Research And Application of Fiber Bragg Grating Temperature Sensor For Energy Storage Battery In-situ Detection

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Outline

- Introduce of our Department
- Principle of the experiment
- Experiment details
- Summary of our works

Energy Storage and Electrotechnics Department

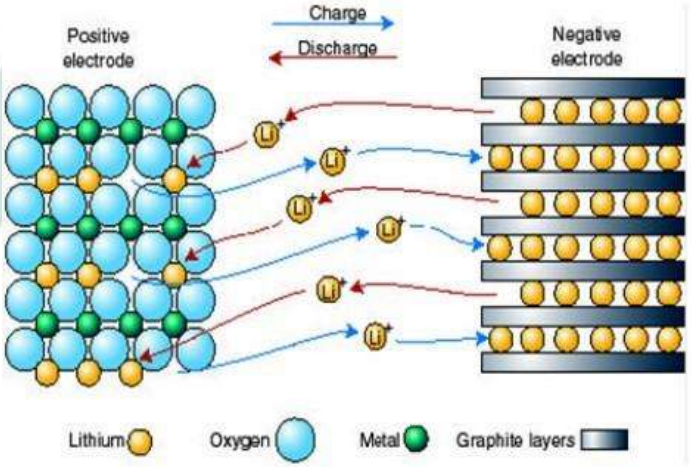
Complete system of testing and R & D

- Different types
- Different packages
- Various testing

BYD, Toshiba, HITACHI, ATL, GE, Altairnano

External Characteristics Area	**Internal Characteristics Area**
Testing Technology Area	**Trial production Area**

In-situ Detection



Complex recession mechanism

Different internal and external characteristics

Different Manufacturer standards

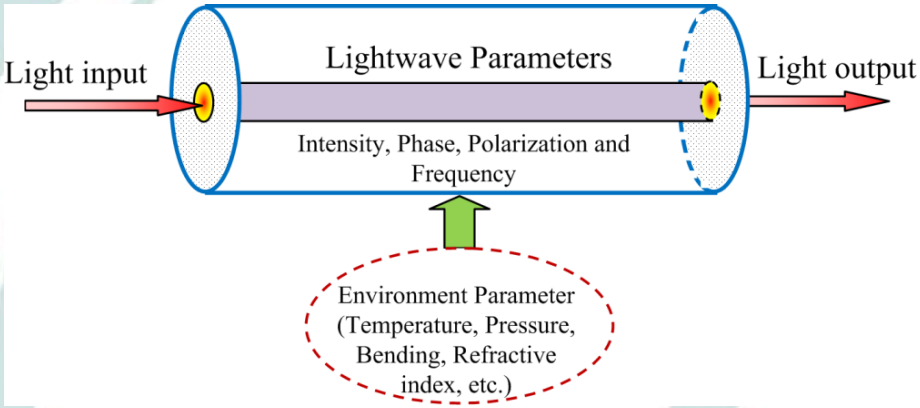
In-situ Detection

Without damage

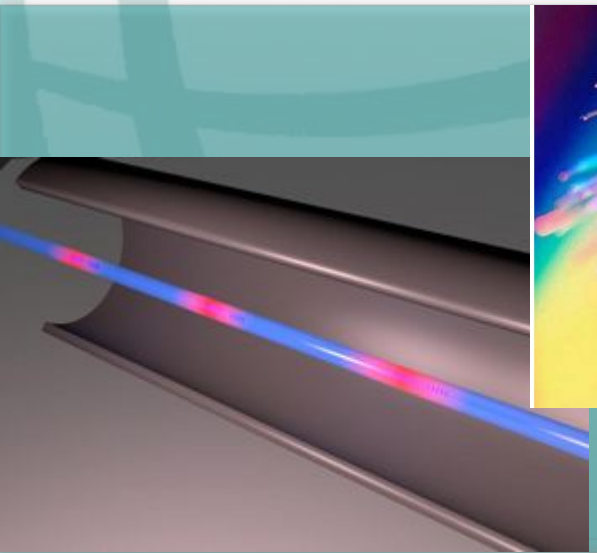
Minimize interference

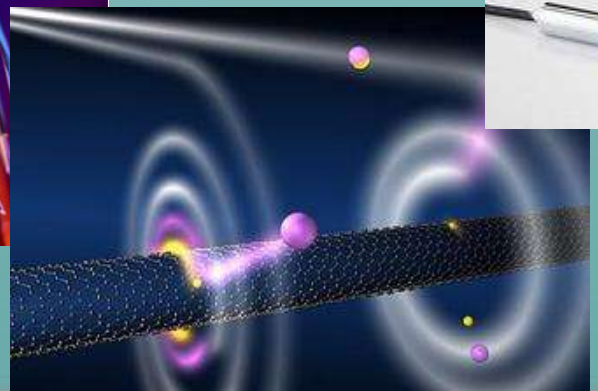
More accurate and fast

Fiber Optic Sensor

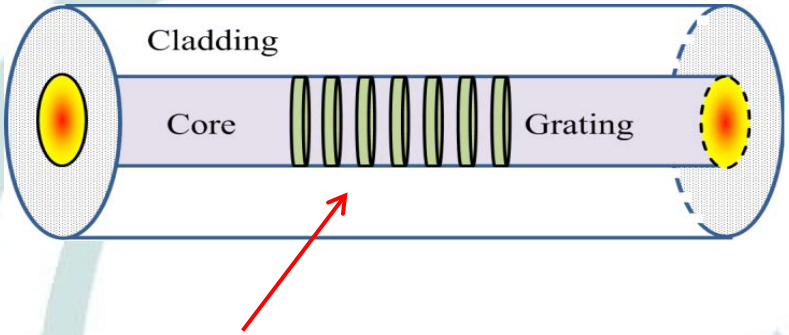


- Anti-corrosion
- Easy to expand
- High precision
- Fast response
- Simple structure
- Low loss

