SP2

Sensors integrable with functional compliance

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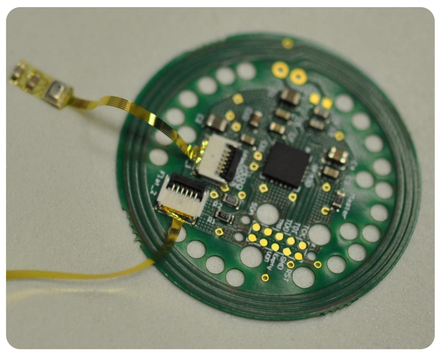
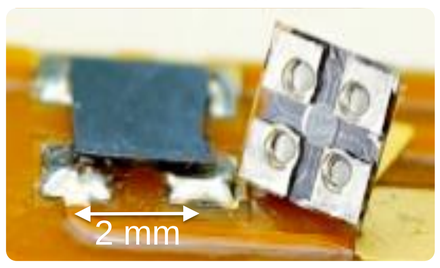
Most Important Preparatory Work

Various PhD-theses have already been supervised by the applicants, mostly funded by the DFG:

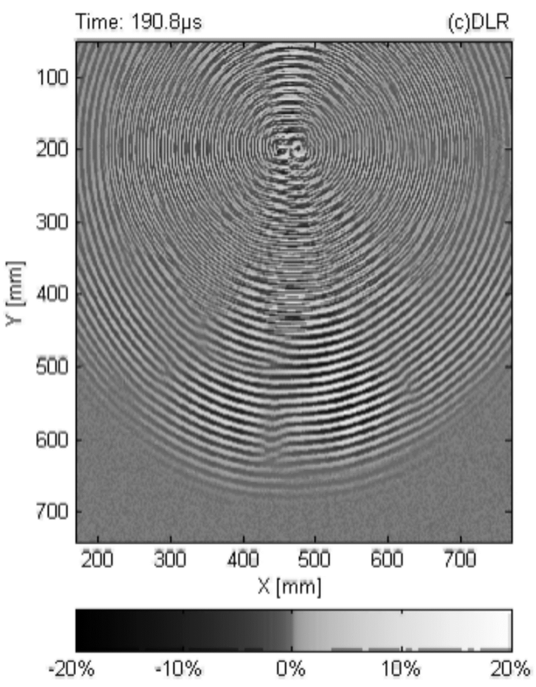
- "Mode Selective Transmission of Lamb Waves in Composite Structures" (D. Schmidt, supervisor Sinapius)
- "Simulative Experimentally DSesign Methodology of Sensor Networks for Structural Health Monitoring" (A. Szewieczek, supervisor Sinapius)
- "Localization of interaction of Lamb Waves in complex composite structures" (F. Raddatz, supervisor Sinapius)
- "Micro sensor systems for aeronautical application in harsh environment" (M. Schwerter, supervisor Dietzel)
- „Capillary Self-Assembly of Components for Systems-in-Foil" (Gari Arutinov, supervisor Dietzel)
- „Wireless Sensors and Actuators for Structural Health Monitoring of Fiber Composite Materials " (M. Salas Ramirez., supervisor Lang)
- „Fabrication and characterization of a flexible capacitive sensor for monitoring of CFRP" (D. Boll, supervisor Lang)



Structure integrable, wireless sensor node ø 3.2 cm



Structure integrable MEMS thin chip pressure sensor (CRC880)



D-Scan of a wave field

Objectives of the First Funding Period

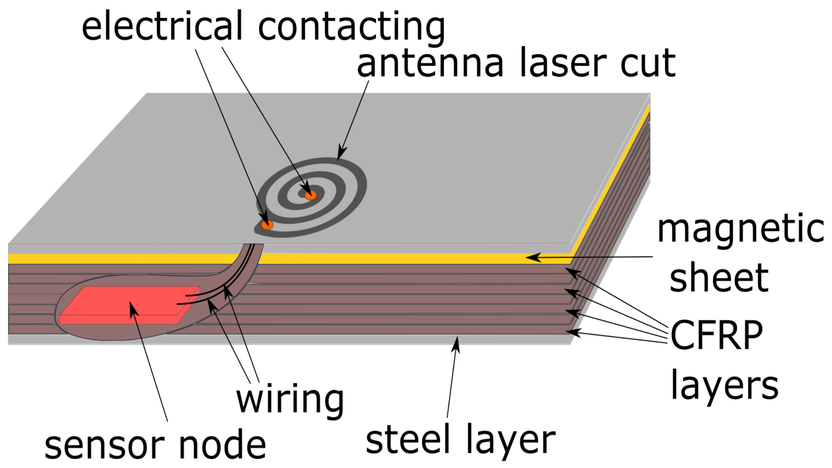
- ❑ *Observability of the propagation of guided ultrasonic waves for relevant modes in the interior of fibre metal laminates.*
- ❑ *Information and energy provided by wireless transmission.*

