Dr. Ruishu F. Wright is a Research Physical Scientist within the Oil and Gas Center at the DOE National Energy Technology Laboratory's (NETL) Research and Innovation Center. She serves as Technical Portfolio Lead for Natural Gas Infrastructure Program.

In this role, Dr. Wright leads an interdisciplinary R&D team developing real-time sensors and advanced functional sensitive materials to monitor and mitigate corrosion and gas leaks in pipelines, enable subsurface geochemical and geophysical monitoring, ensure wellbore integrity, and enhance power grid reliability.

Dr. Wright holds a Ph.D. from The Pennsylvania State University. She has co-authored over 100 technical articles, delivered more than 110 conference presentations, and holds 13 awarded or pending U.S. patents. Her impactful contributions to energy infrastructure safety earned her the 2023 and 2024 R&D 100 Awards and the 2025 Samuel J. Heyman Service to America Medal.

NETL Sensor Technologies Progress Overview

Presenter: Ruishu F. Wright, Ph.D.
Research Scientist,
Technical Portfolio Lead,
Research and Innovation Center
National Energy Technology Laboratory (NETL)

UPitt Infrastructure Sensor Collaboration (UPISC)
Annual Workshop
June 2 and 3, 2026

NETL Sensor Expertise and Capabilities for Energy Infrastructure

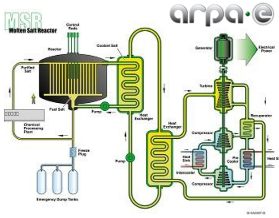
Advanced Sensors for Energy Efficiency, Safety, Resilience, and Sustainability

- ✓ Monitor systems and conditions
- ✓ Improve performance & efficiency
- ✓ Enhance reliability & safety
- ➢ Temp, acoustics, chemical, gas, corrosion
- ➢ Composite nano-materials, thin films & fiber optics, sensor devices development

Sensor Platforms | Sensing Materials

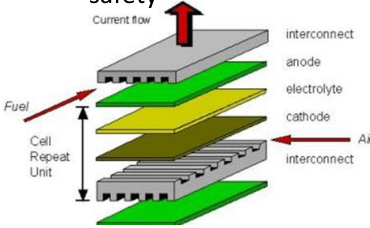
GENERATION

Turbines: Real-time fuel composition and combustion temperature for improved service life and efficiency



Nuclear: Core **monitoring and molten** salt temperatures for reactor fuel efficiency & reactor safety

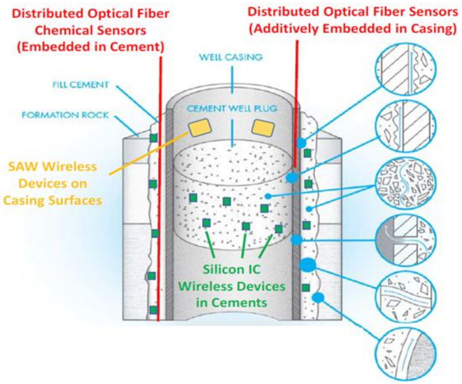
SOFCs: Fuel concentration & temperature gradients for improved lifetime and efficiency



ENERGY DELIVERY & STORAGE

Pipelines: Monitor corrosion, gas leaks, T, acoustics to predict/prevent failures. NG, H_2, CO_2

Grid: Transformer, powerline failure prediction, fault detection, state awareness



Subsurface: Wellbore integrity, failure prediction, leak detection for subsurface gas of NG, H_2, CO_2, or abandoned hydrocarbon wells.

UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

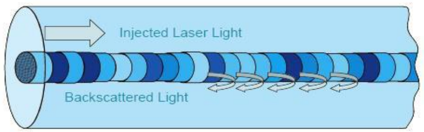
COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

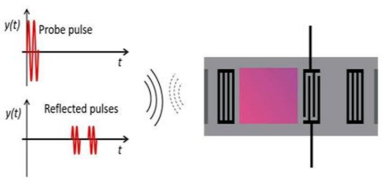
Innovative Sensors to enable Affordable, Reliable, and Secure Energy

Sensor Technologies

Distributed Optical Fiber Sensors

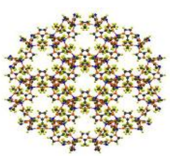


Passive Wireless Sensors

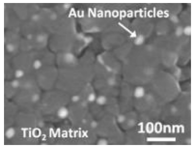


Electrochemical Sensors

Functional Sensing Materials

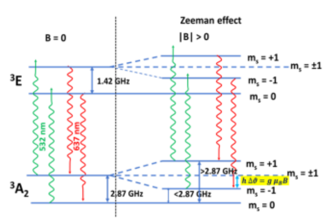


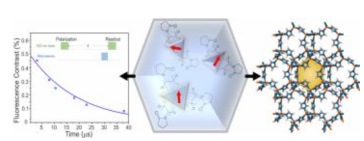
Metal Organic Framework (MOF)



Plasmonic Nanoparticles

Quantum Sensor





Nanodiamond with NV centers

Single-crystal Optical Fiber

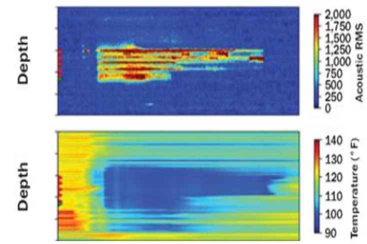
Sapphire or YAG fiber

Sensor Applications

Oil and Gas Pipelines

NETL fiber optic sensor being installed on a Colonial Pipeline

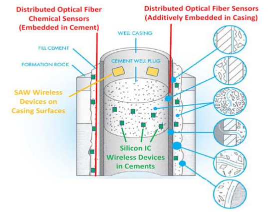
Geophysical Monitoring

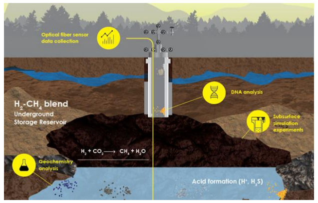


Fiber optic distributed acoustic, temperature, strain sensing

DAS/DTS Put New Light On Stimulations

Wellbore integrity, Subsurface Gas and Chemical Sensors





2024 R&D 100 WINNER

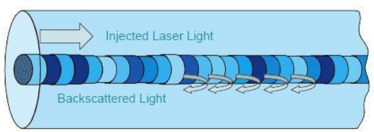
2023 R&D 100 WINNER

2022 R&D 100 WINNER

Multiple Sensor Technology Platforms at NETL

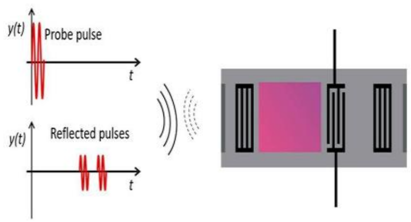
Long-distance Distributed Optical Fiber Sensors

Imperfections in fiber lead to Rayleigh backscatter:



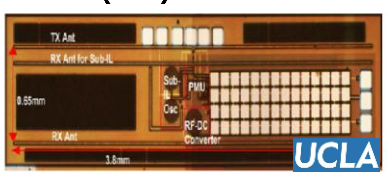
Rayleigh backscatter forms a permanent spatial “fingerprint” along the length of the fiber.

