Fraunhofer LBF: R&D Campus »North«

- Location: Darmstadt – close to Frankfurt International airport
- No. of employees: approx. 540 (incl. TUD)
- R&D budget: approx. EUR 30 Mio.
Technology & application: vibration & acoustics

- **Vibration & acoustics**
  - **Semi-active** engine mount to reduce structural borne noise in compartment
    - Broad band mount using piezo-actuation system for vibration control
    - System analysis & development, prototyping and vehicle integration

- **Polymers**

- **Lightweight**

- **Reliability**
Technology & application: polymers

- Vibration & acoustics
- Polymers
- Dual-Cure adhesives w/ variable Young’s modulus
  - Kationic UV-initiated epoxy hardening
  - Aminic epoxy hardening
- Lightweight
- Reliability

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Technology & application: reliability

- Vibration & acoustics
- Polymers
  - Full vehicle road simulator (25 channel)
    - Service load simulation w/ drivefiles from proving grounds
    - Integration of active chassis components
- Lightweight
- Reliability
Technology & application: lightweight

- Vibration & acoustics
- Polymers
- Lightweight
- Reliability

- CFRP passenger car wheel w/ in-wheel motor
  - Material selection and characterisation
  - Composite layer optimisation and build (RTM)
  - CAE and lab tests (ZWARP)
UC12 Lightweighting
Advanced wheel products for passenger cars

- Passenger car **wheels** have **mass about 7 ... 13 kg** (14“ ... 20“ size)
- Typically wheels using medium strength **steels** and flow forming processes, or **aluminum** casting or forging
- Utilizing **fibre-reinforced plastics** for mass reduction & product differentiation

polymer hybrid
Al wheel disc
CfrP wheel well

Polymer wheel structure
SMC

Polymer wheel structure
CfrP
Lightweight potential of different material systems

- CFRP
- GFRP
- 22MnB5
- PM (Partial Martensitic Steel)
- FB (Ferritic-Bainitic Steel)
- CP (Complex Phase Steel)
- DP (Dual Phase Steel)
- TRIP (Retained Austenite Steel)

Graph showing the ratio of ultimate tensile strength ($R_m$) to density ($\rho$) versus elongation (%) for different material systems.
UC12
Wheel fatigue incidents
Main landing gear wheel failure involving a Boeing 737

On 10 June 2014, a Boeing 737 aircraft landed at Sydney Airport. During taxiing, the crew felt a slight shuddering from around the main landing gear. After parking the aircraft, an examination confirmed that the inboard wheel half-hub had fractured into several pieces.

- The wheel hub consisted of an inboard and outboard section.
- It was likely that the fatigue crack initiated in the stress-concentrated, transition region between the bearing bore wall and the circumferential radius.

Source: ATSB | Aviation Safety Occurrence Investigation | June 2015
The NHTSA said it is investigating 20,000 2014 Ford Edge SUVs for aluminum wheel rim failures.

In November, NHTSA received a complaint of a sudden failure of a 22-inch alloy wheel rim 2014 Ford Edge with 8,500 miles on it from an incident in Dickerson, Maryland. There were no injuries in the incident.

The “right-front corner of the vehicle suddenly dropped while driving, causing the vehicle to drive off the road and into a field. The right-front wheel rim was found to have broken into two pieces. The owner said that there was no prior warning or wheel related problems with the vehicle,” NHTSA said.
UC12
Recent LBF projects
Airflow optimized wheel disc design for in-wheel motor

Vehicle subsystem test at university wind channel
Wheel/hub durability of automated people mover vehicle

- Methodology transfer to railway certification process

Picture: Bombardier Transportation
Biax technology integration program

- Complete technology integration & implementation at customer‘s site
  - Customer‘s scope & requirements review
  - Technology integration proposal & offering
  - Test rig hardware built
  - Technology implementation, load file development & users training
Accelerated testing representing operational signatures

- Relevant road load data
  RLD: time histories

- LBF design spectra representing total vehicle operation

- Design spectra representing individual operational signatures

- LBF test spectra for biax accelerated life testing