

Serial Crack Propagation Strain and Temperature Sensors

Program Kickoff

7057-DOE-1S - 36i Phase I

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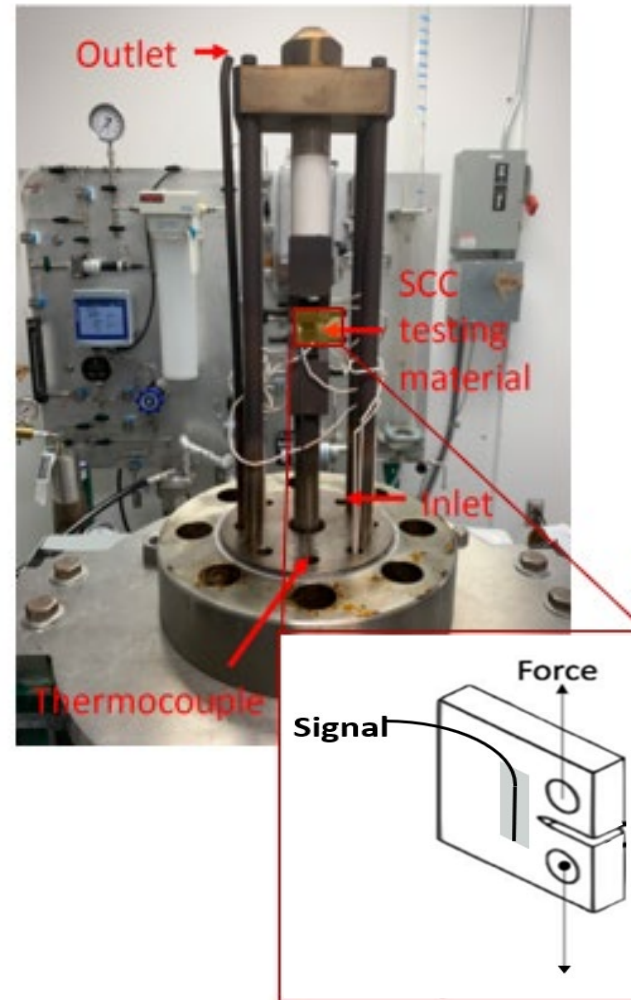
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Motivation

- Development of multi-parameter optical sensors for harsh environment SCC testing and monitoring
 - Temperature
 - Strain
 - Other measurands of interest?
- Sensors utilize Fiber Bragg Gratings (FBGs) and Fabry-Perot (FP) Interferometers (FPI)
- Coarse wavelength division multiplexing allows for serial deployment of FPI
- Luna's Hyperion platform allows interrogation of sensors up to 5kHz.
 - Full waveform at ~800Hz

Fiber-Optic Multifunctional Sensor for Crack Monitoring in Harsh Environments

Feasibility

- Determine success criteria
- Integrate sensor with test coupon
- Demonstrate survivability in high temperature environments
- Measure crack propagation with single port multifunctional sensor
- Develop initial Phase II plans

Development

- Refine system requirements
- Demonstrate operation in chemically harsh environments such as molten salt or liquid metal
- Develop packaging for nuclear reactors
- Mature transition and commercialization strategy