Passive Wireless Sensors



Advanced Electrochemical Sensors

Wireless Miniature Silicon Integrated Circuit (SiIC) Sensors



	Geospatial Attributes	Cost	Targeted Function
Distributed Optical Fiber Sensors	Linear Sensor Adjustable Distance and Resolution	Cost Per Sensor “Node” Low	Temperature, Strain, Gas Chemistry (CH_4, CO_2, H_2O, H_2, etc.) Early Corrosion/pH Detection
Passive Wireless SAW Sensors	Point Sensor	Low	Temperature, Strain, Gas Chemistry (CH_4, CO_2, H_2O, H_2, etc.) Early Corrosion/pH Detection
Advanced Electrochemical Sensor	Point Sensor	Moderate	Water Content, Corrosion Rate, T, Pitting Corrosion
Wireless Miniature SiIC Sensors	Point Sensor	Low	pH and Chemical Sensing

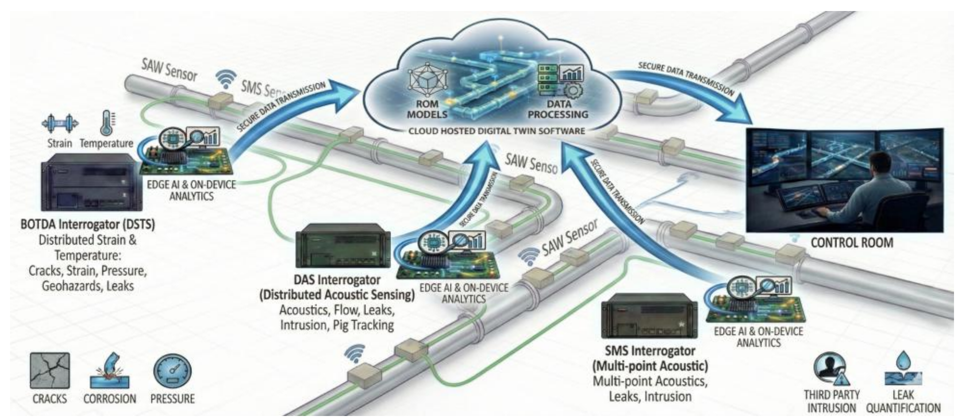
Multiple Sensor Platforms with Various Cost, Performance, and Geospatial Characteristics have been developed at NETL and via collaborations.

NETL Sensor Technologies Progress and Achievements in 2025-2026
-Natural Gas Infrastructure Technologies

- **Multiple distributed fiber optic pipeline sensor technologies developed by NETL** were tested on underground gas pipelines at Hope Gas facility via CRADA with Hope Gas Company.
- Successfully demonstrated ultra-long distance optical fiber sensors > 100 km interrogation, external corrosion sensor, and AI-enabled cloud-based gas leak and third-part intrusion monitoring.

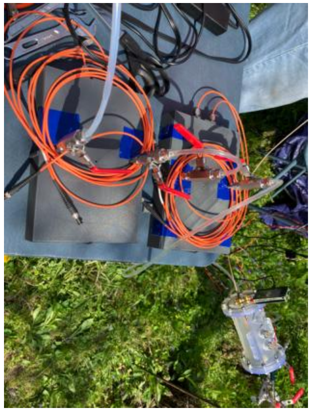
Field Test of NETL Sensors at Hope Gas facility

Pipeline Digital Twin framework



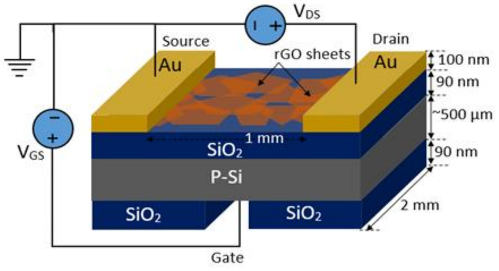
NETL Sensor Technologies Progress and Achievements in 2025-2026
-Novel Methane Sensor Demonstration at a well

- Field demonstration of optical fiber-based and surface acoustic wave-based methane sensors at an abandoned well to monitor, quantify and mitigate methane loss from oil and gas industry.
- New sensor platforms including resistive and field-effect transistor sensor with ppb and ppm level sensitivity for small leak detection.



NETL sensors installed at an abandoned well, with 3D printed sensor assembly.

Resistive Sensor Device

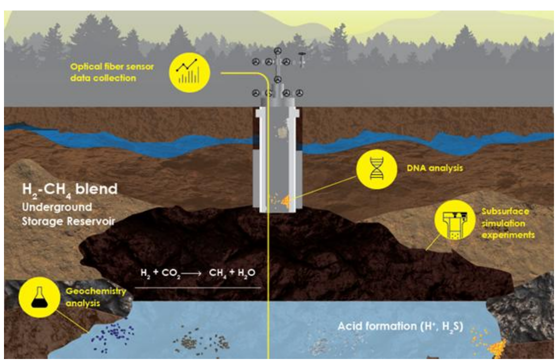


Field-effect transistor sensor

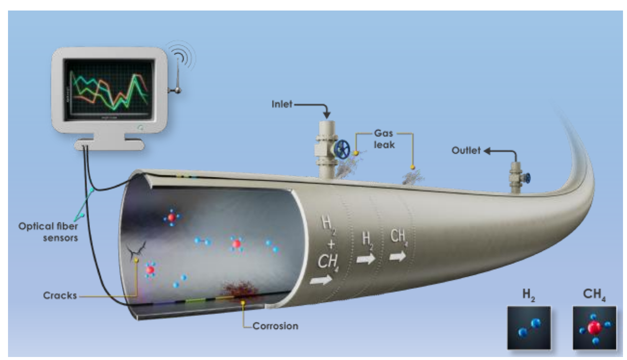
NETL Sensor Technologies Progress and Achievements in 2025-2026
-Hydrogen Pipeline and Subsurface Storage, Hydrogen Leak Detection

- The optical fiber H_2 sensor has demonstrated real-time H_2 sensing in harsh subsurface conditions with different temperatures (20-80 ℃), pressures (1-103 bar), and humidities (0-100% RH) ***in situ and real time***.
- A low-cost fiber optic hydrogen sensor prototype with user friendly GUI is completed and validated in the lab, ready for field validation at NLR.

