SUCCESS STORY

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i^{3}Sense
Intelligent, integrated and impregnated cellulose based sensors for reliable biobased structures

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Module

Type of project: Module, 2022-2025, multi-firm

ACTIVE COMPONENT MONITORING USING PAPER-BASED SENSORS

INTEGRATED, PAPER-BASED SENSORS FOR CRACK DETECTION IN FIBER-REINFORCED COMPOSITES

As conventional fiber composite components are typically designed with a higher safety factor compared to ferrous materials to account for potential defects or manufacturing issues, leading to increased material consumption, our focus is on addressing this issue in a manner that conserves materials and resources.

Adhering to the principle of "as much as necessary – as little as possible," we have created a sensor technology that facilitates the integration of thin walls without significantly altering the wall thickness. These sensors enable active monitoring of components, providing warnings of potential damage before a component fails. The goal is to prevent the unnecessary oversizing of components while still prioritising safety considerations. The i^{3}Sense project revolves around intelligent, integrated, and impregnated sensor technologies designed to pave the way for sustainable and future-oriented developments in new materials and material technologies. Conventional tests for fiber composite components are often conducted retrospectively, require expensive measuring equipment, or are susceptible to errors. Therefore, our approach is centered on monitoring components as straightforwardly and actively as possible to predict potential failures and detect cracks at an early stage. Beyond addressing system complexity, a critical aspect was ensuring that the integrated sensors have a negligible impact on component geometry, even in the case of thin-walled components (refer to Figure 1), so as not to affect the dimensioning.

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The paper-based sensors we developed have a layer thickness of 0.02 mm. The measurement method relies on a change in resistance, allowing for a cost-effective and straightforward measurement process without the need for complex equipment.

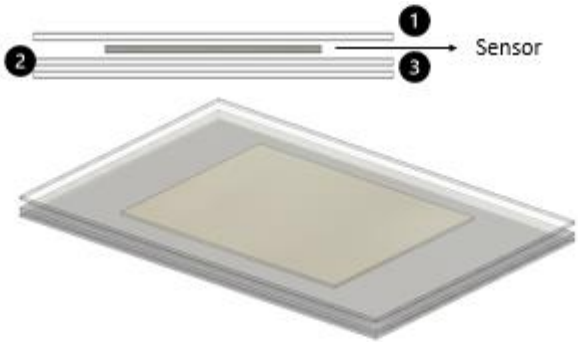

Figure 1: Schematic representation of embedded sensor in 3-layer fiber composite (©Wood K plus)

Impact and effects

Active component monitoring offers the capability to identify and forestall failure states and related events at an early stage. The impact of a mechanical load on the surface, such as a simulated stone impact (refer to Figure 2), manifests as a change in the resistance of the sensor. This alteration in resistance results in a loss of signal when the structure breaks, thereby signaling a defect in the fiber composite structure.

The implementation of active component monitoring serves to minimise risks by allowing for the precise determination of the component's condition. This, in turn, enables adjustments to calculated service life cycles based on actual conditions, ensuring a more accurate and adaptable approach.

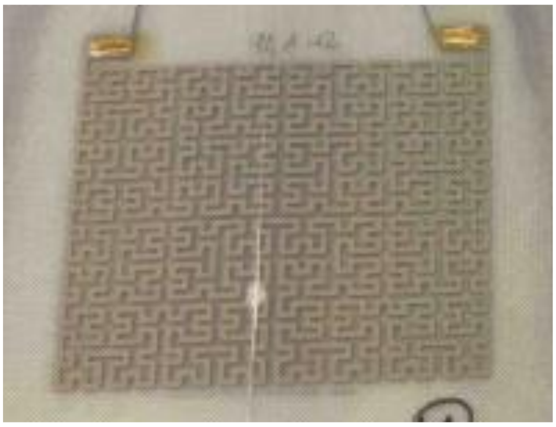

Figure 2: Simulated stone chip fracture sensor in fiber composite (©Wood K plus)

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