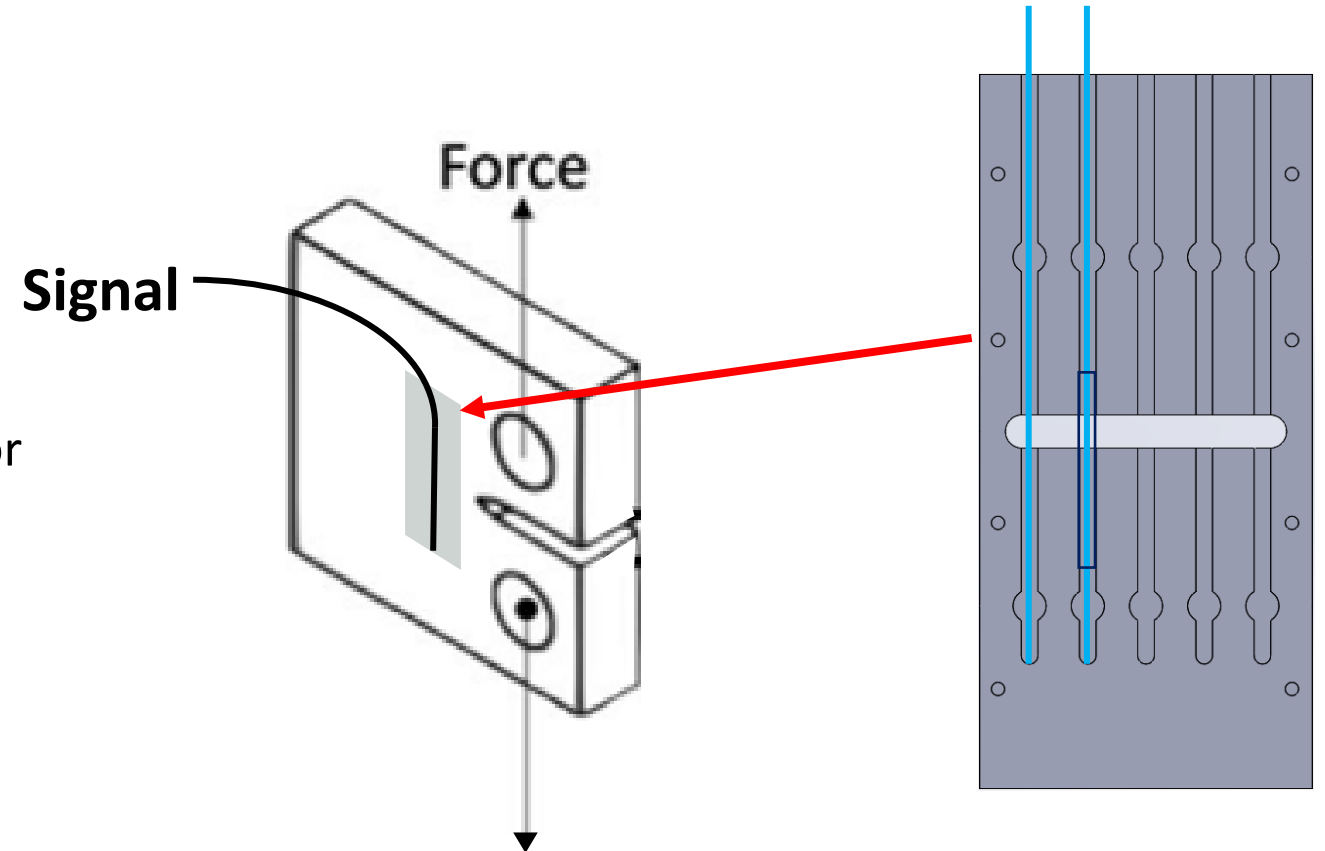
Transition

- Partner with industry leader to guide transition product into commercial reactor market
- Develop packaging for high temperature market
- Streamline methods to attach sensor to test sample
- Transition to a commercial product and identify path for high volume production ~1000/year



Design Multi-Parameter Crack Monitoring Sensor for Sample Integration in VT's Stress Corrosion Cracking (SCC) Tester

- Evaluate crack propagation in pe-notched 316 stainless steel test coupons
- Displacement gauge was housed on a spot weldable sensor mount
- Sensor application will need to be developed for nonmetallic samples
- Configuration will provide displacement due to notch opening and temperature near the gauge