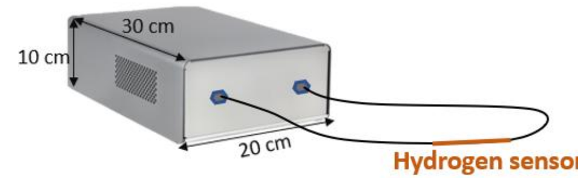
SHASTA
Subsurface Hydrogen Assessment, Storage, and Technology Acceleration

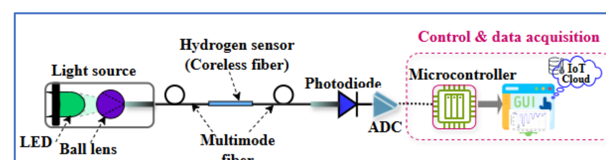


Natural Gas and Hydrogen Transport



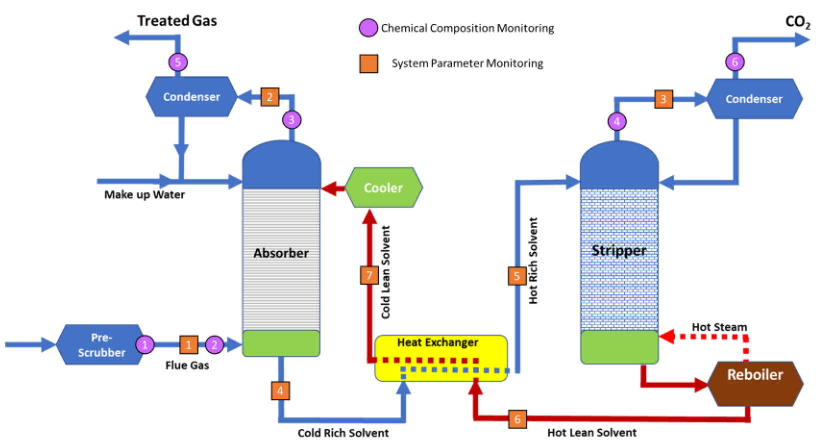
Low-cost highly sensitive H2 sensor prototype





NETL Sensor Technologies Progress and Achievements in 2025-2026
- In-situ Amine Degradation Monitoring

- **Demonstrated optical fiber-based amine degradation sensor prototypes for in-situ real-time monitoring in a post-combustion solvent-based CO_2 separation loop system** at National Carbon Capture Center (NCCC) for pilot-scale demonstration since 2024.
- Developed PCA and ML methods to enable NETL fiber optic amine degradation sensor to monitor multiple parameters and quantify solvent degradation.



Schematic of a carbon capture system with currently available monitoring technologies

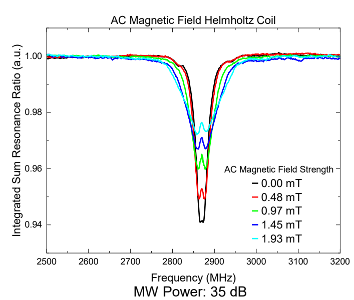
NETL fiber optic amine degradation sensor assembly and installation at NCCC

NETL Sensor Technologies Progress and Achievements in 2025-2026
-Power Grid Modernization and GRID-Q

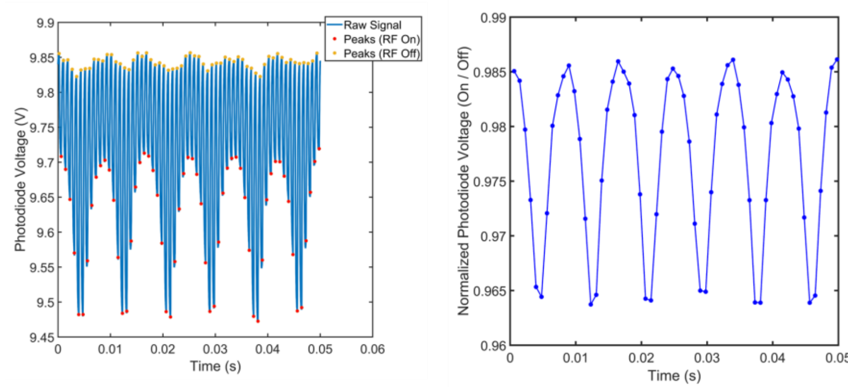
- **Grid Research, Integration, and Deployment for Quantum (GRID-Q) is** funded by the U.S. Department of Energy Grid Modernization Laboratory Consortium (GMLC)
- Multi-lab efforts: ORNL (lead), **NETL (quantum sensing thrust lead),** LANL, LLNL, ANL.
- Presented progress at Semi-annual QUEST workshop.

GRID MODERNIZATION INITIATIVE
U.S. Department of Energy

Optically detected magnetic resonance (ODMR) system



AC magnetic field sensing



Time-resolved measurements of an AC magnetic field of 60 Hz, at sampling rate of 1.2 kHz.

