AMPED *SENSOR*:

Embedded Fiber-Optic Sensing for Battery Packs

AMPED Meeting 2014, Denver, CO

Project Team/Key Personnel

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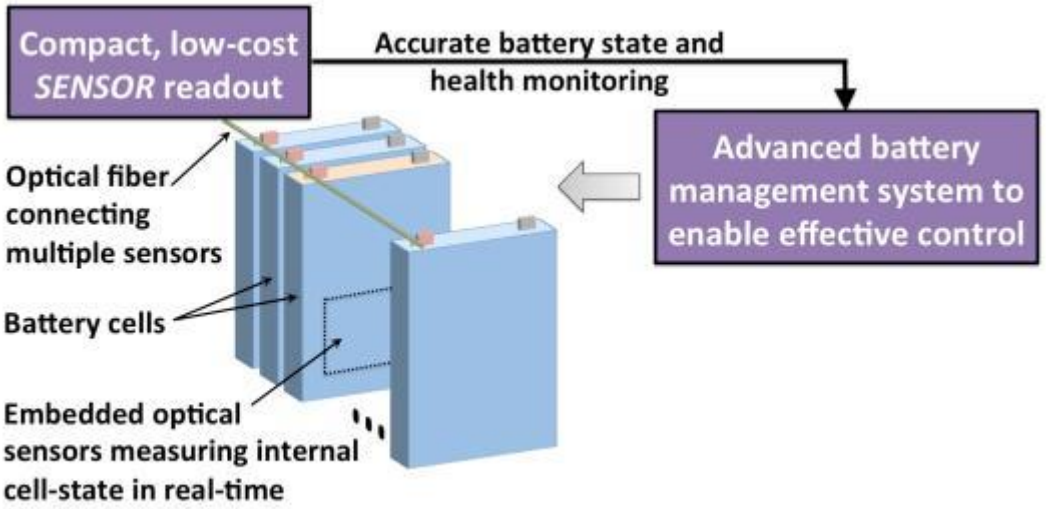
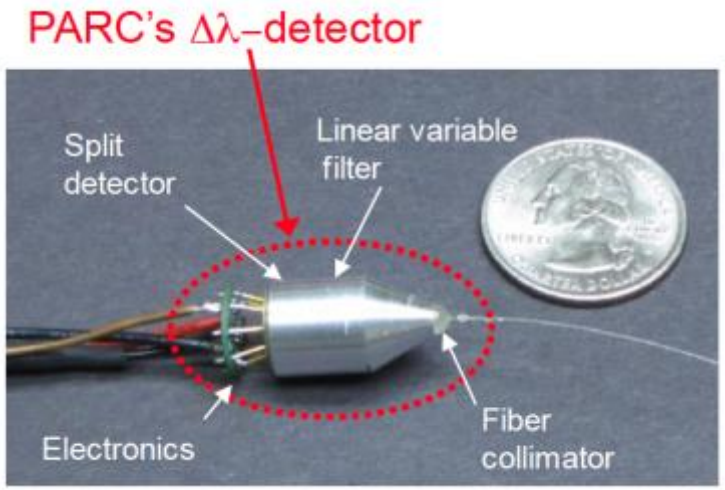
SENSOR Overview





Technology

- Embedded FO sensors, smart algos for internal cell monitoring
- PARC FO readout ideally suitable
- LGCPI expertise for EV-grade tech

Advantages/Differentiation

- EMI, spark-free effective BMS
- Multiplexed FO to reduce cabling
- Full, safe cell capacity use
- Reduced pack oversizing

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Performance Targets and Validation Plan

Metric	State-of-the-art	Targets of Proposed *SENSOR* Technology
Internal cell temperature	Up to 20°C (from external skin temp.)	Direct internal temp. monitoring with 1°C accuracy
SOC accuracy	5%	2.5%
Side-reaction monitoring	No internal sensing	<1% vol. fraction accuracy for internal gas sensing
Cost	Up to 3x battery pack oversizing	>25% reduction with 3 to 7% cost overhead (OH)
Performance overhead	No internal sensing	<0.05% energy density, volume & weight OH

Validated experimentally (years 1-3)

Cost-performance model (year 3)