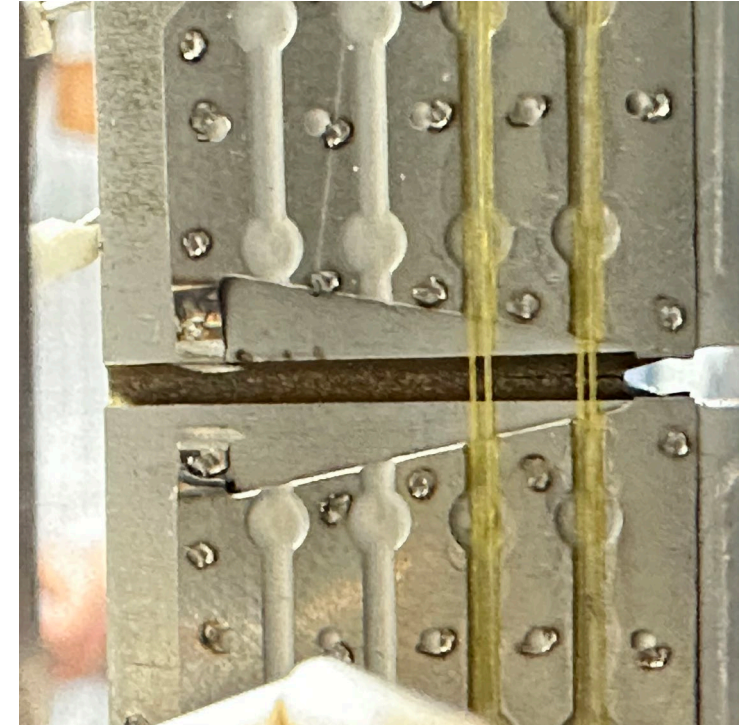
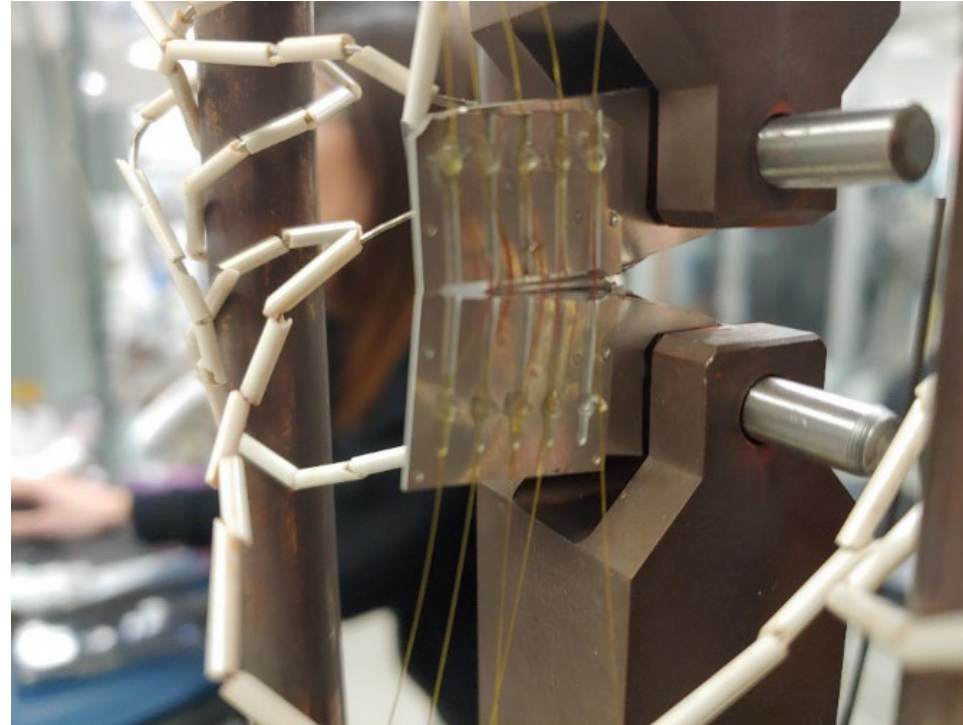
Characterize Prototype Sensor Capability for Crack Propagation

- Phase I SCC sampling was conducted at the following conditions:
 - Sample at room temperature
 - Sample at high temperature (up to 320°C) in inert gas
 - Sample submerged in liquid metal (Pb)
- Phase II SCC testing will be conducted to assess survivability in molten salt