NETL and U. Pitt. Sensor Technologies Progress and Achievements 2025-2026

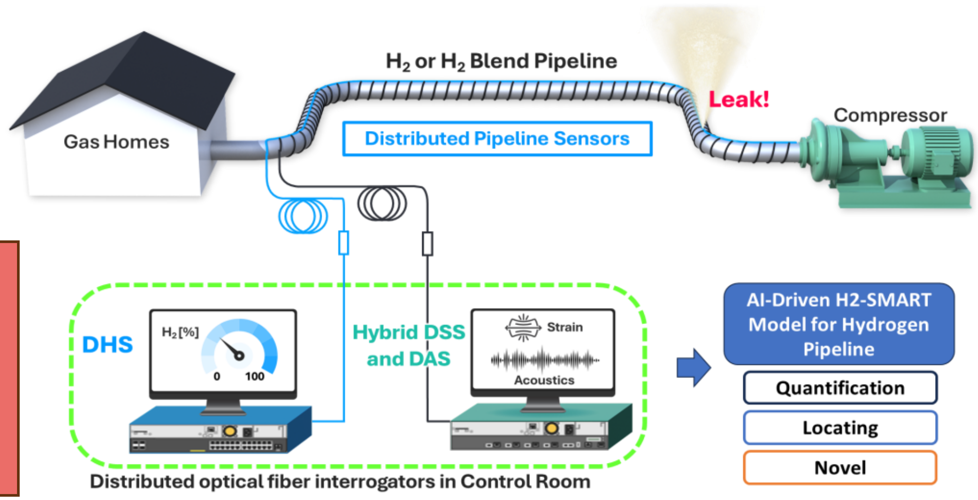
ARPA-e H2SENSE Project

NATIONAL ENERGY TECHNOLOGY LABORATORY

University of Pittsburgh

Hope Gas

Innovation: H2 emission Sensing, Modeling, and AI-driven Real-time Quantification (H2-SMART) approach can harness the distributed sensing data and leverage AI-enhanced data fusion and multi-physics simulations to locate and quantify H_2 emissions from the pipeline.



- Project "**Novel Fiber Optic Sensor Systems and AI-driven Methods for Hydrogen Pipeline Emission Quantification**" was kicked off in 2025.
- Will establish a group of Industry Technical Advisors for Technology to Market Strategies. Welcome more industry partners!

Dr. Paul R. Ohodnicki is the Director of the Center for Energy and RK Mellon Faculty Fellow in Energy at the University of Pittsburgh. He also is faculty lead for the University of Pittsburgh Infrastructure Sensing Collaboration Workshop and the founding director of the INfrastructure Sensing for Intelligent Transportation and Energy Systems consortium.

In this role, Dr. Paul Ohodnicki teaches interdisciplinary courses and leads an interdisciplinary R&D team spanning materials scientists, mechanical engineers, and electrical engineers focused on applied and fundamental research spanning from new materials to integration within devices and field validation. Previously, from 2010-2019, he was a Technical Portfolio Lead at the National Energy Technology developing real-time sensors for a range of energy applications.

Dr. Ohodnicki holds a Ph.D. from Carnegie Mellon University and a Bachelor's in Engineering Physics and Economics from University of Pittsburgh. He has co-authored over 200 technical articles and holds more than 60 awarded or pending U.S. patents. His contributions have been recognized by a total of 7 R&D 100 awards and the Presidential Early Career Award in Science and Engineering.

PITT Sensor Technologies Updates and Overview

Presenter: Paul R. Ohodnicki, Jr.

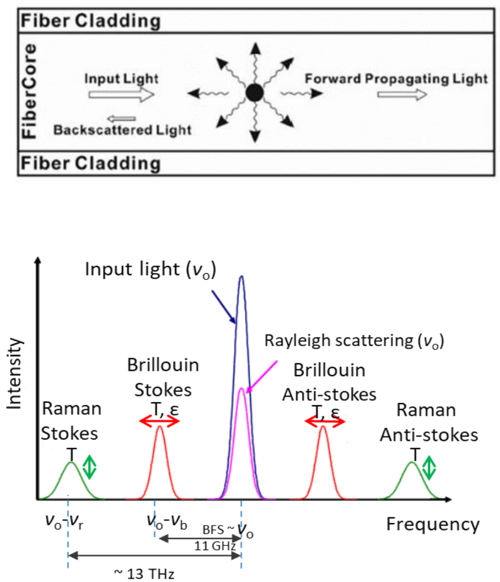
Director – Center for Energy
RK Mellon Faculty Fellow in Energy
Swanson School of Engineering
University of Pittsburgh (PITT)

UPitt Infrastructure Sensor Collaboration (UPISC)
Annual Workshop
June 2 and 3, 2026

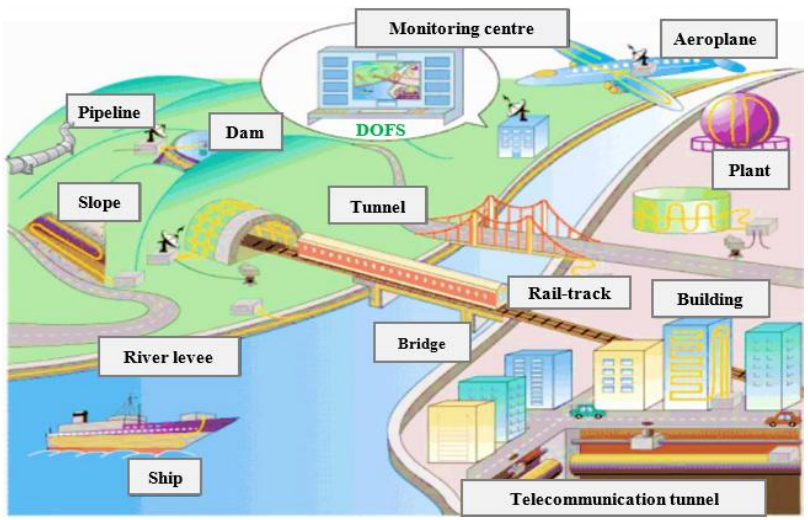
PITT Sensor Technologies Updates and Overview

Distributed Sensing and Infrastructure Monitoring

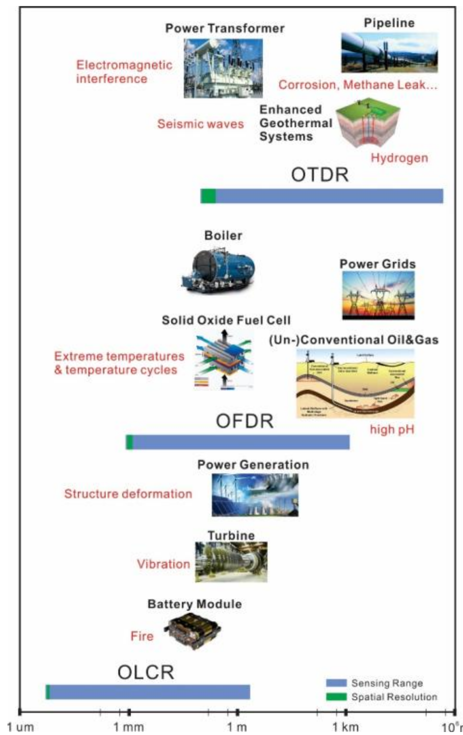
Scattered light spectrum of optical fiber



