi-finished products
  - 72 data records for individual production processes
  - 40 data records Production aggregated

Integration of holistic assessment into the development phases of composites

- Expansion of developments from completed projects in current and future projects
- Transfer to the industry

Ecological assessment of the bio-based production of carbon fibres and matrix materials

- Processing of publicly funded projects (e.g. GreenCarbon and Nature) and industrial projects

03

Further education programme

Composite Engineer

Course overview

Modular further training:

Fundamentals* - 4 basic modules* - 4 advanced modules* - Final module

Qualification goal:

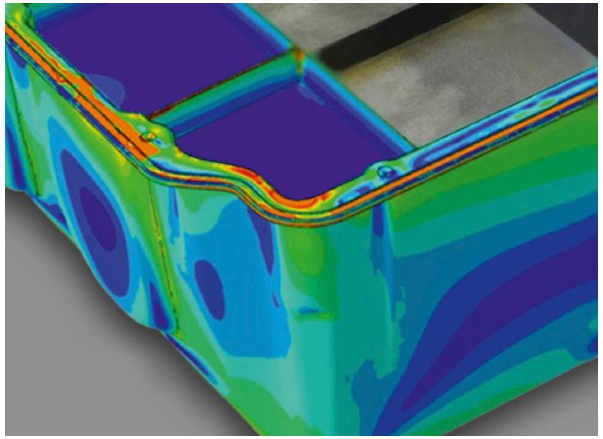
Professional support of a component made of fibre-reinforced materials over the entire product life cycle. Interdisciplinary thinking, evaluation, decision-making and action when using fibre-reinforced composite technology.

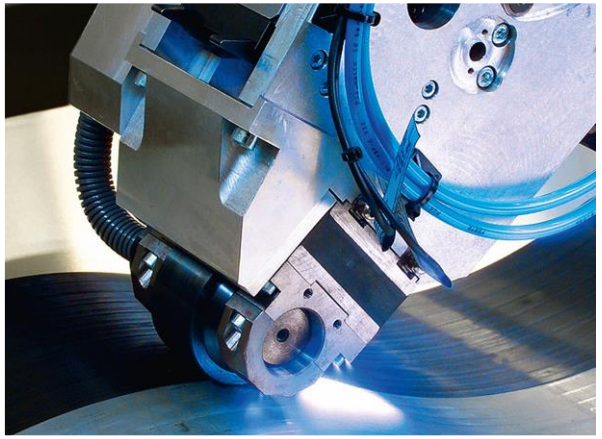
Composite Engineer certificate and diploma

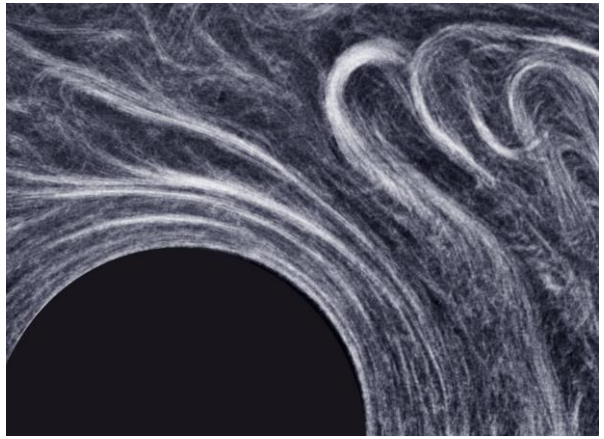
Issued by the Fraunhofer Personnel Certification Body
Requirements fulfilled according to DIN EN ISO / IEC 17024

Target group:

Engineers, scientists and specialists with professional experience







*Modules can also be booked individually independently of a CE certificate request

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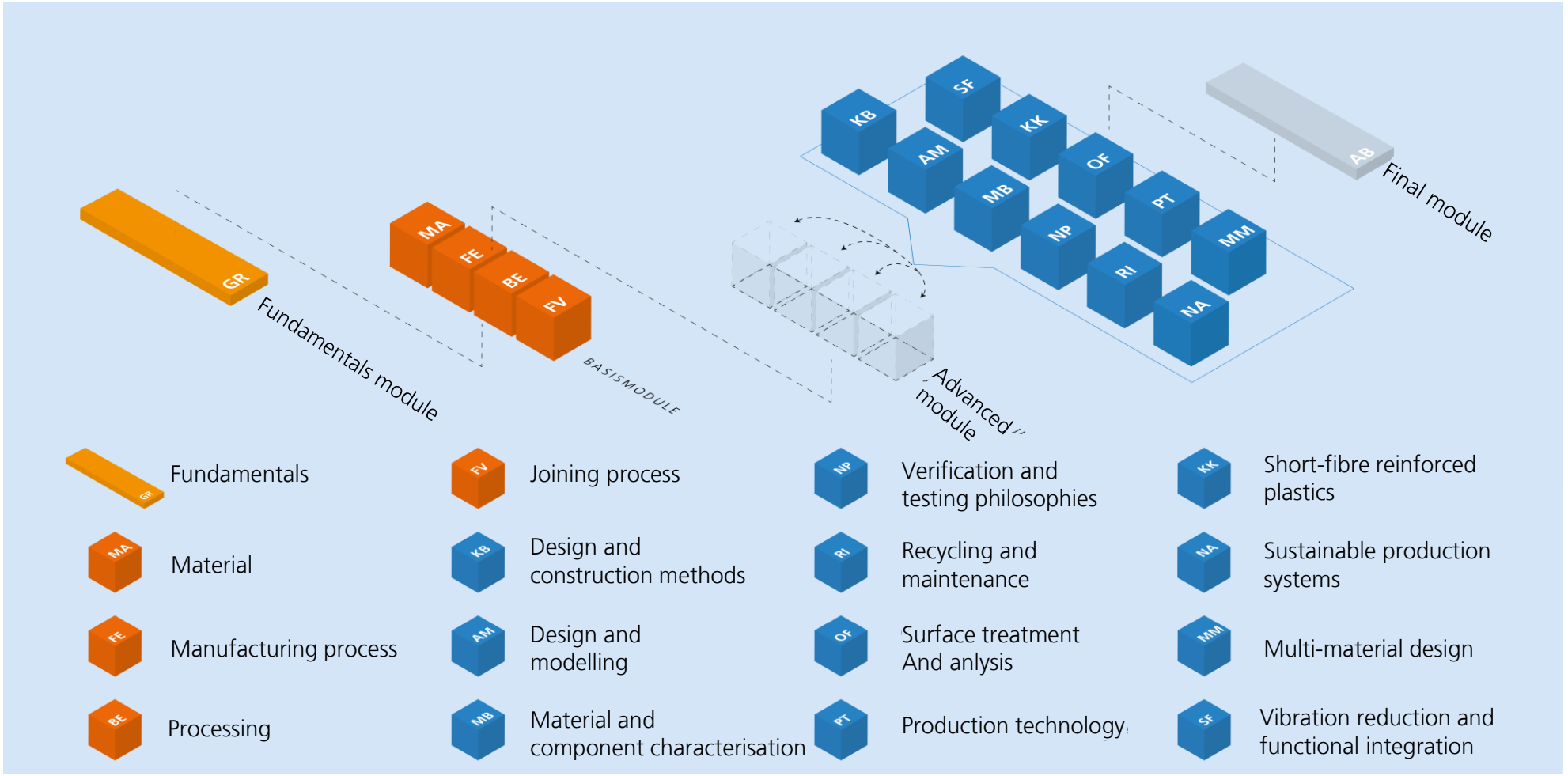
Composite Engineer

Module overview



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Thank you for your attention

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