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3D-Printed Embedded Sensors: Mechanical and Thermal Characterization and Numerical Modeling

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The use of 3D-printed sensors integrated into structures manufactured through additive manufacturing opens up new possibilities for accurate and real-time monitoring of physical quantities that vary over time, even in locations that are difficult to reach with traditional sensors. However, to ensure reliable, repeatable, and accurate measurements, it is essential to optimize both the printing process and the entire data acquisition chain.

In order to achieve this, numerous experimental tests have been conducted, varying load conditions and environmental factors such as temperature and humidity, to determine the piezoresistive and mechanical properties of conductive PLA and optimize the acquisition system.

The results obtained enabled the development of a finite element model capable of predicting the behavior of both the structure and the sensor under different environmental and loading conditions. The availability of an FE model that replicates real-world behavior proves particularly useful in the design phase, allowing engineers to predict and optimize the structure's performance with integrated sensors before fabrication. This approach paves the way for new possibilities in the development of intelligent structures capable of real-time self-monitoring.

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