Various Applications



Applied Physics Reviews **6**, 041302 (2019); https://doi.org/10.1063/1.5113955

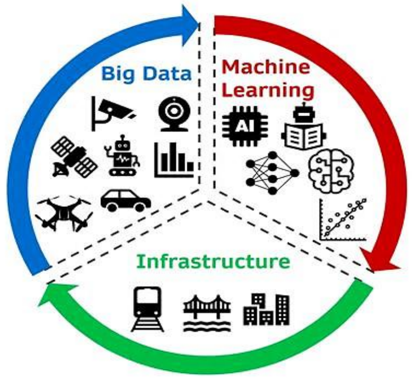


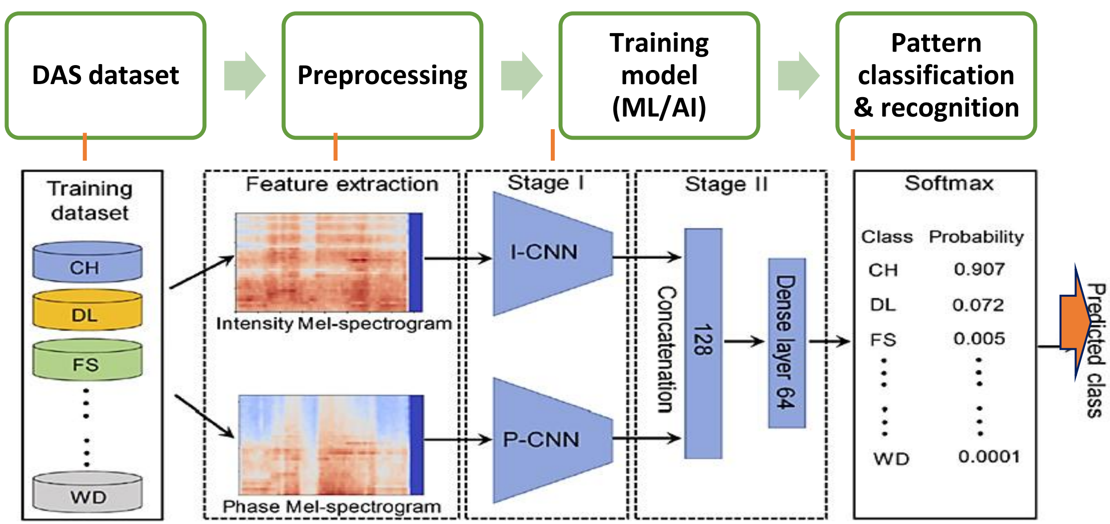
Distributed Sensing Over Different Length Scales

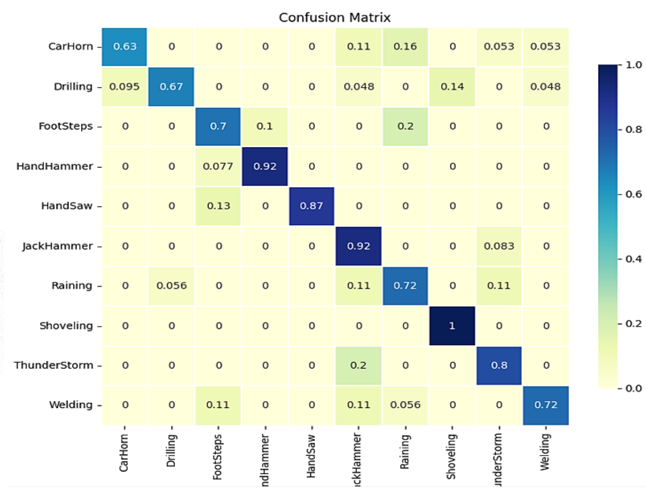
PITT Sensor Technologies Updates and Overview

Intelligent Fiber Sensors: A Fusion of DAS & AI

- Infrastructure type: Threats analysis
- High-quality Datasets: Acoustic signatures of various threats/events
- Data processing: Pre-processing and AI/ML models





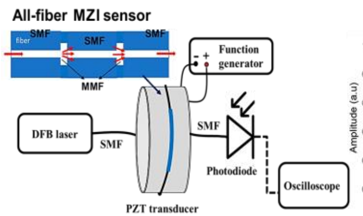


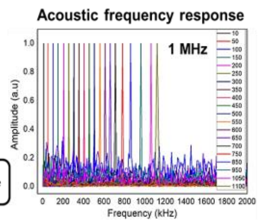
PITT Sensor Technologies Updates and Overview

Distributed Sensing Applications @ PITT Ohodnicki Lab

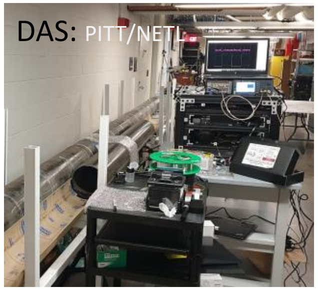
❑ Acoustic sensing

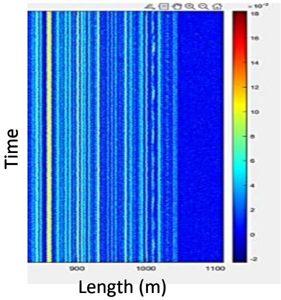
- **Point and Multipoint**





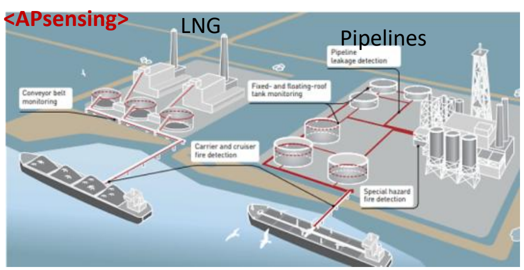
- **Distributed Acoustic Sensor (DAS):**
  - Benchtop Interrogator
  - Commercial Interrogator acquisition

