Battelle
The Business of Innovation

Fault Sensing in Operating Batteries

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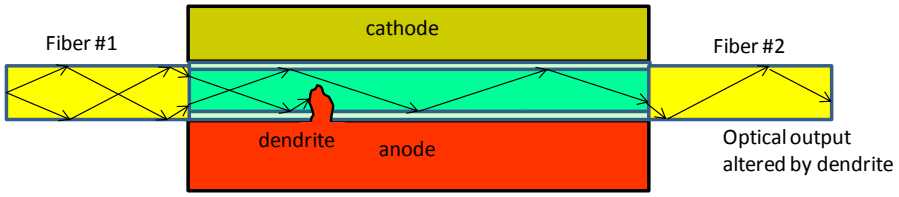
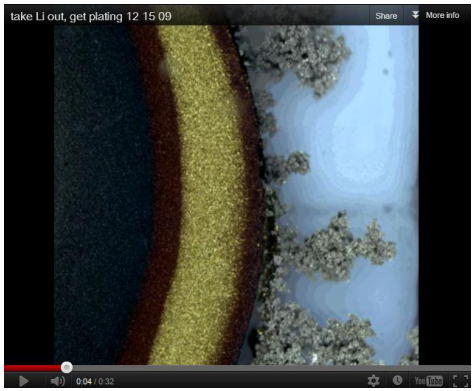
Fault Sensing in Operating Batteries

- Internal faults occur infrequently, are challenging to detect in advance, yet have major safety and reliability consequences.
- Faults often originate locally and are difficult to detect with global measurements such as voltage, current and temperature.
- Battelle, with the assistance of the University of Akron, will modify the battery separator to serve as an optical waveguide, detecting the optical signature of developing faults before they become a problem.
- Designed to continuously monitor the cell, detecting local and global events with low-cost optical hardware developed for the telecommunication and medical devices.





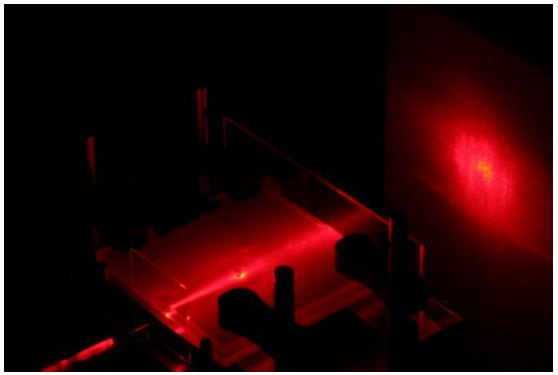
From Harris, www.lithiumbatteryresearch.com.

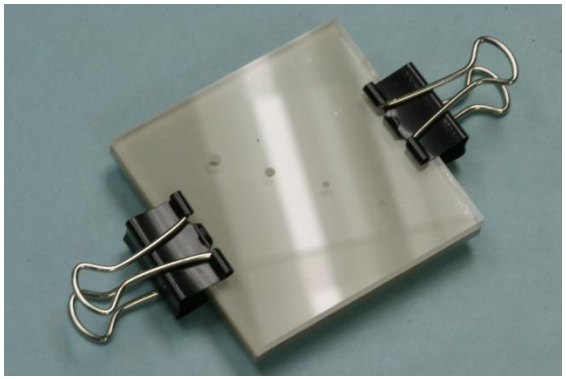
Advantages

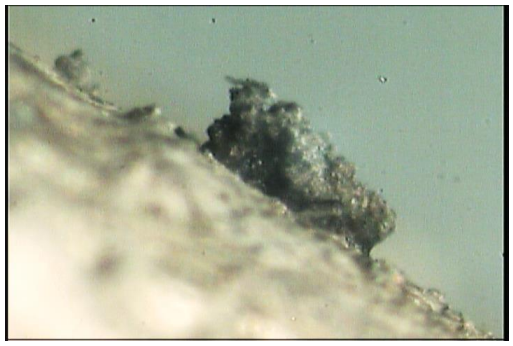
- Modification to existing battery components, keeping the conventional geometry.
- Early detection of faults: allows time for corrective action, reduces need for overdesign and conservative operation.
- Continuous monitoring of local and global events, detecting faults without interrupting normal operation
- Optical measurement, not susceptible to EMI.
- Applicable to a wide variety of battery chemistries.
- Broad class of *in situ* measurement methods that leverage cost reductions in optical devices.

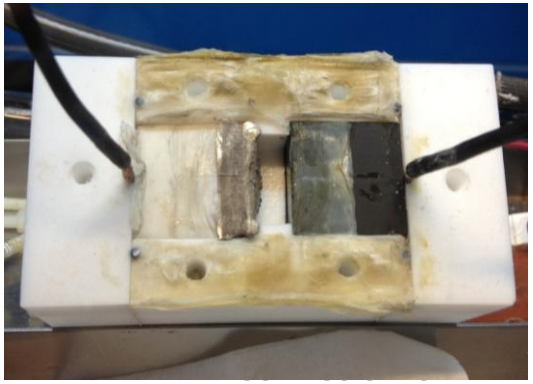
Battery Separator as an Optical Waveguide

- Transmits light through the long dimensions of the sheet:
- Separator must meet both optical transparency and battery performance criteria.
- Validation:
  - Using a mechanical fixture to test materials.
  - Developed a visual cell to understand dendrite growth conditions and for sensor testing.
  - Ultimately test in a small, single cell.







