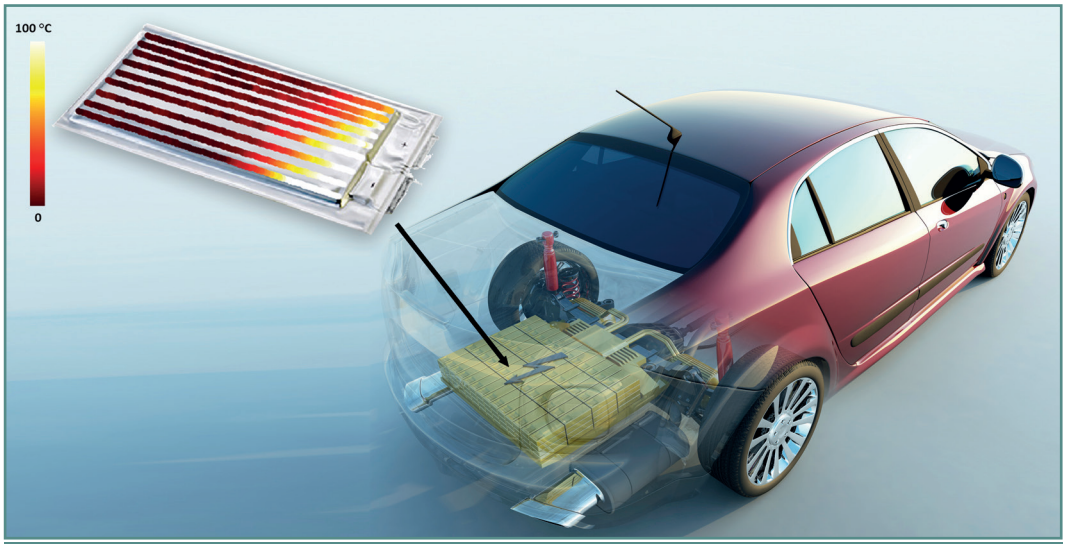
Fiber optic sensing

Distributed fiber optic sensing to determine strain and temperature can be used to streamline battery research in modern EV design, speeding new technologies to market

For decades to come, environmental concerns will be a driving force in transforming both power generation and transportation infrastructures toward a more sustainable footprint. Electric power generation capacity is shifting to a greater percentage of renewable resources that provide the power to recharge hybrid and electric vehicles.

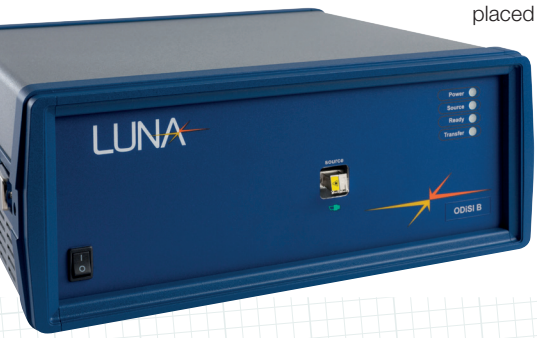
It is widely accepted that the limiting factor preventing a faster conversion to hybrid and electric vehicles is battery technology. While great progress has been made in expanding storage capacity and lowering cost, batteries remain a focal point of research and development in the electric and hybrid vehicle industry. Engineers are faced with the difficult challenge of greatly improving performance and reliability while maintaining operational safety. Improvements in battery technology are often made incrementally and are the result of a continuous process of design iteration and testing. The test environment for electric vehicle batteries is extremely challenging, and obtaining high-quality test data for temperature distribution under all operating conditions is essential.

Luna Innovations of Roanoke, Virginia, has developed an advanced strain and temperature measurement system that uses unaltered fiber optic cable as a distributed sensor. When illuminated with laser light, fiber optic cables have the equivalent of an optical fingerprint. This fingerprint changes in a predictable and repeatable way in response to changes in strain and temperature. When installed inside a battery, a single fiber forms a sensor that replicates a virtually continuous line of discrete temperature sensors with millimeter spacing between sensing points.



The Luna Optical Distributed Sensor Interrogator (ODiSI) (below) is an advanced strain and temperature measurement system helping engineers to overcome energy storage system design challenges for electric and hybrid automotive applications (above)

Unlike conventional temperature sensors, distributed fiber optic sensors are corrosion-resistant, immune to electromagnetic interference (EMI) and inherently dielectric. Fiber sensors can be embedded in the battery and placed directly in contact with the battery's cells without causing short circuits. A single fiber cable can provide an accurate and complete picture of the temperature distribution in the battery under all operating modes. As such, temperature data can be displayed versus length, or individual points can be selected anywhere along the fiber sensor and displayed versus time.



The Luna system uses standard, unaltered fiber cable – as a result, sensor location, measurement density and gauge length can all be changed dynamically through software. This reconfiguration of the distributed fiber optic sensor can be done in minutes, as opposed to the hours it would take to re-instrument a battery with conventional sensors.

The utility of the Luna distributed fiber optic sensing system goes beyond the thermal evaluation of batteries and can be used in a number of other challenging test conditions related to hybrid and electric vehicle design. Fiber optic cables, given their dielectric nature and inherent EMI immunity, perfectly measure the temperature of a vehicle's inverter and the many printed circuit boards used in an electric vehicle system. Additionally, the ability to measure strain can be used to determine the stresses within key structural components of a hybrid or electric vehicle.

The design of battery systems for hybrid and electric vehicles is complex due to the high number of variables involved and the need to make assumptions about the aggregate operating conditions of vehicles in service. High-resolution data provided by Luna's distributed fiber optic sensing system allows engineers to converge on solutions faster and speed the introduction of new products into the market with higher degrees of confidence for long-term reliable operation. Luna's distributed sensing system is 21st century technology specifically developed to help engineers overcome challenging design problems in the energy storage and automotive industries.

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