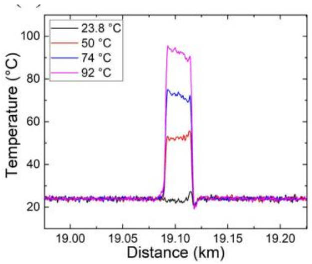




❑ Temperature sensing

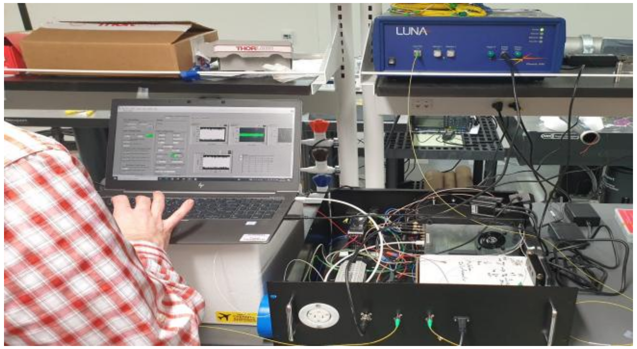
- Distributed Temp Sensor / DTS: Commercial interrogator

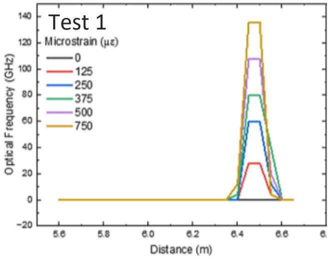


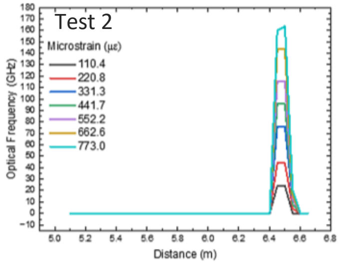


❑ HD Strain/Temperature

- Benchtop OFDR.....PITT/NETL



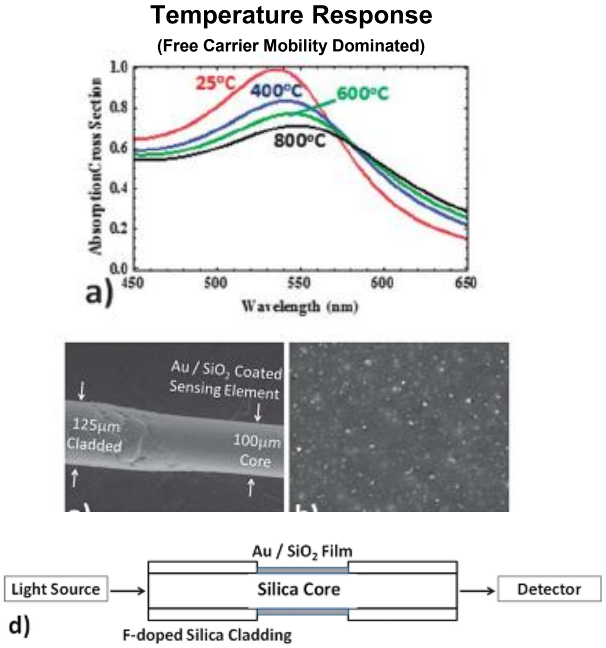




PITT Sensor Technologies Updates and Overview

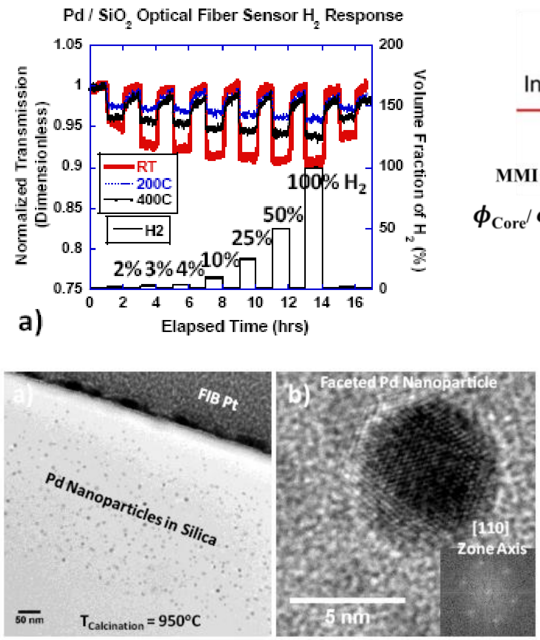
Functionalized Optical Fiber Sensing @ PITT Ohodnicki Lab

❑ Temperature Sensing



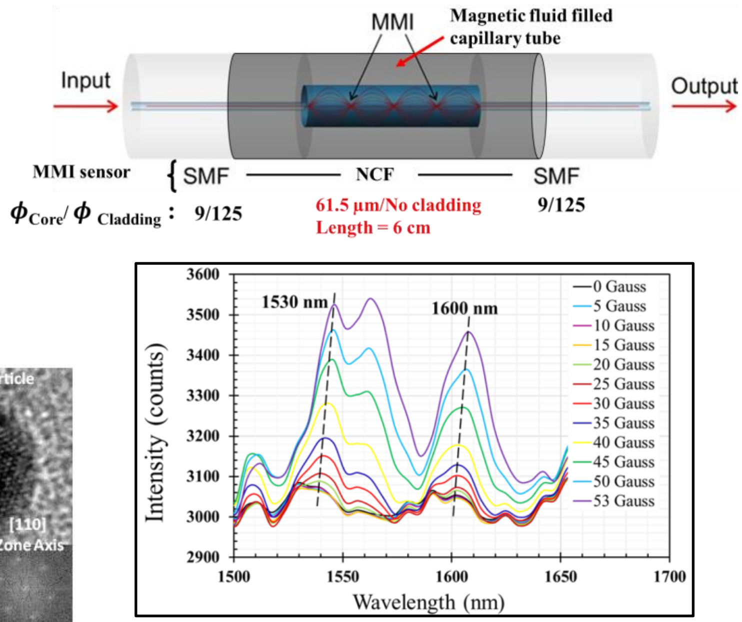
P.R.Ohodnicki et al, Nanoscale 5 (19), 9030-9039 (2013).

