Internal strain and temperature discrimination with optical fiber hybrid sensors in Li-ion batteries

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According with Paris and Madrid agreements (COP21 and COP25), as well as EU 2030 targets, there is a need for significant reductions in CO_2 and greenhouse gas emissions in a short time span. Li-ion batteries (LIBs) are currently seen as important technological enablers to drive the transition towards a decarbonised society. They have recently achieved considerable improvements in terms of their technical performance (such as energy and power density, thermal stability, and durability) and economic affordability, making them as major contributors to successful introduction of electric vehicles and stationary energy storage systems. However, for a successful mass introduction of electrified mobility, renewable, and clean energy systems with market competitive performances, fast charging capability and substantial improvements of electric battery technologies are required.

The sensing of characteristic parameters in LIBs, such as temperature and strain changes are fundamental issues to ensure that they operate in optimal conditions, improving their safety and long-term cycling stability. High local current densities can result in a massive heat release, decomposition of the electrolyte, gas evolution and even explosion of the battery, known as thermal runaway. However, the corrosive chemical environment in the batteries is a challenge to monitor strain and temperature. Optical fiber sensors, due to their high chemical stability and small diameter, can be embedded within the LIBs, thus becoming a quasi-non-invasive solution, for operando and in situ measurements. In this work, an optical fiber hybrid sensing network constituted by fiber Bragg gratings and Fabry-Perot cavities was developed and embedded in LIBs, and galvanostatic cycling at different C-rates was applied, correlating the variations in temperature and strain with LIB processes. To the best of our knowledge, this is the first time that this innovative methodology is proposed for this type of application.

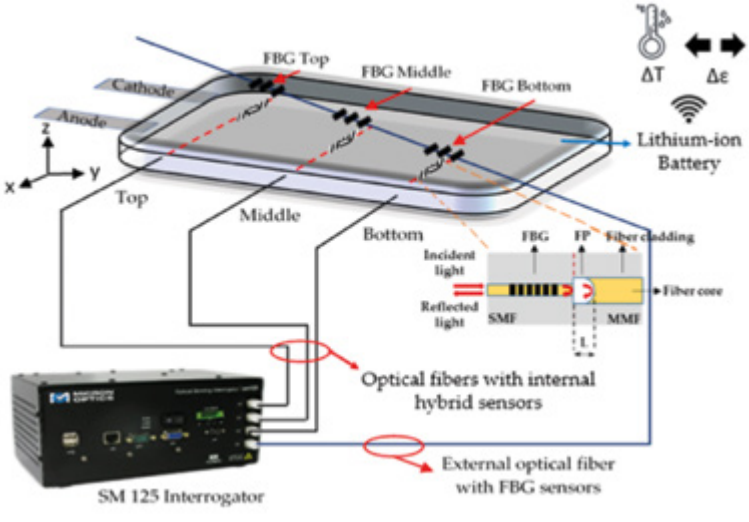

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FIGURE 1
Illustrative diagram of the internal and external optical sensors network used to temperature and strain monitoring of the Li-ion battery.