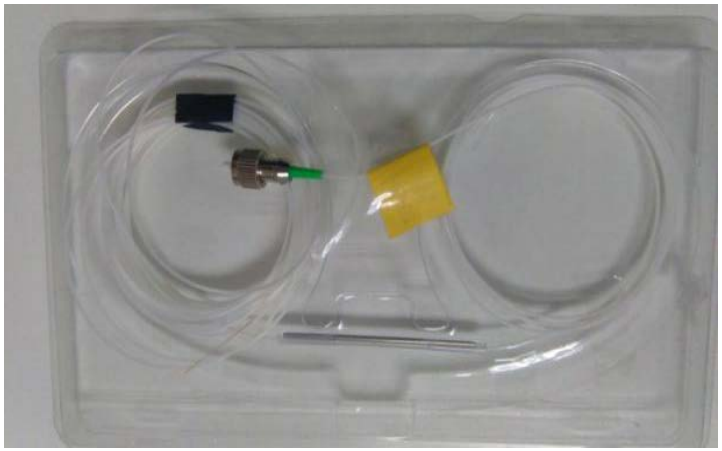




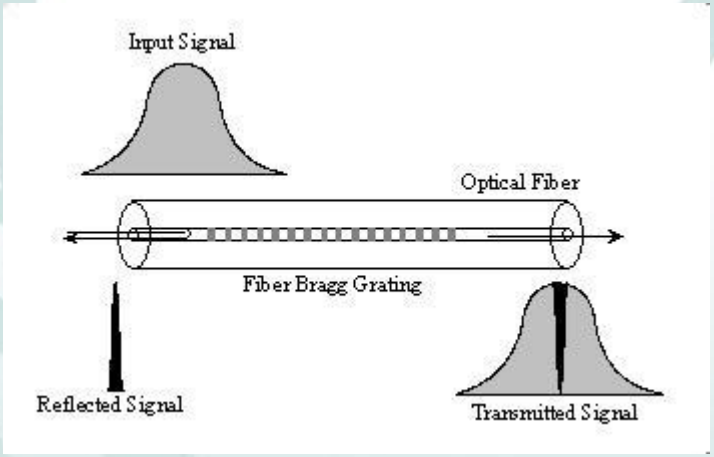
Fiber Bragg Grating Sensor



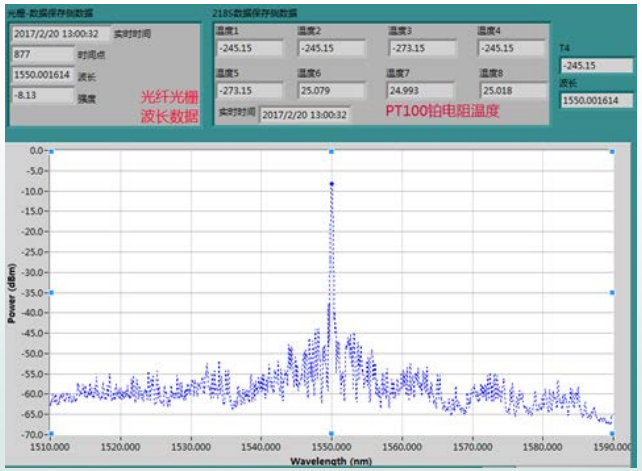
FBG Structure: Passive filter device



FBG Sensor



Sensing principle