❑ Chemical Sensing



P.R. Ohodnicki et al. / Sensors and Actuators B 214 (2015) 159–168

❑ Magnetic Field Sensing

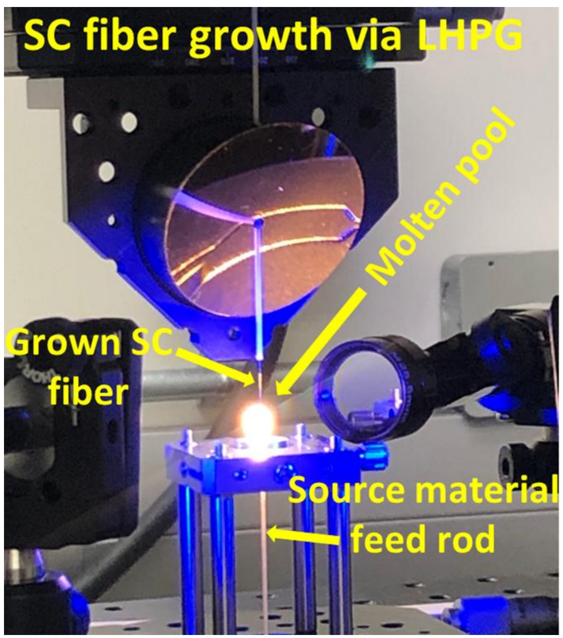


D. Karki et al, Presented at SPIE DCS 2023.

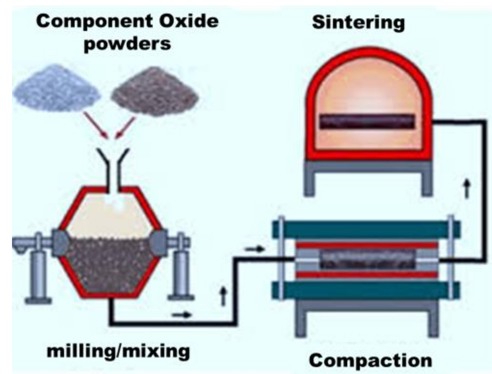
PITT Sensor Technologies Updates and Overview

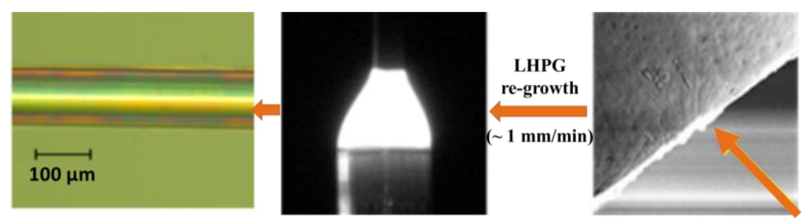
Single Crystal Oxide Fiber Sensing @ PITT Ohodnicki Lab

- Laser Heated Pedestal Growth



- Functional Crystal Oxides





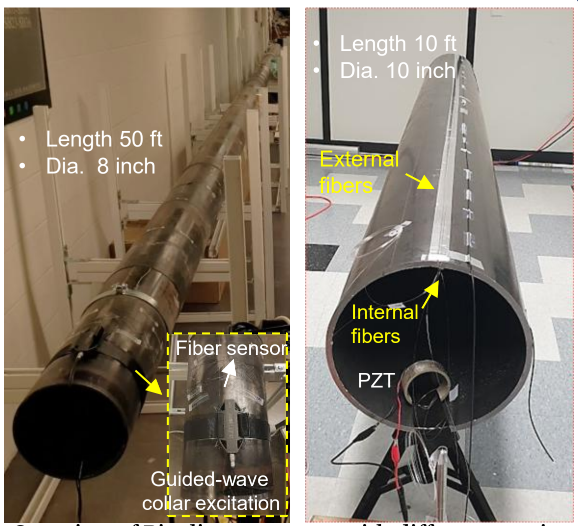
Nd:YAG fiber with HoAG cladding | 120µm Ho, Nd:YAG fiber | HoAG coated 330 µm Nd:YAG fiber

Liu, B., Ohodnicki, P. R., Fabrication and Application of Single Crystal Fiber: Review and Prospective. *Adv. Mater. Technol.* 2021, 6, 2100125. https://doi.org/10.1002/admt.202100125

PITT Sensor Technologies Updates and Overview

Example On-Going Work: Fusion of Acoustic NDE + Fiber Optics

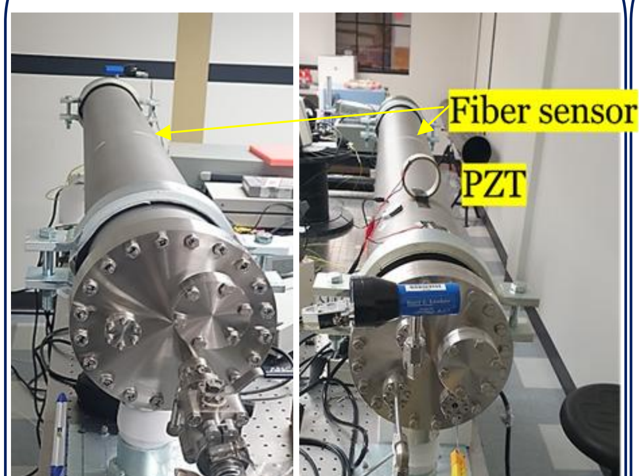
Pipeline monitoring



Overview of Pipeline test setup with different sensing optical fibers deployed internally using robotic FODT

Point & Distributed Acoustic Sensing:
-Structural integrity and degradation
-Natural gas and oil leakages
-SHM: Internal state and corrosion

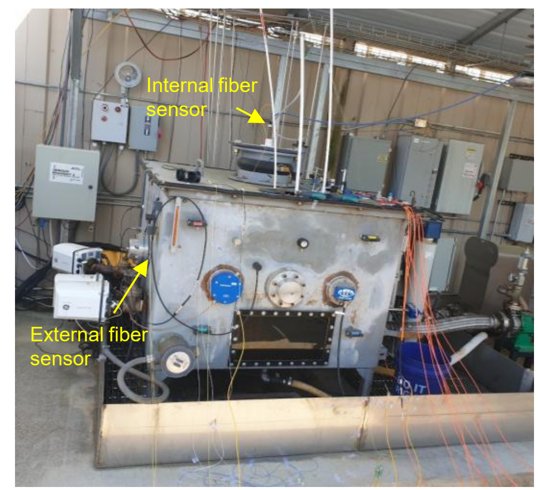
Nuclear Canister monitoring



Dry Cask Storage System for Nuc. Canister monitoring

Q-distributed Acoustic Sensing:
-Internal radio-active leak detection
- Corrosion, gas phase, and temperature monitoring

Elect. Assets monitoring



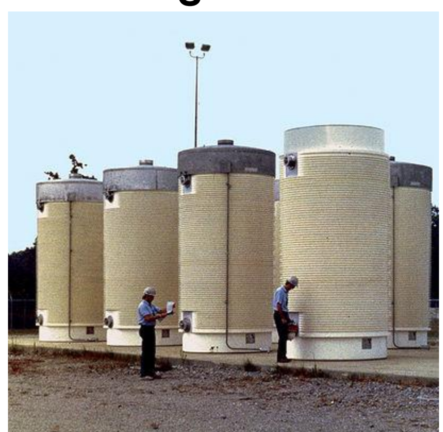
Test setup for Partial discharge detection @ EPRI

