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# High Temperature Photonic Sensors for SOFCs: Instrumentation for Enhanced Performance

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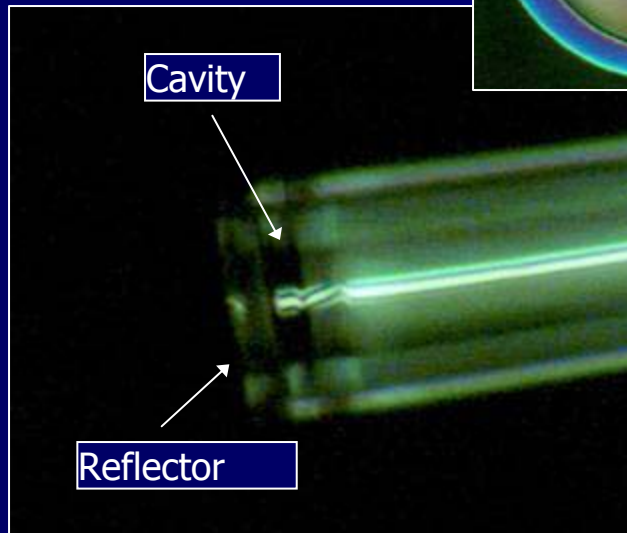
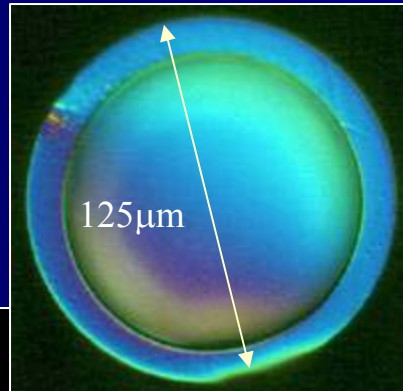
*Providing Sensor Solutions for Harsh Environments*

# Program Objectives

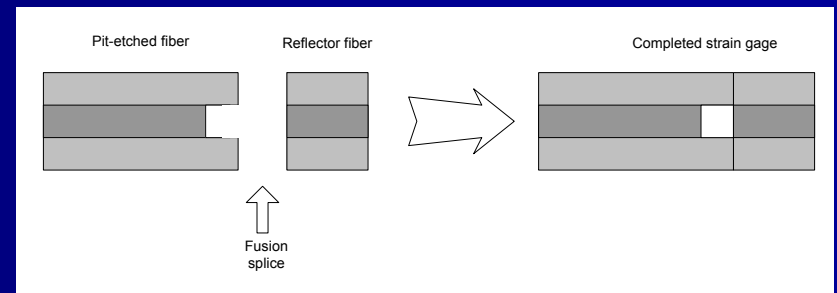
Design and test an optical strain sensor for button fuel cell evaluation.

- Operation at temperatures up to 800°C (1,472° F)
- Deflection range of 150  $\mu\text{m}$  to 1100  $\mu\text{m}$
- Low physical and thermal mass
- Small footprint
- Easy, onsite installation

# Miniature Fabry-Perot Sensor (MFPS) Strain Gage



- **Micromachined silica sensor**
- **Low thermal expansion**
- **Operating temps to 800°C**
- **Static and dynamic pressure**
- **Batch process mfg.**
- **Very small sensor - only 125 μm diameter**