FBG Reflection spectrum

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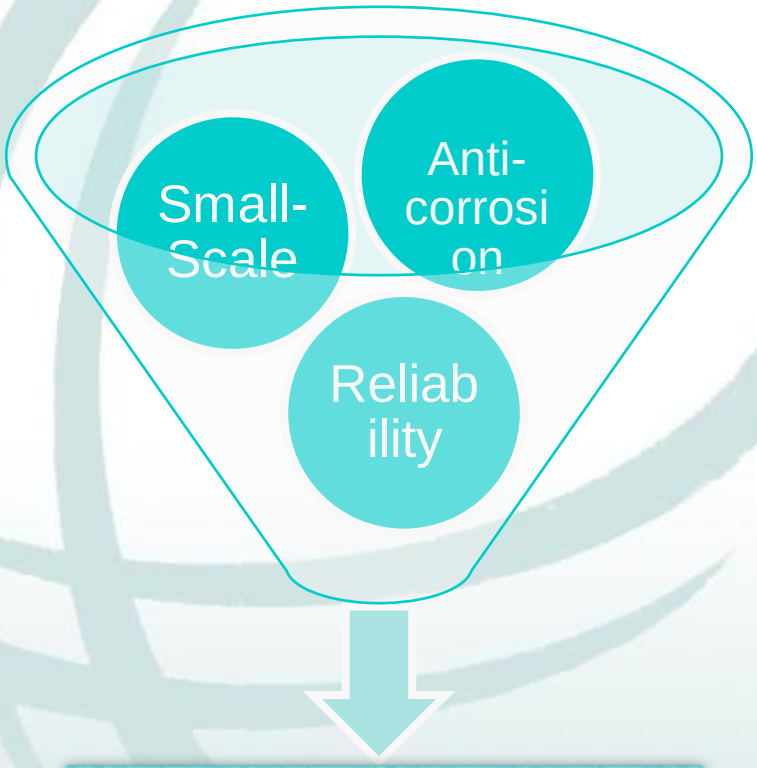
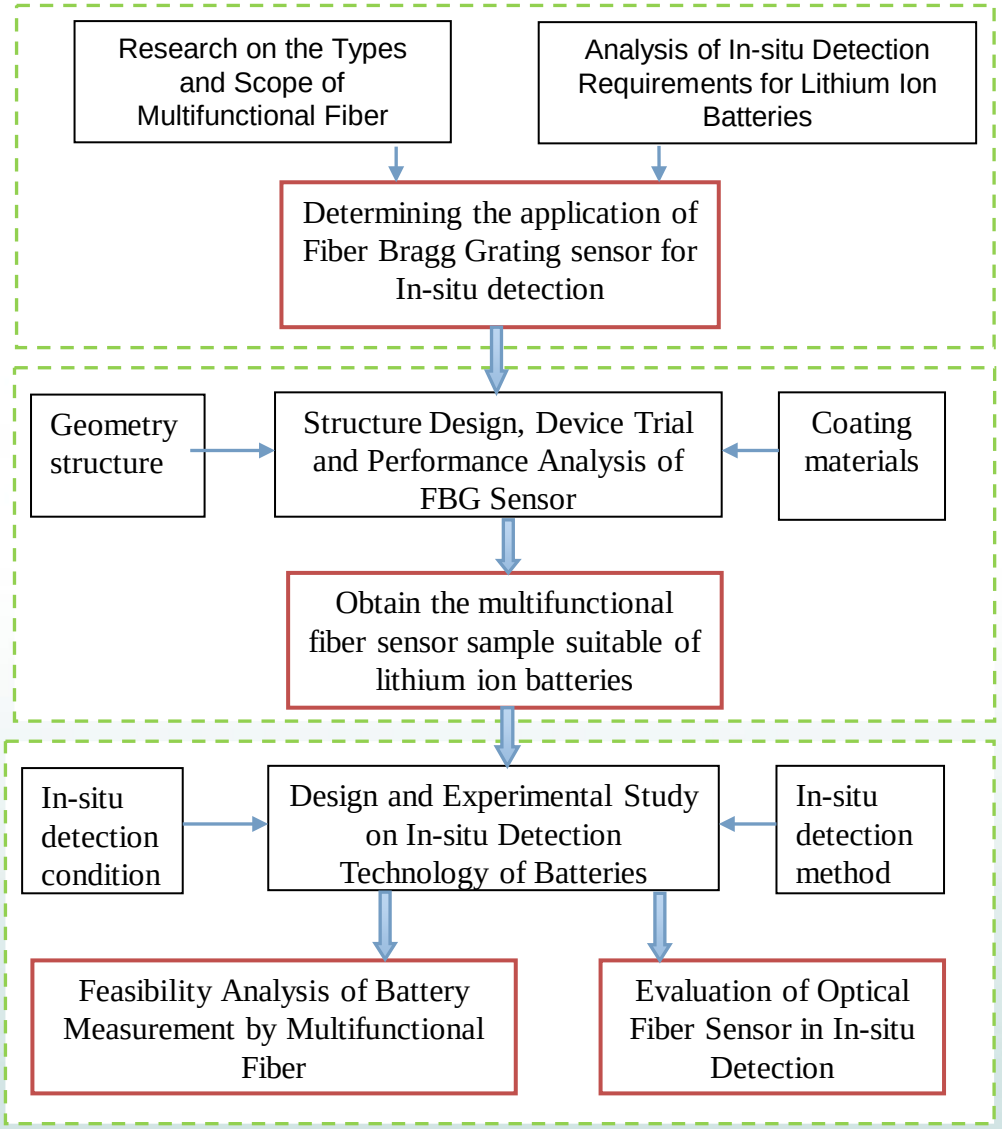
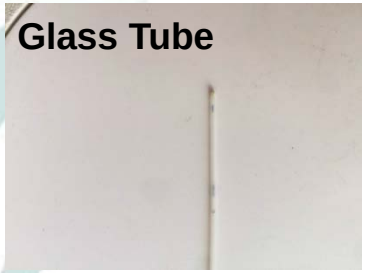
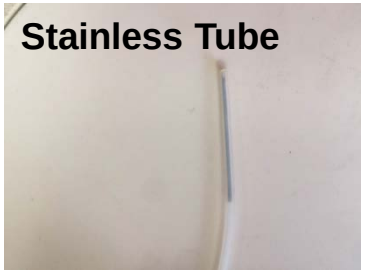
Design

