SUCCESS STORY

i³Sense
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

PAPER-BASED SENSORS FOR PROCESS OPTIMISATION OF RESIN-IMPREGNATED PAPER BY MEANS OF DIELECTRIC ANALYSIS

PAPER-BASED SENSORS WERE INSTRUMENTAL IN OPTIMISING THE CURING PROCESS

Understanding the curing behavior is pivotal for manufacturers of composite panels as it aids in determining an optimal pressing time that strikes a balance between performance and production cost. Typically, commercial sensors based on polyimide are utilised for this purpose, but they are non-biodegradable and can potentially impact the mechanical characteristics of laminates once integrated. To address this issue, this study employed biodegradable, renewable, and thin paper-based sensors to investigate the curing behavior. In this project, dielectric analysis (DEA), a real-time cure monitoring technique, was utilised to measure changes in dielectric properties during resin cross-linking reactions, offering crucial insights into the material's cure state. Additionally, the curing reactions in B-stage resin are more intricate than in liquid resin. Therefore, one of the goals of the i³Sense project is to optimise the curing process of B-stage resin-impregnated papers using paper-based sensors.

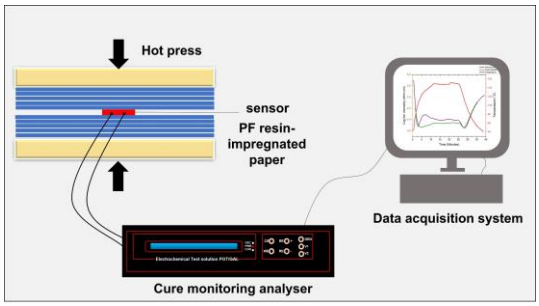

Figure 1: Experimental setup (©Wood K plus)

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The resin-impregnated papers underwent high-temperature and pressure conditions in a hot press, transforming them into thick laminates designed for the furniture industry, as illustrated in Figure 1.

By employing paper sensors and dielectric analysis, the curing time was successfully reduced. Following this, the desired properties of laminates were evaluated for the reduced curing time. It is noteworthy that a significant reduction in curing time was achieved, potentially resulting in substantial cost and energy savings. Furthermore, the results obtained from both techniques, DEA and DSC, were compared (see Figure 2), revealing a strong correlation between them. This underscores the efficacy of paper sensors in facilitating efficient cure monitoring [1].

Impact and effects

This research contributes significantly to sustainability by employing a biodegradable paper substrate for the sensor, distinguishing it from conventional commercial sensors. The outcomes ensure the final product meets specified quality standards and enables identification and rectification of issues during the curing process, preventing defects as well as inconsistencies. Additionally, the research leads to cost and energy savings for industries.

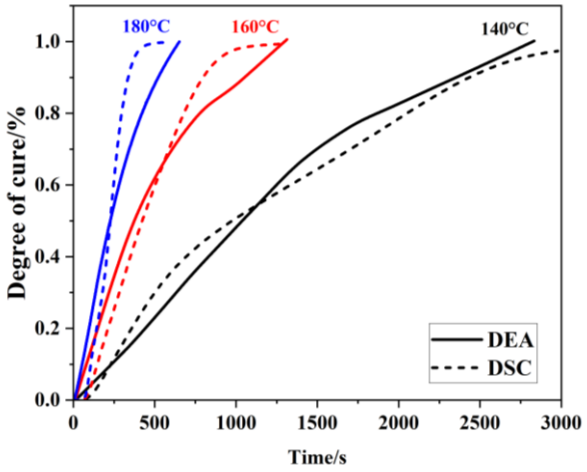

Figure 2: Degree of cure correlation for DSC and DEA data for PF resin-impregnated paper (©Wood K plus)

References

1) Nitin Gupta, Arunjunai Raj Mahendran, Stephanie Weiss, Mohammed Khalifa. 'Thermal curing behavior of phenol formaldehyde resin-impregnated paper evaluated using DSC and dielectric analysis,' 2023, Journal of Thermal Analysis and Calorimetry (Accepted).

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Project partner

- Fundermax, Austria
- FACC, Austria

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