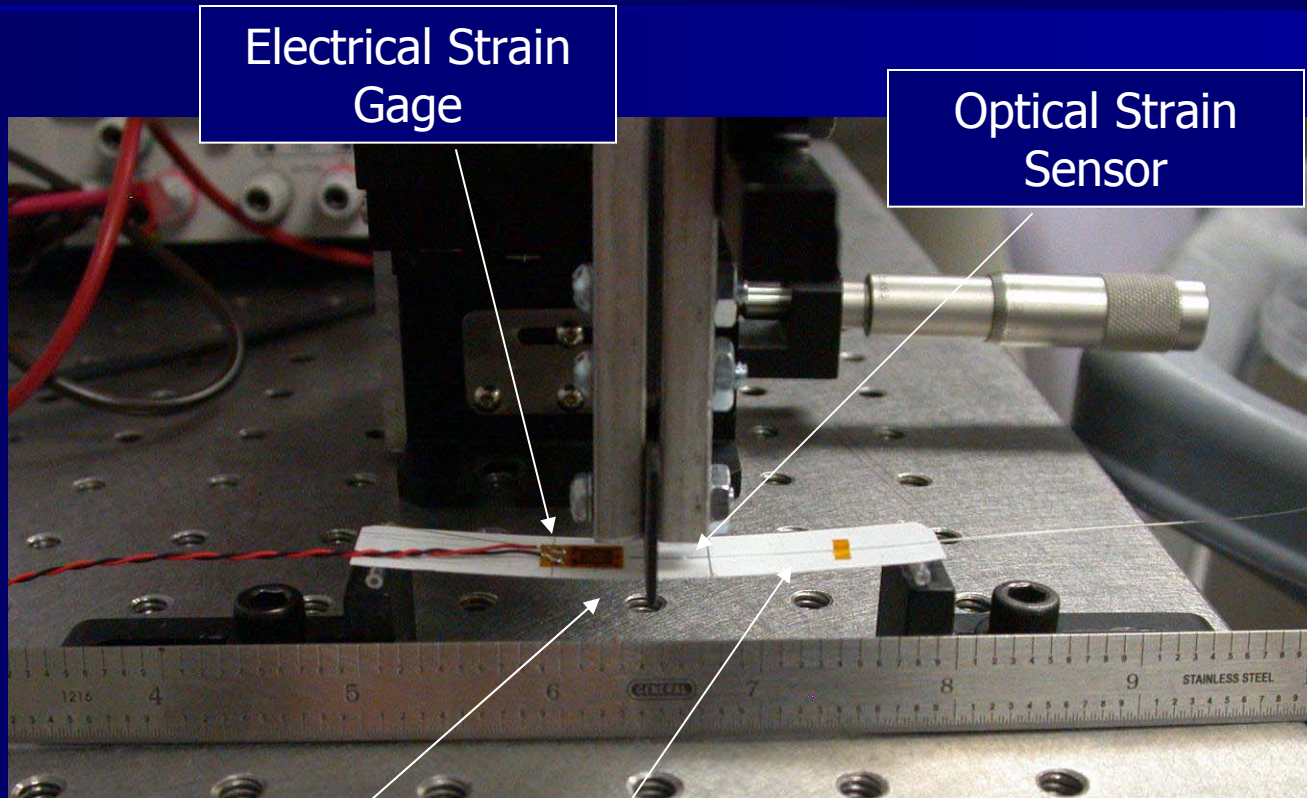


# VectorLight™ 300: Interrogator for MFPS strain gages

Channels	4	
Accuracy(% FS)	0.05	
Resolution (% FS)	0.56	
Dynamic Range	50 dB	
Scaled Output	1Hz	Ethernet; RS-232; RS-485; USB
Accessories:	VectorSwitch416: Analog Output:	Converts to 16 Channels 4-20mA