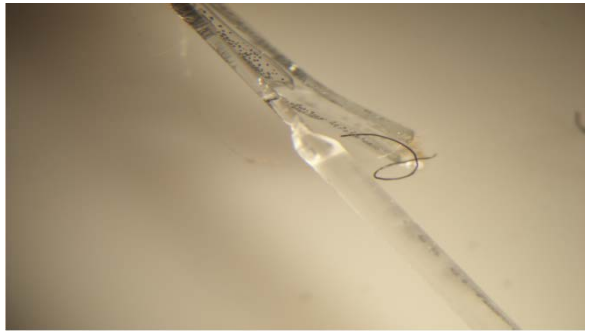


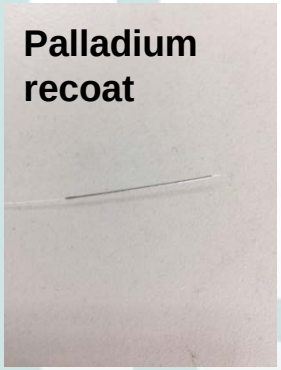


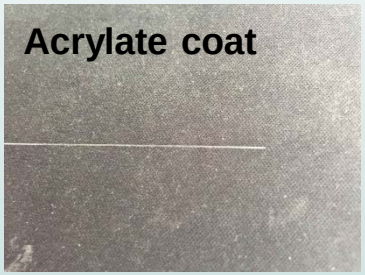
Design





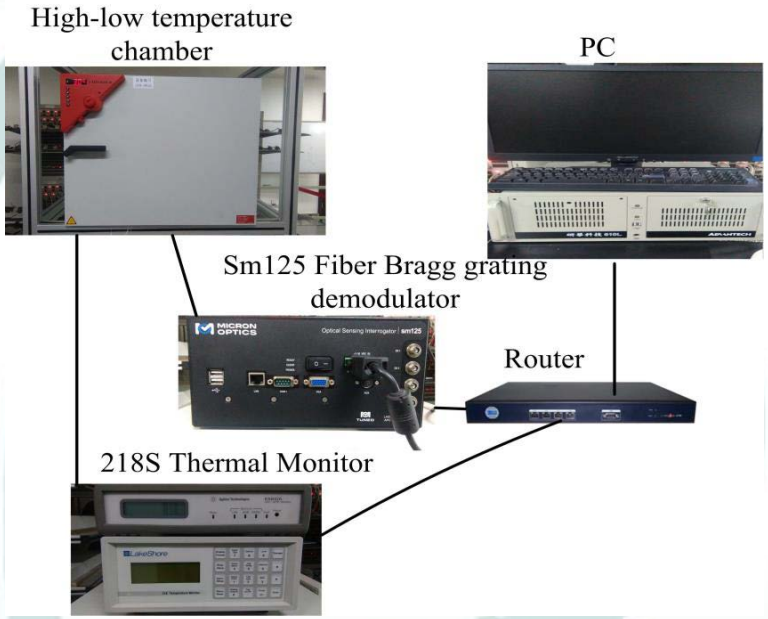






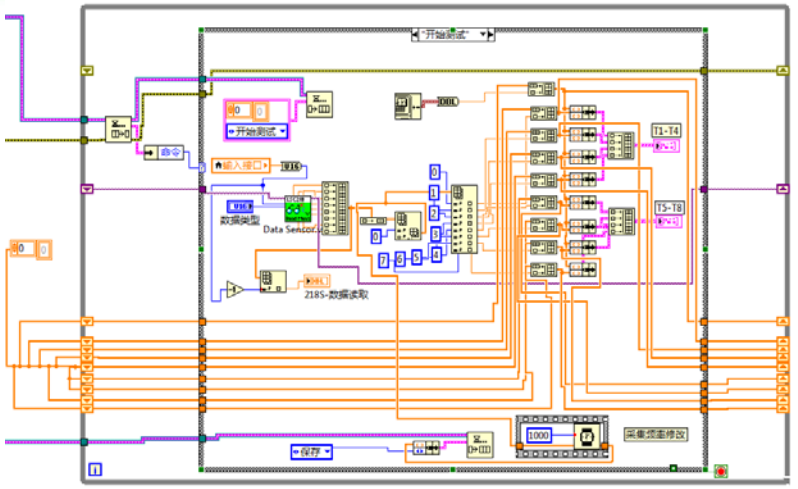
	Problem
Gold	Lack of adhesion
Palladium	Lack of adhesion
Silver	Lack of adhesion
Glass Tube	◎
Stainless Tube	Size
Plastic Tube	Rigidity, Reliability

Performance Evaluation

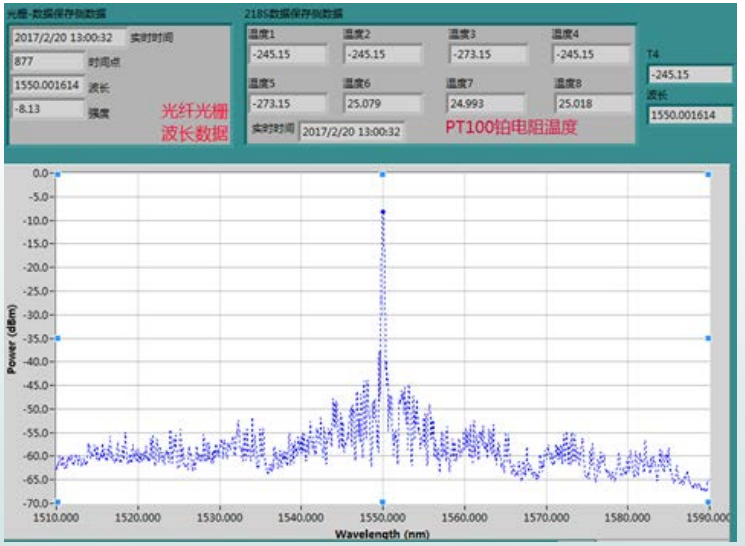


Calibration system

Chamber:
Setting ambient temperature
Thermal Monitor：
Calibrating temperature
FBG Demodulator:
Demodulating wavelength