Aggressive targets set for 3-year project
Culminate in module-level demo

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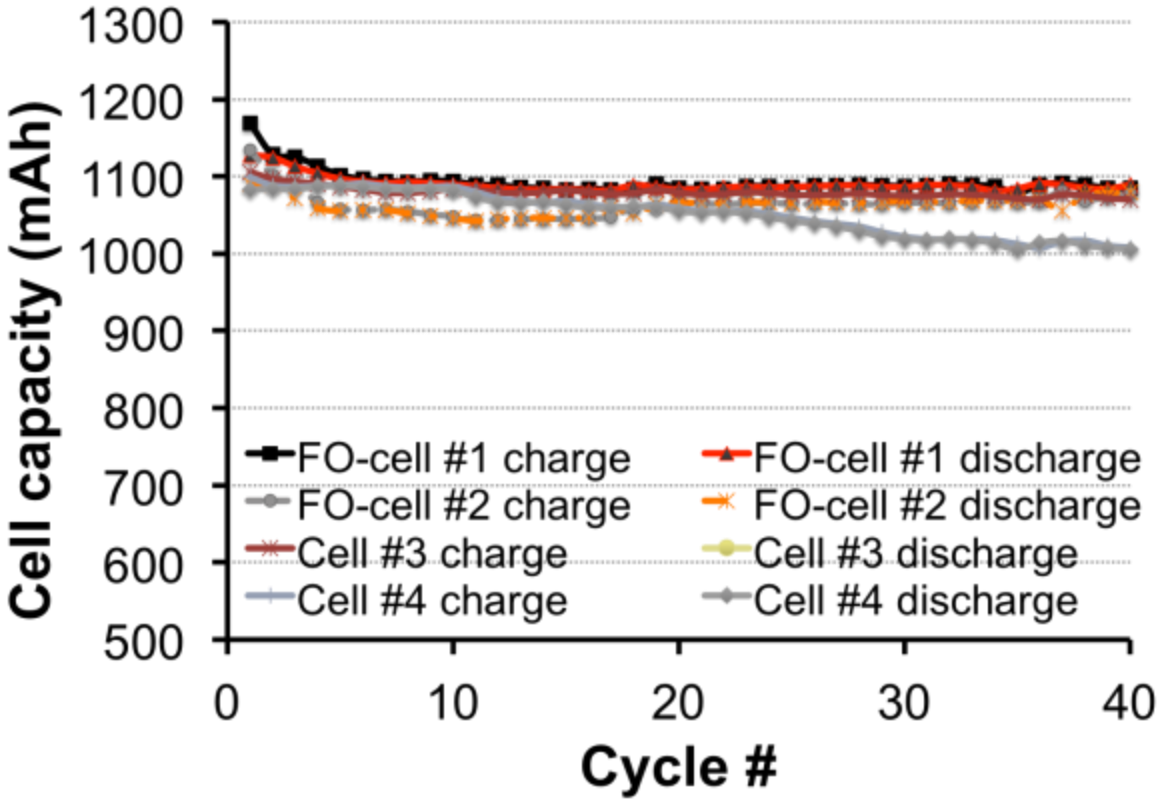
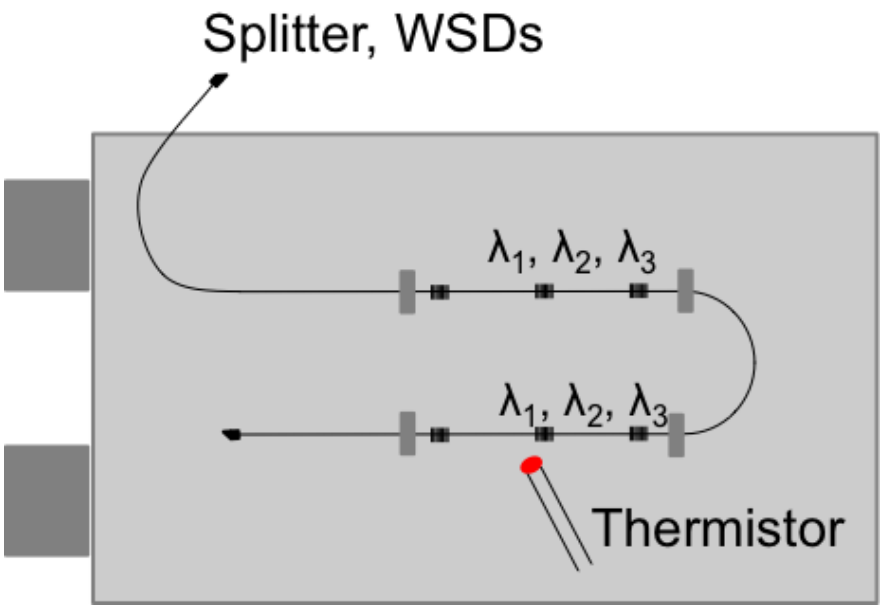
Functional LGC Cells with Embedded FO



