FASERINSTITUT FIBRE BREMEN

PROJEKTE

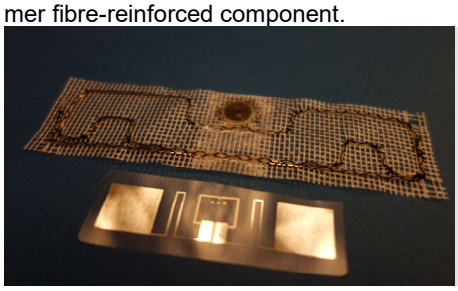
Curing-Transponder
Development and integration of RFID-tags for cure monitoring during production and tracking of the entire product life cycle of polymer fibre-reinforced composites

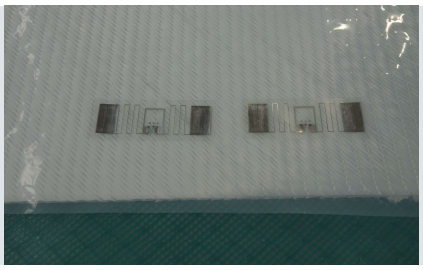
Motivation and Goals

The continual and consequent raising of the resource efficiency during production and using polymer fibre-reinforced composites is mandatory in order to maintain the competitive position of Germany in this industry. (It is imperative to continually and consequently raise the resource efficiency during producing and using polymer fibre-reinforced composite components in order to maintain the competitive position of Germany in this production field.) To support this, the project aims at several issues during the production cycle of polymer fibre-reinforced composite components and uses the RFID (radio frequency identification) technology as base for intelligent optimization. The goal of this research project is the development of a RFID curing transponder, which can be integrated into composite components and their moulds, to gain online and in situ information about the degree of cure of the polymer matrix (curing monitoring). The measurement method should also provide data on the resin flow front during infusion and injection processes in real time allowing for a detailed picture on the resin filling state in the preform and the degree of cure. This specific information should be stored on the transponder chip, so that it can be used for process analysis and optimization. Furthermore, the innovative transponder should store important information and keep it ready throughout the entire life cycle of the component in a digital file. For example, this file, which is integrated into the component, will significantly simplify the required proof of quality, recognition of plagiarism, logistics and the management of replacement parts for the user.

Approach

An approach followed in the project is the simultaneous use of the transponder antenna as a sensor for the measuring of curing degree changes. Model calculations and experimental testing are necessary to find suitable transponders. Test structures with varied geometry and transponders will be manufactured to examine, for example, the influence of size and surface texture of the embedded tags on the structural integrity of the polymer fibre-reinforced component.

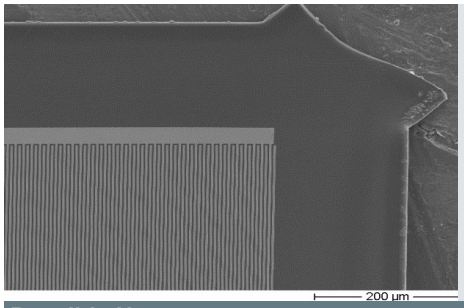


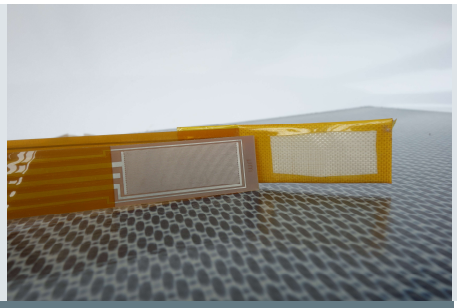


Left: Examples for different sensor geometries
Right: Sensors on woven fibres

This influence will be analysed by quasi static and dynamic load experiments. A very significant role is played by the mutual adhesion of the carrier and the matrix material, for this reason different resin systems will be investigated. Due to the fact that the use of RFID technology in this specific field of material analysis is a novelty, new intelligent designs and circuits for the transponders will have to be developed to enable simple integration into the production process of the components and to guarantee their function – particularly in regard of electrically conductive carbon fibres. To verify the curing process measured by the RFID sensors known procedures will be used, specifically differential scanning calorimetry (DSC) and mechanical testing like dynamic mechanical anal-

ysis (DMA). Furthermore, comparative measurements of the curing process will be taken by conventional dielectric sensors..The possibility of using the sensors remaining in the component for product life cycle management will be shown.





Left: Scanning electron microscope pictures of a miniature dielectric sensor manufactured by scientists of IMSAS
Right: Dielectric sensors

Possible Use

By the use of the intelligent curing transponder to be developed in this project for curing degree monitoring – together with a knowledge-based expert system – shorter process times and a better component quality can be reached without a need for post-process treatment. This will make the purchase of such a technology economic for a component producer. The RFID method allows a simultaneous, wireless gathering of information about the degree of cure of different components and at different locations in the components. The collected sensor data about the production process can also be used to improve the processes and the product, because the specific production conditions of a component can be monitored in real time and documented during the product life cycle and then be used to analyse failure statistics. The online process monitoring (OPM) with RFID sensors allows a better validation of simulation models for the prediction of the flow front and the curing during the development phase of new complex polymer fibre-reinforced composite components.

Contact

M.Sc. Elisabeth Hardi · Telephone: +49 (0)421 218 596 62 · hardi@faserinstitut.de

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Faserinstitut Bremen e. V.

The Faserinstitut Bremen e. V. works on research and development in the fields of testing, developing and processing of fibres, textile semi-finished products and fibre composites. In the competence field measurement systems and monitoring the scientific work is concentrated on the development of innovative solutions for process and structural health monitoring of high performance fibre composites using a wide variety of measurement methods, ranging from µ-CT and graphic analysis to piezoelectric, electromagnetic and optic sensors.

Faserinstitut Bremen e. V. · Am Biologischen Garten 2 (IW3) · 28359 Bremen · Germany
Telefon +49 (0)421 218 587 00 · Telefax +49 (0)421 218 587 10 · www.faserinstitut.de

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