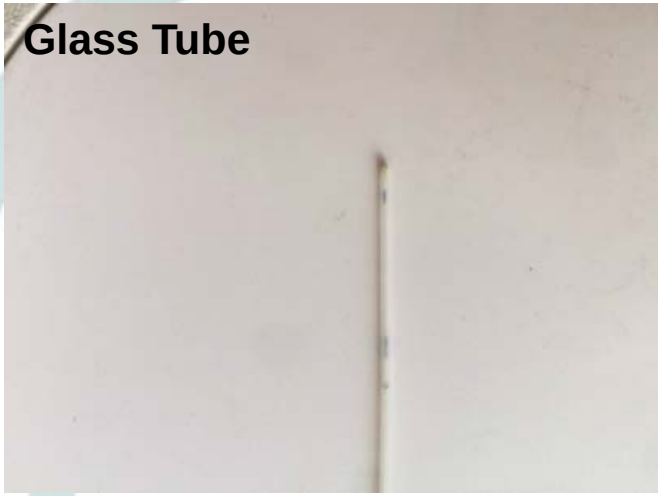


Labview



FBG Reflection spectrum

Performance Evaluation

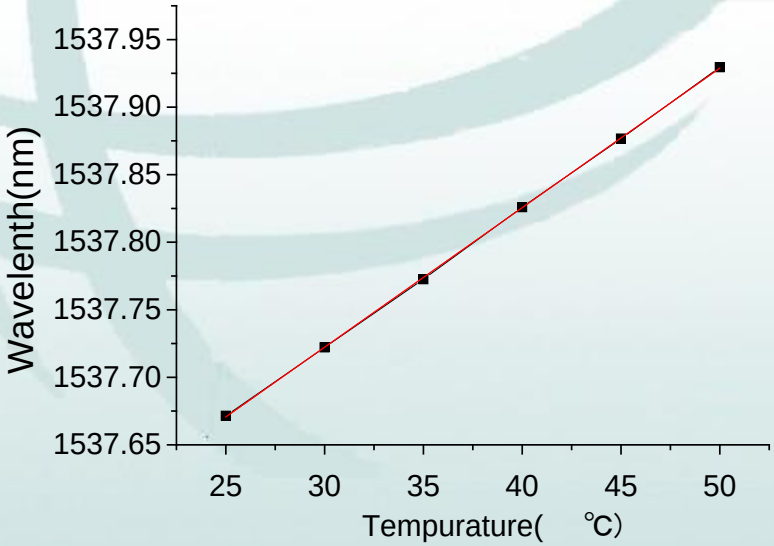


diameter of the glass tube is 0.5mm

minimize the influences on the battery.

