

# Towards smart and secure batteries: Linking pressure and temperature profiles with electrochemical behavior through hybrid optical fiber sensors

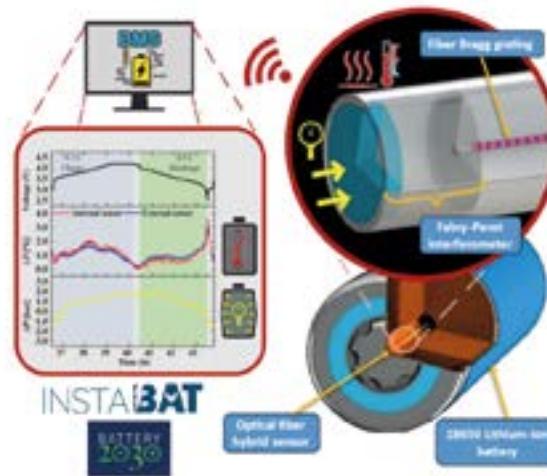
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In response to the need for a compact technology capable of reducing the overall battery cost and determining with great accuracy factors such as critical parameters that will improve their safety and lifespan, the Battery 2030+ Research Initiative, financed by the European Union, was created. An essential aspect of this mission is the development of sensors for the meticulous monitoring of internal battery parameters. The *INSTABAT* project<sup>1</sup> was a member of this initiative and aimed to research smart lithium-ion batteries (LiBs) and develop smart methodologies to sense critical parameters within the battery cells. By employing an innovative hybrid sensing configuration based on fiber Bragg grating and intrinsic Fabry-Perot interferometer sensors, it was possible to decouple and monitor critical safety parameters (such as temperature and pressure) inside a cylindrical LiB, as shown in Figure 1. Thereby, by correlating this data with electrochemical events during the battery operation, it was possible to evaluate their performance under several cycles at different environmental temperatures and operating conditions<sup>2</sup>. Our findings challenge conventional wisdom, revealing that pressure dynamics within LiBs are associated with internal electrochemical events (such as the phase transitions of their materials) that occur during battery operation on the lithiation and delithiation processes and mainly behave as a “breathing profile” during the successive charge/discharge steps. This work represents a significant stride in enhancing the performance, safety, and understanding of lithium-ion batteries (LiB), ultimately contributing to the transition towards a more sustainable and secure energy future.

## Reference

[1] "Instabat project – based on battery 2030+ group." <https://www.instabat.eu/>.

[2] L. Matuck, et al., Chemical Engineering Journal, vol. 500, 156806, 2024, doi: 10.1016/j.cej.2024.156806.



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**FIGURE 1**

Operando monitoring of internal temperature and pressure variations of a LiB using tailored hybrid optical fiber sensors.