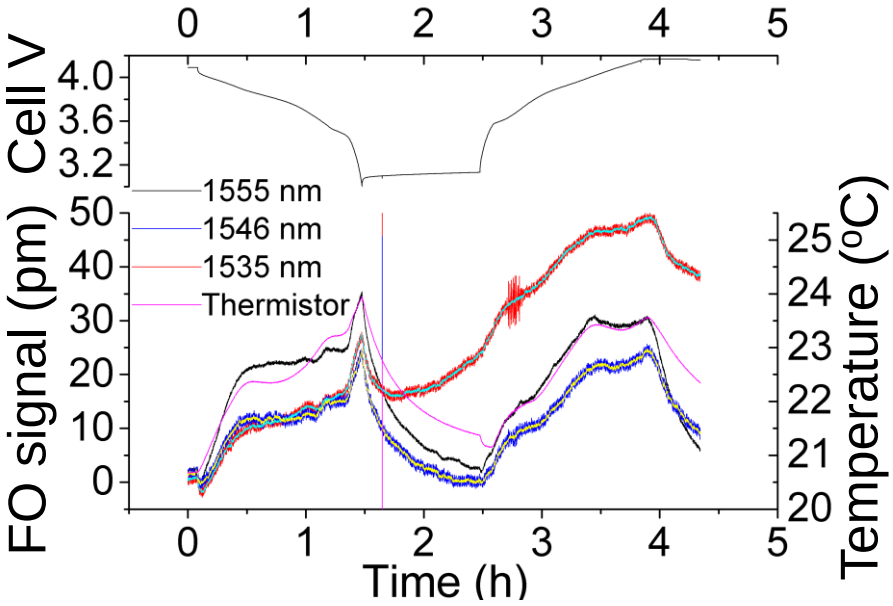
Experimental cell capacity w/ cycling

- Experimental cells w/ embedded FO sensors fabricated
- Initial performance comparable to regular cells
- Novel cell-state signals from FO for effective BMS

Cell Skin Monitoring: Advanced Readout



Multiple FO sensors on cell skin



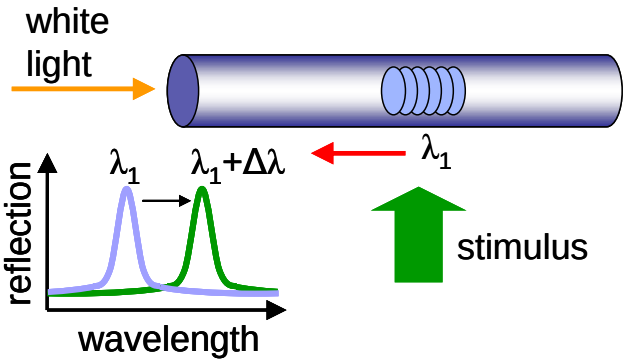
3-channel FO signals from advanced readout

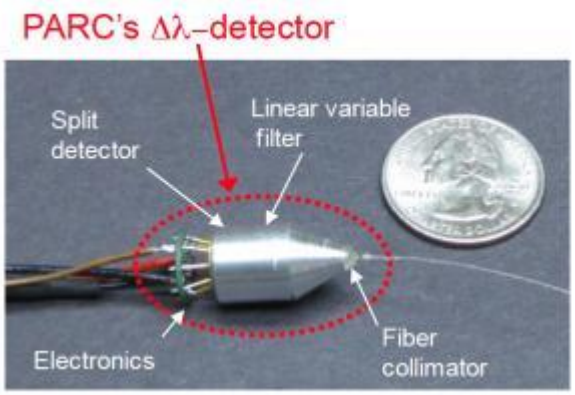
First version of advanced multi-channel readout built

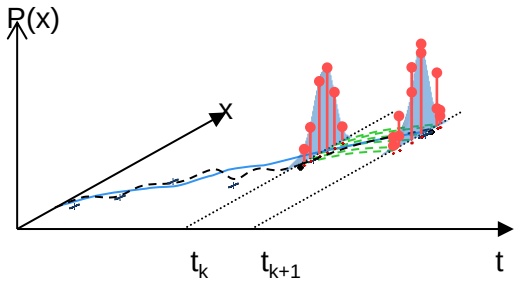
0.25°C or better accuracy for cell skin temperature

Summary

- FO sensing can enable internal cell state monitoring
- Technology promising for XEV BMS:
  - Use of PARC's low-cost, accurate readout technology
  - Initial tests indicate potential for XEV-grade tech
- Can significantly improve safe pack utilization, control

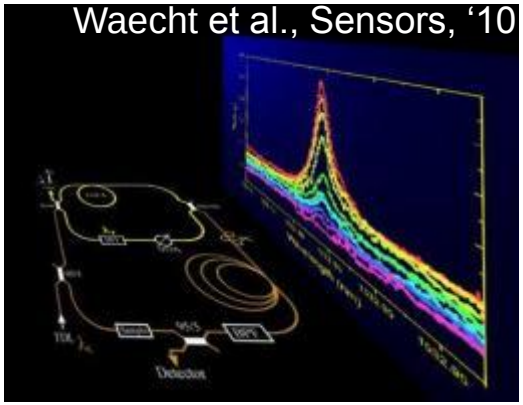






Next Project Steps

- Chemical sensing experiments:
  Cell side-reaction monitoring



- Module-level configurations, SOX:
  Path to pack scalability, control

- Further validation:
  Make case for deployment in BMS