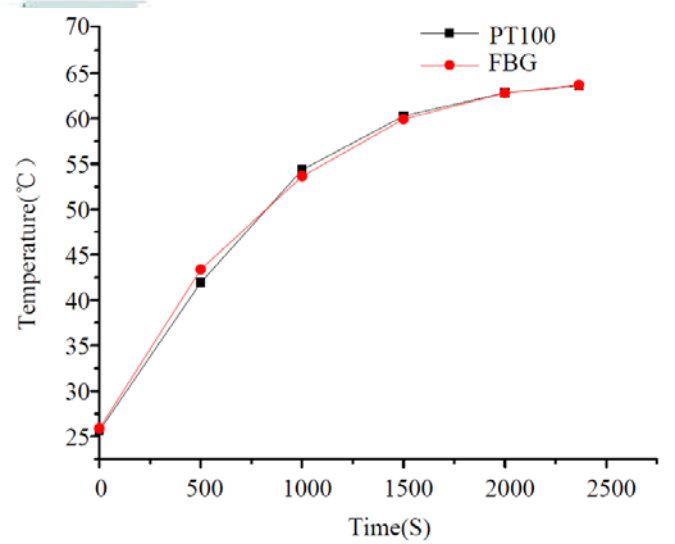
Inside the cladding

the front end is sealed



- ✓ Slope：≈0.01nm/℃
- ✓ Good Linearity
- ✓ Accuracy level：0.1℃
- ✓ Range：20℃~70℃

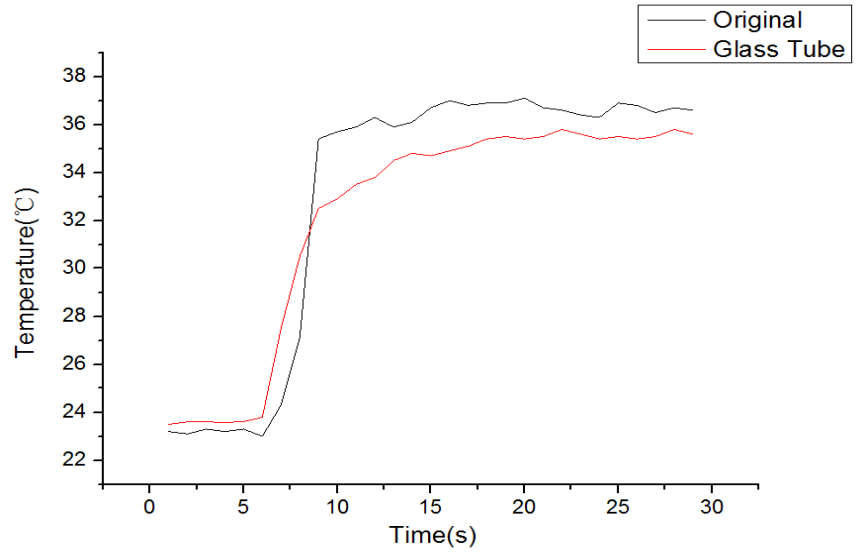
Performance Evaluation



Compared with Platinum resistance sensor

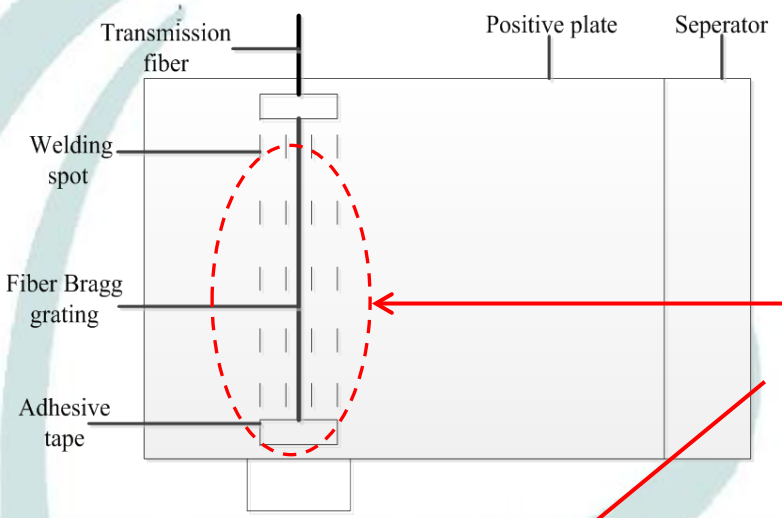
Error less than 1%

The response time is slower than original sensor, but is acceptable



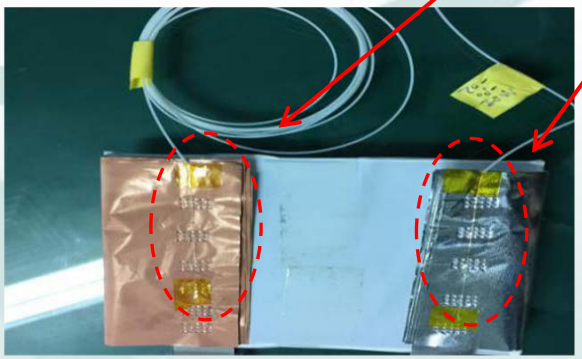
Performance Evaluation

Fixing method

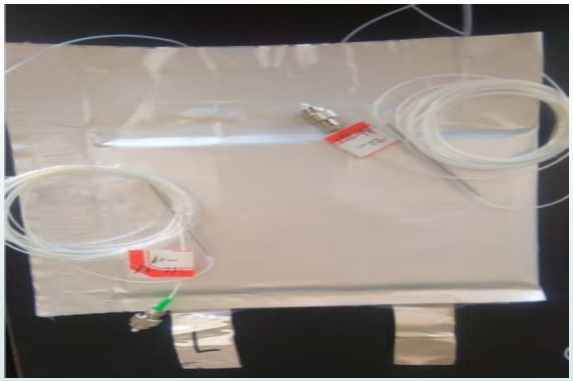


Fixing the FBG at the electrode

- Easy to fix
- Chemical reaction is active
- Battery sealability

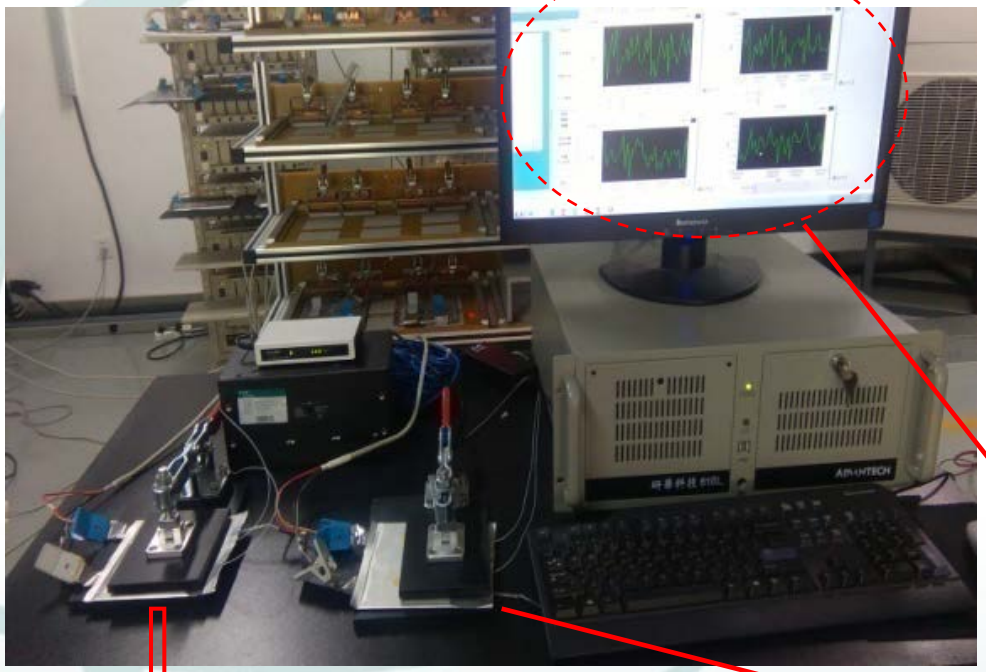


Packaging process



