



Functional integration in Fiber Reinforced Polymers

Integrated sensors, heaters, electrical connections

Wing profile including temperature, impact, and ice sensor, heating structure, RFID antenna and LEDs.
Project Go Beyond 4.0

The specific properties of fiber-reinforced polymers (FRP) make them perfectly suitable for lightweight applications with high mechanical loads. These applications are mostly safety relevant (airplanes, cars, boats, wind turbines etc.) and condition monitoring is desirable. Printed sensors / structures can be integrated without changes in the FRP production processes and compromises in the mechanical properties.

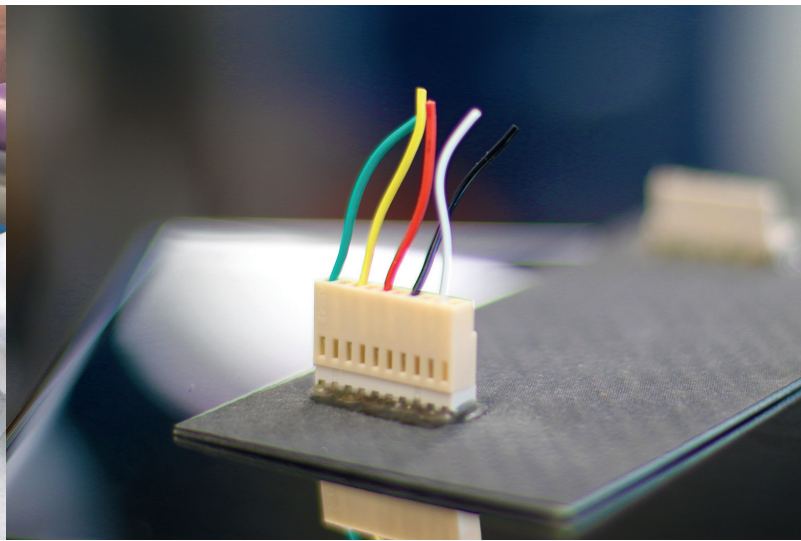
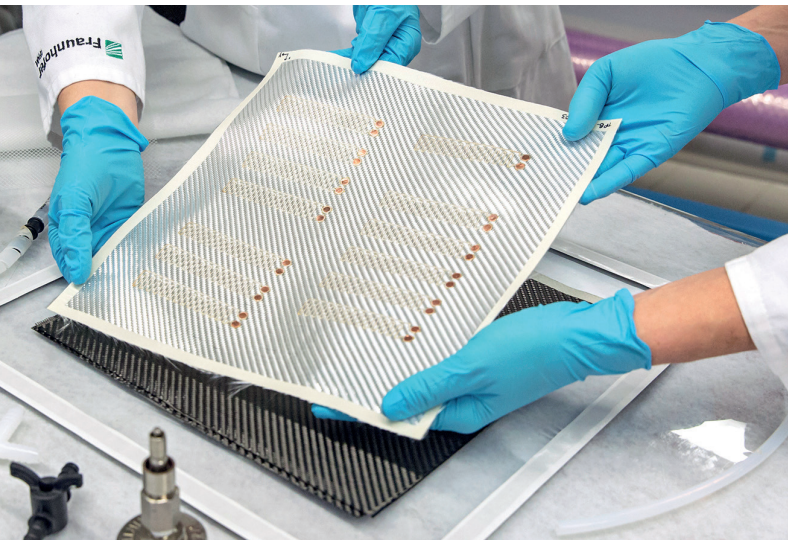
Printing directly on the fabric

By using printing processes and suitable printable materials, custom-printed electronics, contacts, and sensor structures can be applied directly to the textile semi-finished product (e.g. woven fabrics, non-woven mats) that are used as reinforcement in the fiber composite manufacturing process. The key advantages of this approach are:

- minimum influence on the mechanical properties of the composite materials as only a small amount of fabric is covered with the printed structure
- individualized layout and production of sensor structures achieved by a digital manufacturing process
- ideal positioning of sensors on or in the component for maximum design freedom

- integration into the manufacturing process for the composite material, avoiding the need for additional / manual steps
- reduction of wiring effort by using integrated electrical tracks.
- Connectors can be mounted directly on the surface in suitable locations
- Sensors are protected inside the fiber composite

The manufacturing process (e.g. vacuum infusion / autoclave process) does not need to be adapted to the integration. The fabric prepared with printed sensors is integrated into the layer structure as normal. The contact points can be placed in low stressed areas, where it has no effect on the load distribution of the part.



Left: Fabrication of a fiber composite with integrated sensors
Right: Connector contacting the internal sensors on mounted CFRP surface

Applications

Functionally integrated lightweight components made of fiber composite materials can be used in aircraft and satellite construction, automotive applications, and wind turbines. The assembly effort is significantly reduced and the functionalization needs no additional installation space. Depending on the application, the following functionalization options are possible:

- Heating structures
- Strain gauges, cracking -, temperature -, impact -, or moisture sensors
- Antennas and circuits
- Connectors and integration of SMD components
- Wiring inside a component for energy or data transfer lines

Our offer

Fraunhofer IFAM offers you the following R&D services, from the consultation stage through feasibility studies to pilot manufacturing and knowledge transfer:

- Fiber-reinforced plastics and printed sensor consulting services
- Feasibility studies for Function integrated Fiber Reinforced Composites Plastics. Including:
 - Production of prototypes
 - Mechanical testing of prototypes
 - Sensor testing and calibration
 - Development of analysis electronics
- Process integration, profitability studies and know-how transfer

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