Fraunhofer Research Field Lightweight Construction
FROM CONCEPT TO PRODUCT
» CUSTOMISED EXPERTISE FROM 14 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
- 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

Product Idea → Lightweight product → Use → Re-Use, Re-Manufacturing, Recycling

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. Expertise at a glance
   - Manufacturing technologies
   - Evaluation
   - Component testing, validation

2. Key topics
   - Circular economy
   - Lightweight construction of battery-powered vehicles
   - Lightweight construction for hydrogen technologies
   - LCA for lightweight solutions

3. Further training programme »Composite Engineer«
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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
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

Numerical simulation
Example: 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

Example: Fatigue behaviour of high-strength steels

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Component testing
Validation

Wood-based material and natural fibre technologies
Load-bearing behaviour, quality testing and evaluation, fire protection
Recycling of waste wood and biocomposites (WPC)

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.

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

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
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

Fraunhofer LBF - Plastics research area - YouTube
Recycling of Composites
Separation of fibres and matrix using pyrolysis

Pyrolytic oven on IGCV
- 440 x 700 x 540mm³ (WxLxH)
- Maximum Temperature: 800 °C
- Adjustable atmosphere (Ar, N₂, O₂)
- Heating rate: 6K/min
- Oxidation and partial oxidation possible
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)
- Transparency 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
Circular products and resource-conserving (re)fabrication

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

1. Dismantling car roof
2. Inspection
3. Data provision using RFID
4. Remanufacturing
5. Component brake shield plate
Lightweight construction of battery-powered vehicles

Design | Production | Suitability for use
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
Sustainable production systems

Main topics

**Sustainable energy supply concepts**
- Dimensioning of sustainable energy supply concepts
- 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
Further education programme
Composite Engineer
Course overview

Modular further training:
Qualification goal:

Composite Engineer certificate and diploma
Target group:

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

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

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

Fundamentals module

- Fundamentals
  - Material
  - Manufacturing process
  - Processing

Joining process

- Design and construction methods
- Design and modelling
- Material and component characterisation

Advanced module

- Verification and testing philosophies
- Recycling and maintenance
- Surface treatment and analysis
- Production technology
- Short-fibre reinforced plastics
- Sustainable production systems
- Multi-material design
- Vibration reduction and functional integration

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Thank you for your attention

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