Battery with FBG inside

Situ-detection system



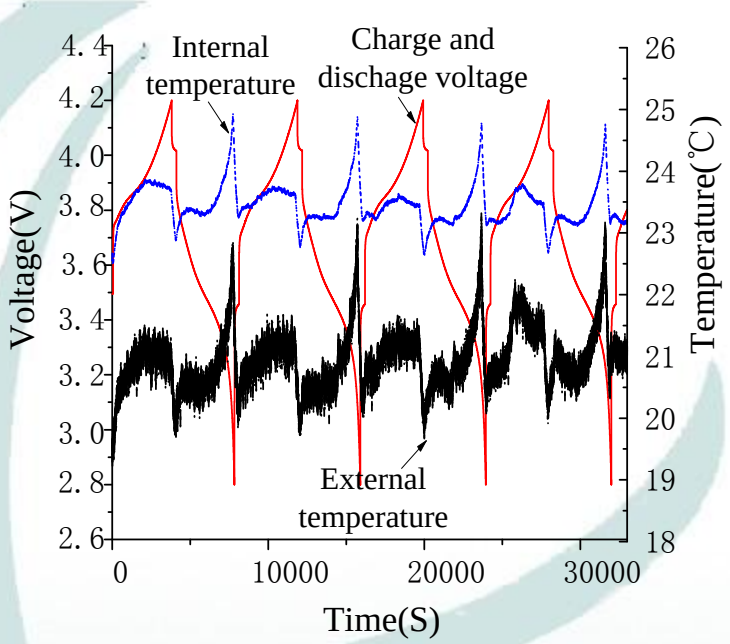
Situ-detection system:
Charge/Discharge equipment
FBG Sensor
Thermal Monitor
FBG Demodulator
Computer(Labview)

4 Channel measurement achieved by Labview

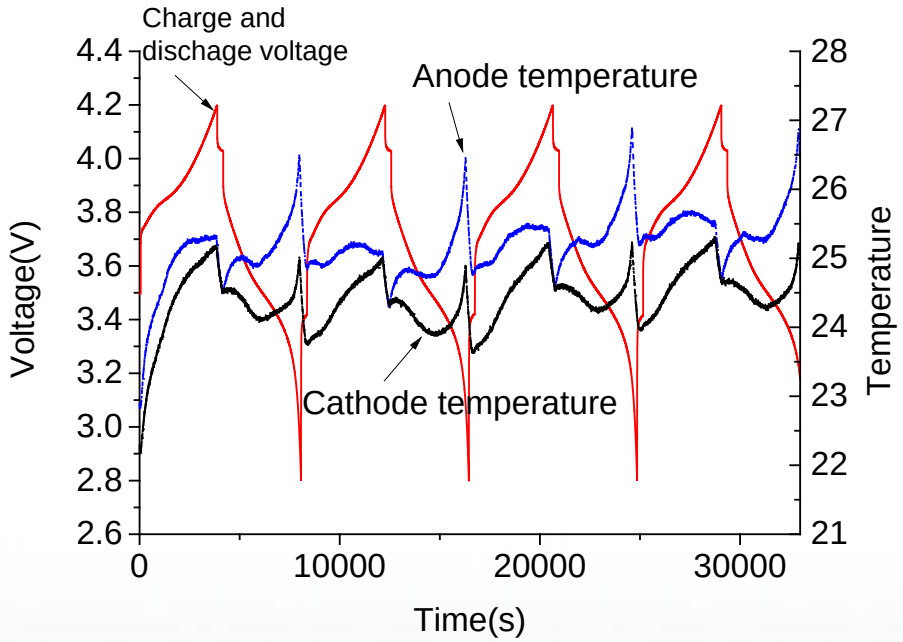
Charge/Discharge equipment for simulating the working status of batteries

2 Sensors for each battery

Charge/Discharge Experiment



- periodically changed with the charge and discharge voltage
- Internal temperature is higher than external temperature

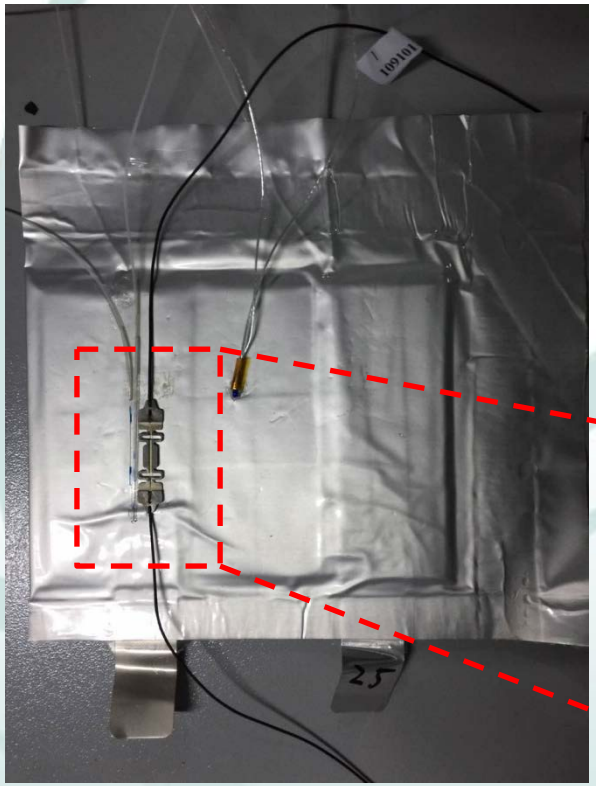


- periodically changed with the charge and discharge voltage
- Anode temperature is higher than Cathode temperature

