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Projecttitle: „Eddy current sensor for the detection of filament damage to carbon fibres“

– Eddy SCARF –

Partner: SURAGUS GmbH, Dresden

Hightex Verstärkungsstrukturen GmbH, Klipphausen

SAERTEX GmbH & Co. KG, Saerbeck (associated partner)

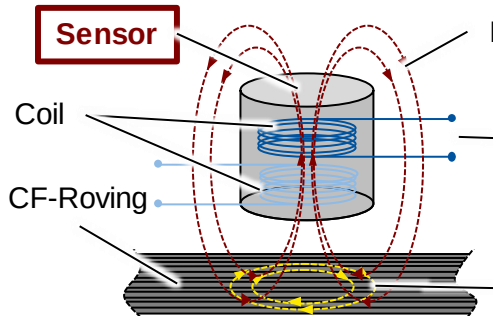
Teijin Carbon Europe GmbH (associated partner)

Term: 10/2019 – 9/2021

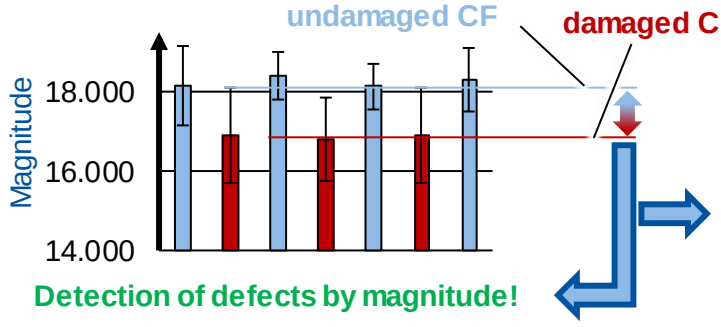
Funding Agency: ZIM

Central image of the ZIM project EddySCARF

State of the art: optical sensor technology and destructive offline testing methods
- **E.g.**: Weftmaster Falcon-i (Loepfe)/ Fibrevision Fraytec (Saurer)/ DIN EN ISO 6892-1
- **Deficits**: none 100% inspection/ not online/ only external defects/ destructive
- **Consequence**: Processing and further added value for faulty rovings/ oversizing due to material uncertainty/ test rejects



Approach
Development of an eddy current sensor for online non-contact 100% inspection of CF rovings



Approach
Translating magnitude into quality criteria depending on...
- Filament breaks?
- Protruding filaments?
- Ondulations?

Approach
Installation of Eddy Current sensors at different points of the process chain

Issue

Carbon fibre reinforced plastics (CFRP) are becoming increasingly important in various fields of application. While certified quality assurance with corresponding test procedures already exists for metallic materials, testing and quality assurance of the CFRP process chain are still in the development stage. The quality assurance of carbon fibre rovings is particularly relevant here. If a damaged roving is removed from the process chain at an early stage, it will not be given any further added value and not be processed into a component. In this way, a suitable test procedure can contribute to increased economic efficiency, resource conservation of the energy- and cost-intensive material "carbon" and the safety of the finished CFRP component.

Until now, quality assurance for carbon fibre rovings has been carried out in the form of outgoing and incoming goods inspections by destructive off-line testing. However, these inspections are time-consuming and are usually only carried out on a random basis. The quality control of the entire bobbin is not 100 %, so that an uncertainty regarding the quality of the goods remains. Non-destructive testing methods offer an alternative, whereby optical sensor technology is currently used primarily. The disadvantage of optical sensors lies in the detection of filament breaks that are exclusively near the surface.

Aim and Approach

The aim of the ZIM project "EddySCARF" is the development of an eddy current measuring system that can be used by carbon fibre manufacturers and processors (Figure 1).