# 3-Point Bend Testing



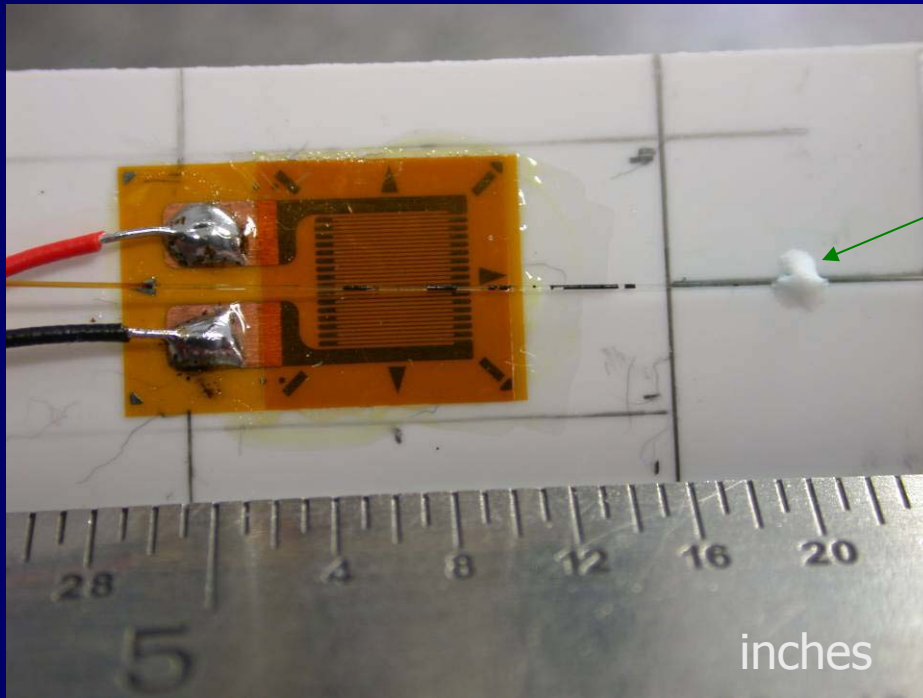
Electrical Strain Gage

Optical Strain Sensor

Deflection of 5mm

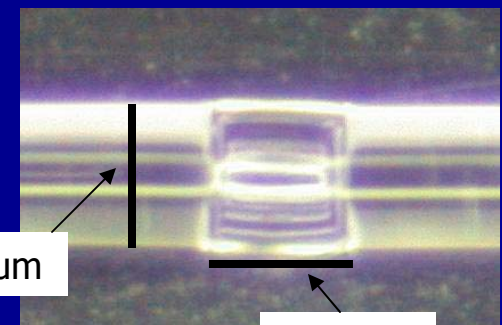
125 $\mu$ m thick Alumina Substrate

# Strain Gage Footprint



Optical Strain Gage Attachment Point

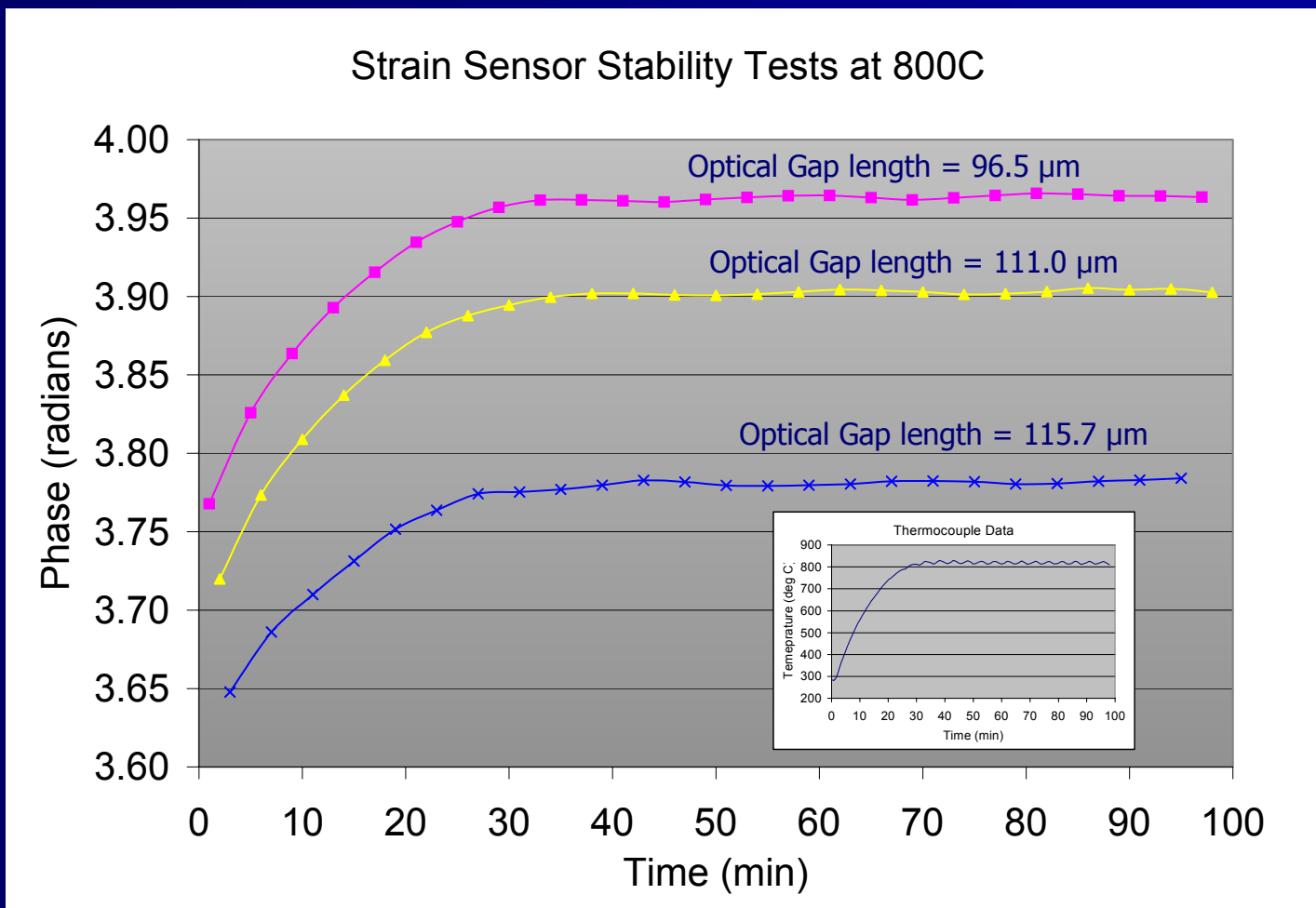
Optical Sensor Gap



125  $\mu\text{m}$

99  $\mu\text{m}$

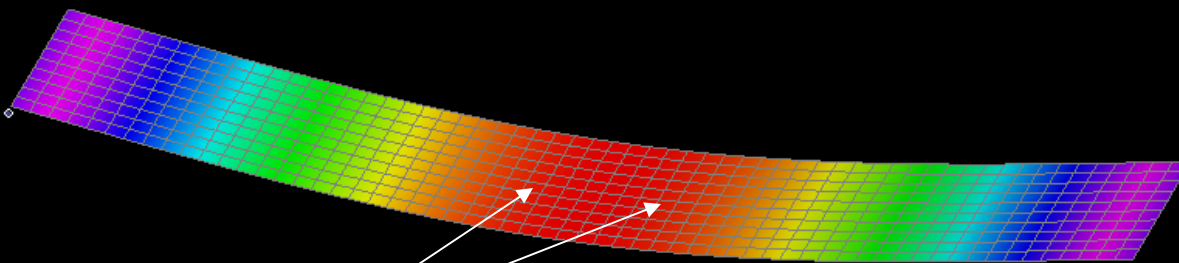
# High Temperature Stability



# Finite Element Analysis

V1  
L2  
C2

## FEA model of 3-point bend test on experimental test beam



$\epsilon = 0.019\%$

Beam center-line displaced a total of 1.5 mm. Indicated strain at gage installation locations = 0.019%.

Contours of total displacement shown on a deformed mesh, displacements magnified for clarity.



# Test Results

3 Point Bend Test - Beam center Point Displacement vs Strain