In-situ detection is feasible by FBG sensor

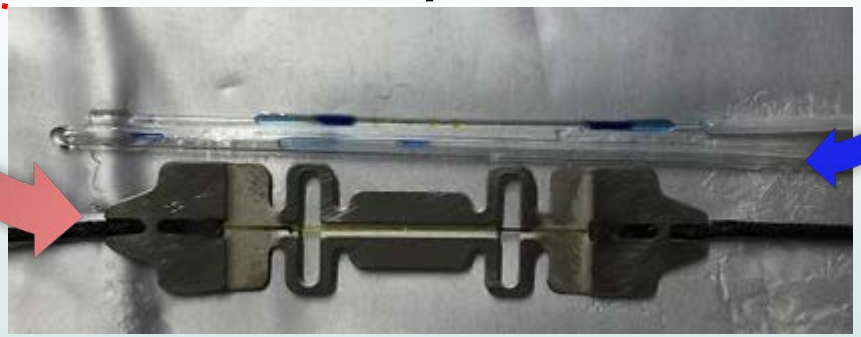
Stain measurement of battery surface

To find the relationship between internal temperature and battery status, we put a strain sensor outside the battery



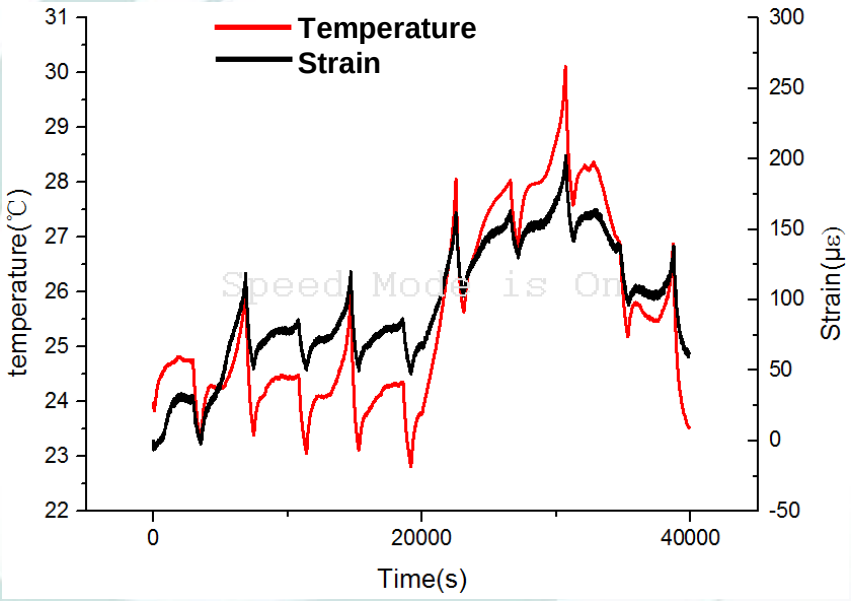
Stain sensor for deformation measurement

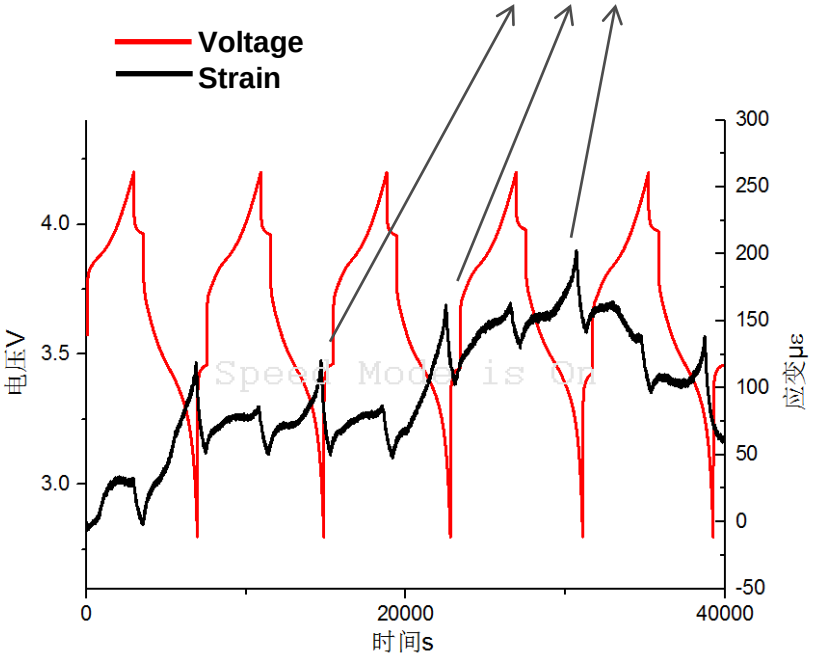
FBG sensor for outside temperature



Charge/Discharge Experiment

Switch time of charge/discharge





- **Surface strain changed with the internal temperature periodically**
- **The maximum value of deformation appears at Switch time of charge/discharge**
- **Focus on the Switch time of charge/discharge and set a reasonable security threshold**

Summary

- ✓ To provide corrosion, different packaging and coating methods were tested and glass tube was the best choice.
- ✓ The glass tube packaging senor was evaluated, the accuracy level is 0.1 ℃, the range is 20℃~70℃, the response time is reasonable.
- ✓ Battery In-situ detection system is built and the In-situ detection is feasible by FBG sensor.
- ✓ The relationship about the anode/cathode temperature, internal/external temperature and charge/discharge voltage was defined.
- ✓ The relationship between the strain of battery surface and charge/discharge voltage was defined.
- ✓ Focus on the Switch time of charge/discharge and set a reasonable safety threshold.

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Thank You!