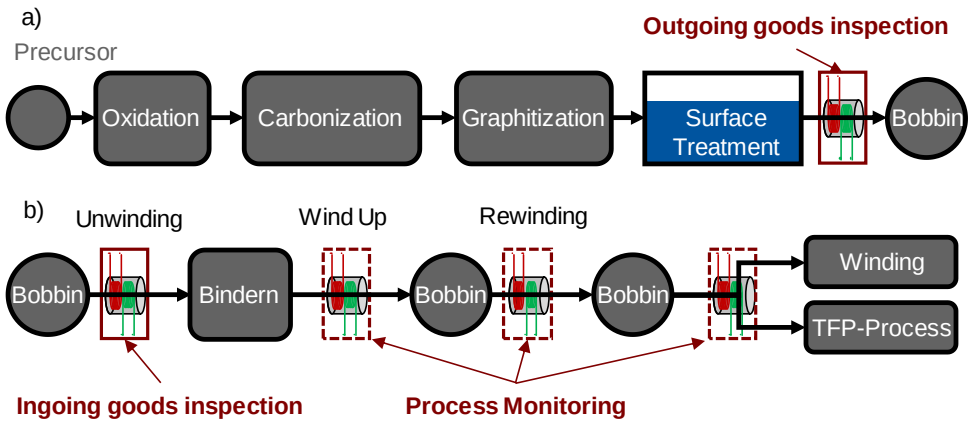


Figure 1: Application of the eddy current sensor in a) carbon fiber production and b) processing

By monitoring quality using eddy current, manufacturers can reduce fiber damage (filament breaks) in the production process or classify non-defective goods for lower strength applications. Processors can use eddy current to quantify fiber damage along their process chain, optimize the various sub-processes and perform a 100% incoming goods inspection. The measuring system can thus reduce scrap and material usage in CFRP production. As a result, the lightweight construction factor of the material "carbon" is more fully exploited. Due to the flexible use of the sensor, the application possibilities of the sensor are broadly diversified, both for manufacturers and processors. This is a multiplication factor of the eddy current technology and enables cross-process application.

Economic Significance & Benefits

Following the successful completion of the project, a new market is opening up for SURAGUS GmbH. Both carbon fibre processors and manufacturers can implement the sensor system in their existing process chain and are therefore a potential customer group for the developed sensor system.

Hightex Amplification Structures GmbH can monitor the quality along the entire process chain and further improve the production processes regarding fibre damage and production speed by using the vortex flow sensor. This allows the cost-intensive material carbon to be used more efficiently and rejects to be minimized.

Solution

To develop the sensor system, the requirements for use under industrial conditions are first specified and influences on carbon fibre damage in the CFRP process chain are determined. Subsequently, a tribological test rig is developed, which allows a reproducible and quantifiable damage of the carbon fibre and a validation of the sensor in laboratory scale. The sensor development itself is iterative and runs through a Deming cycle several times (Figure 2).

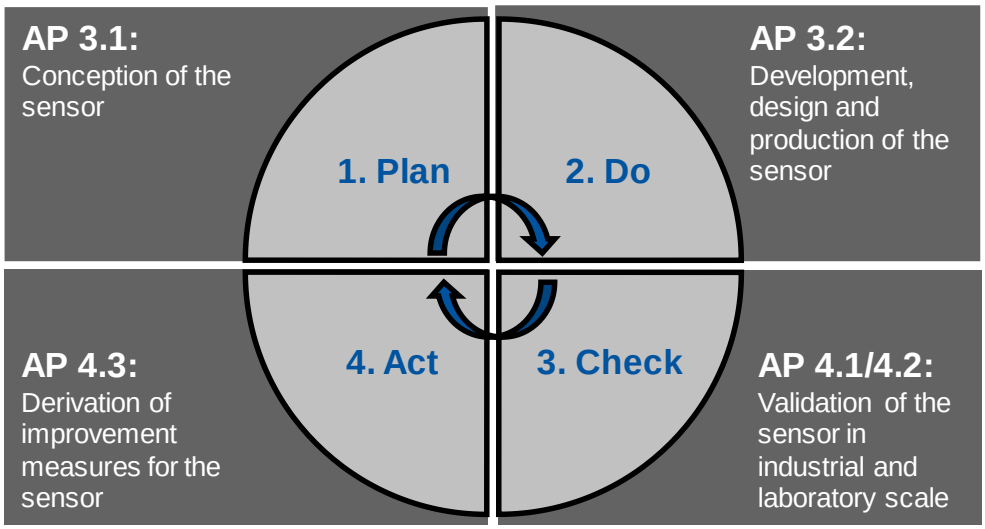


Figure 2: Deming cycle for the iterative development of the eddy current sensor

The sensor is first designed, then manufactured and validated on a laboratory scale. Finally, improvement measures for the next iteration of the conceptual design are derived from the validation. Finally, the sensor is validated in an industrial environment to obtain an assessment of its use under production conditions.

Parallel to the sensor development, the correlation between the signal of the eddy current sensor and the quality of the carbon fiber is worked out in order to establish an analytical or empirical relationship. The project is completed by the implementation of the sensor system in a real production process, which aims at a quality-oriented control of the process depending on the measured value of the eddy current sensor.

Acknowledgement

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