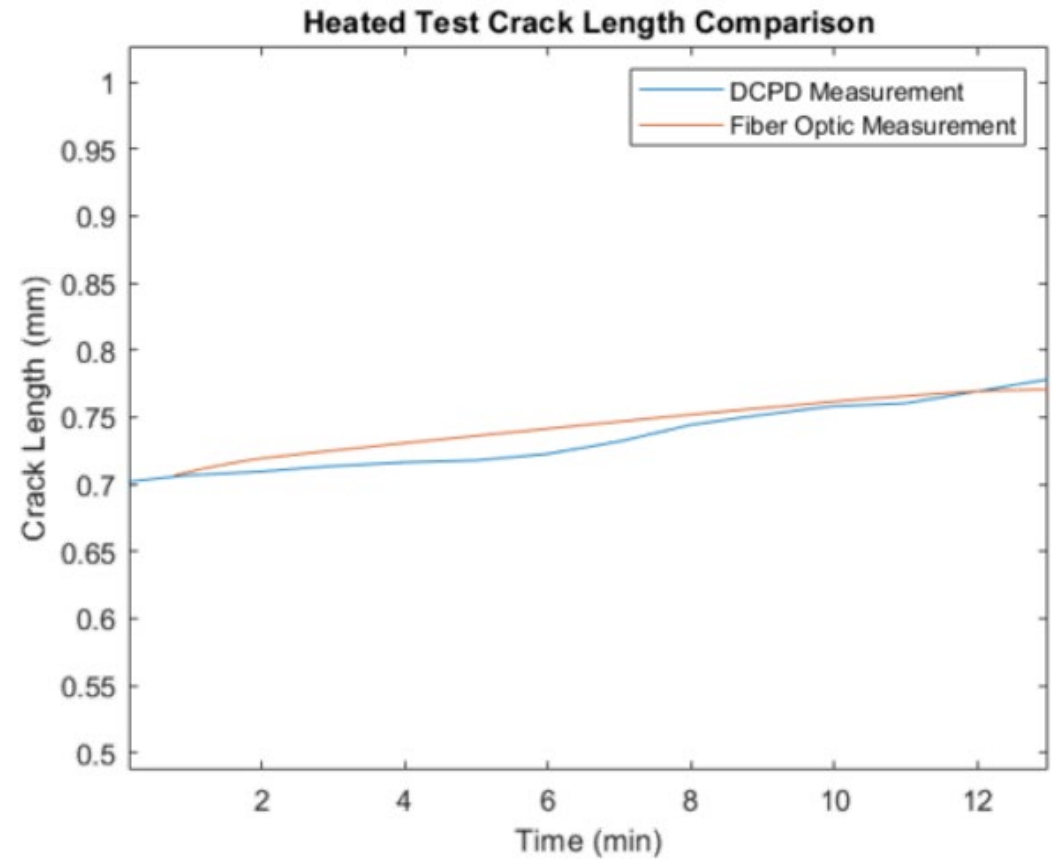
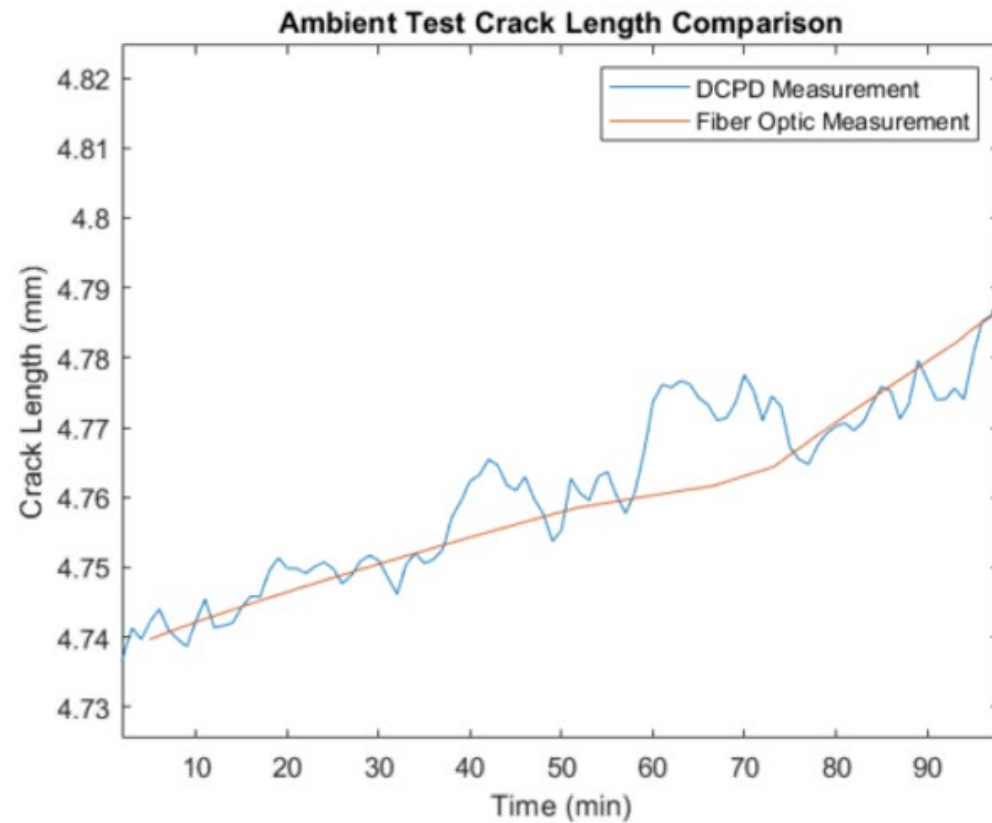


Fatigue Load Testing Setup

- Fatigue testing on an ASTM E647 standard specimen of stainless steel
- Load frequency varied between 1-2 Hz
- Stress intensity factor was constant at 20 MPa√m



ASTM E647 Test Data Results



Molten Lead Bismuth Eutectic Testing

- LBE testing was conducted to assess the survivability of the fiber optic sensors in high temperature, liquid lead environments
- Evaluation was done on both FBG sensors and HD-FOS
- Temperatures ranged from 260°C for long durations and 400°C for short intervals
- Testing was done for a continuous 190 hours