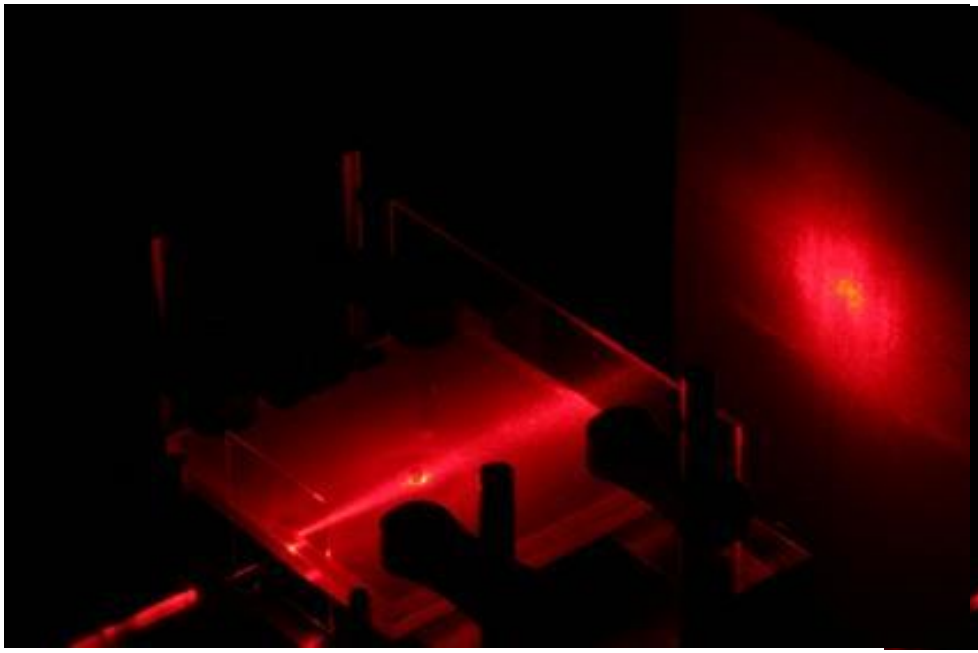


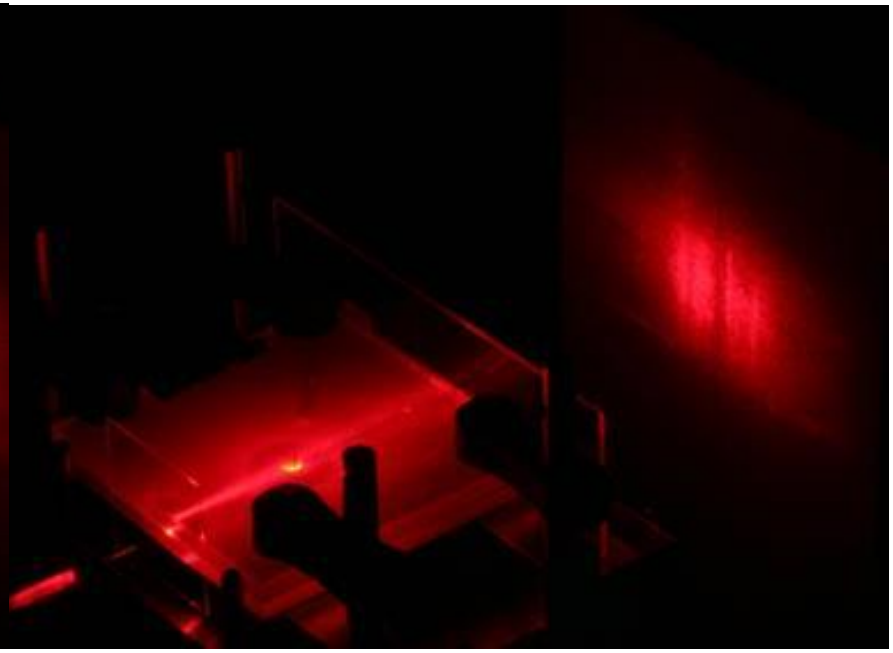
Signal from an Artificial Dendrite in a Polymer Separator

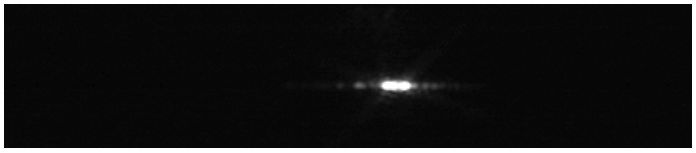
- Needle simulates dendrite

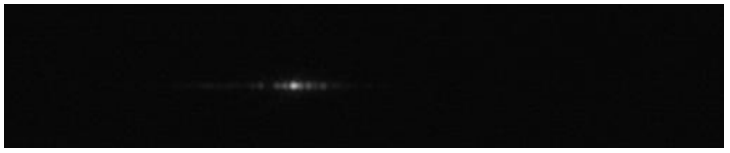
Without dendrite

With dendrite









Output face views

System Design Implications

- With current materials, light transmission is sufficient for ≈ 6 inch cells.
- Using low cost, visible light sources and detectors.
- Single source and detector for multiple cells.
- Initially, testing with a linear array of detectors on a fixture and ultimately on a single cell
- Model-based signal extraction techniques are being developed.