Research hypotheses:

- The integrity of the adhesive bond between fibre composite and metal can be monitored by sensors located at the interface.
- Novel structure-integrated, micro-manufactured MEMS sensors can detect ultrasonic waves.
- Outer metal layers can be used as transmitting antennas for wireless energy and signal transmission.

Important aspects:

- Precise knowledge of the wave field in order to align the sensor at strain maxima.
- Minimizing effects of the FML manufacturing processes on the sensor function (function-conformity).
- Sensors integration with low influence on FML structural properties to avoid weakening (structure-conformity).

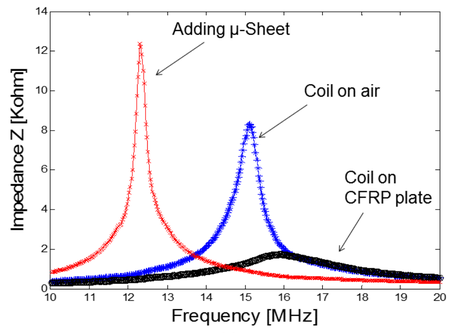


Preliminary concept of structure integrated sensor node with laser structured antenna.

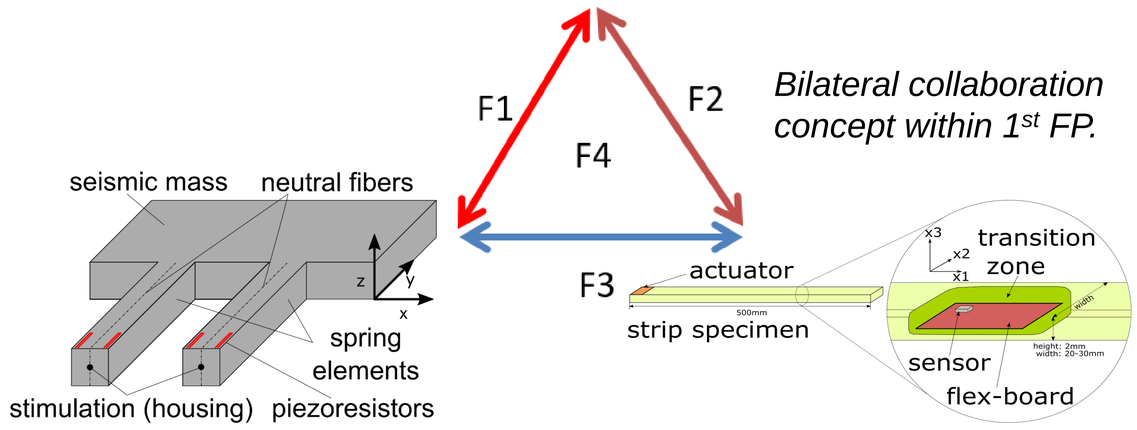
Methods

To achieve sensor functionality, wireless data transmission and structural conformity, the following methodology will be applied:

- Three consecutive versions of MEMS sensors will be developed
- Acoustic impedance matching between sensor node and laminate by material and geometry adjustment.
- Bilateral integration tests. F1: sensor ↔ wireless data transmission; F2: sensor node ↔ structural integration; F3: sensor ↔ integration in electronics (sensor node).
- Reference measurements with established methods for calibration of the new sensor.
- Design and fs-laser fabrication of the antenna.
- Characterization of the embedded electronics.
- Strength investigations of the structure with embedded sensor nodes or applied antennas for various load cases.



Wireless transmission

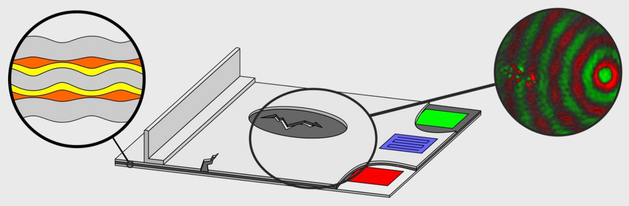


Bilateral collaboration concept within 1st FP.

Multi-directional transducer

Structural integration

Ultrasonic Monitoring of Fibre Metal Laminates Using Integrated Sensors



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