Q-distributed Acoustic Sensing:
-Partial Discharge detection
-Gas and temperature monitoring

PITT Sensor Technologies Updates and Overview

Example Major R&D Programs Sponsored at University of Pittsburgh

- Low-Cost Electrical Grid Asset Sensing + Grid Analytics
- Spent Nuclear Fuel Waste Facility Monitoring
- Molten Salt Reactor Monitoring
- Distribution Pipeline Sensing
- Marine Carbon Capture



SOLAR ENERGY TECHNOLOGIES OFFICE
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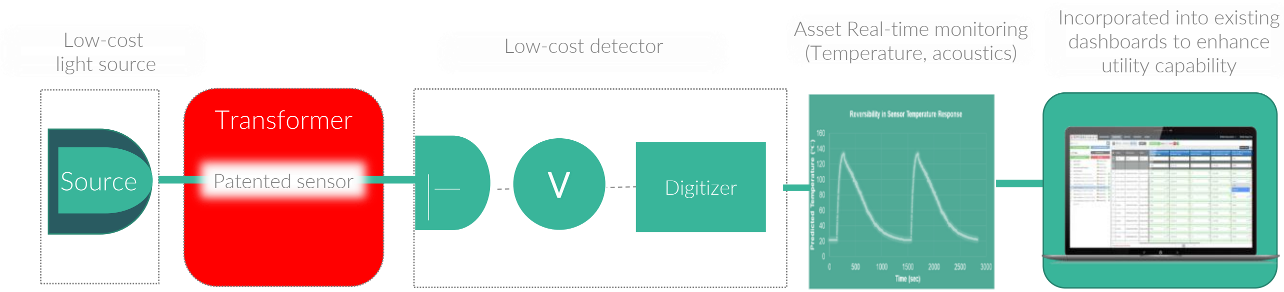
NEUP Nuclear Energy University Program
U.S. Department of Energy

arpa·e
CHANGING WHAT'S POSSIBLE

PITT Sensor Technologies Updates and Overview

Commercialization and Technology Transfer Activities : Electrical Asset Sensing

Low-Cost Fiber Optic Sensing Technology

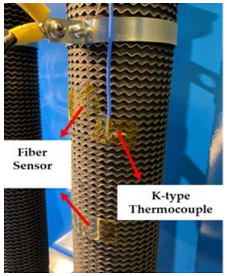


University of Pittsburgh & National Energy Technology Lab Spin-Off

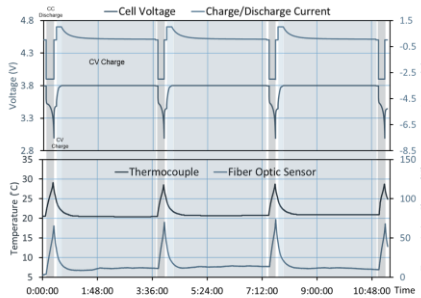
SENSIBLE PHOTONICS

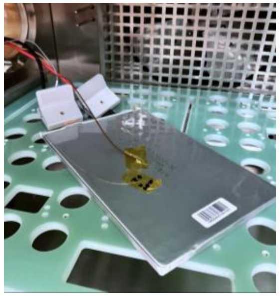
www.sensiblephotonics.com

Electrical & Magnetic Components Sensing (e.g. Transformers)



Internal and External Battery Monitoring





University of Pittsburgh

NATIONAL ENERGY TECHNOLOGY LABORATORY

2023 R&D 100 WINNER

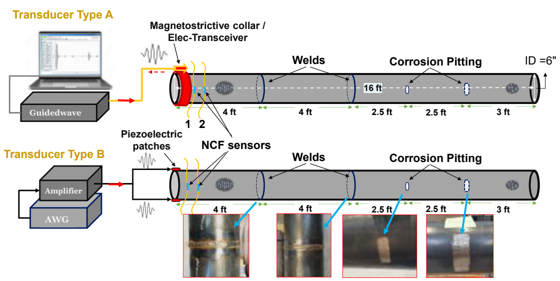
UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING
COLLABORATION WORKSHOP

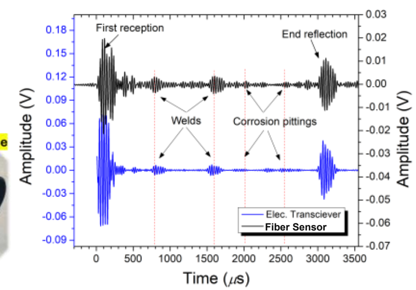
NATIONAL ENERGY TECHNOLOGY LABORATORY

PITT Sensor Technologies Updates and Overview

Commercialization and Technology Transfer Activities : Ultrasonic Photonics

Pipeline Structural Health Monitoring





University of Pittsburgh & National Energy Technology Lab Spin-Off

SENSIBLE PHOTONICS

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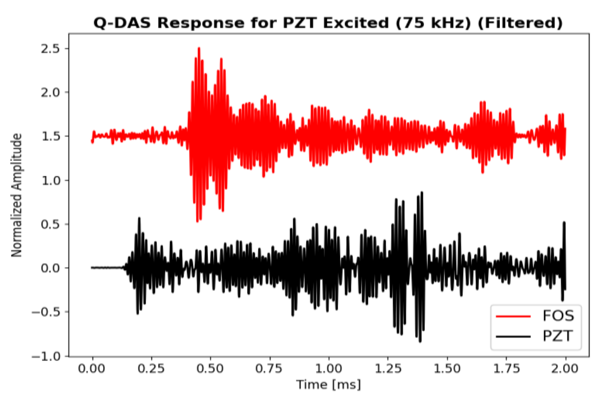
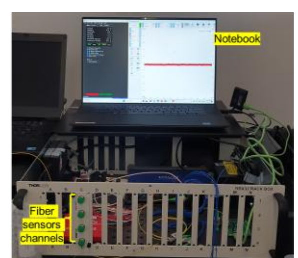
Spent Nuclear Fuel Canister Monitoring

Ultrasonic Acoustic NDE of Canisters





University of Pittsburgh

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2024 R&D 100 WINNER

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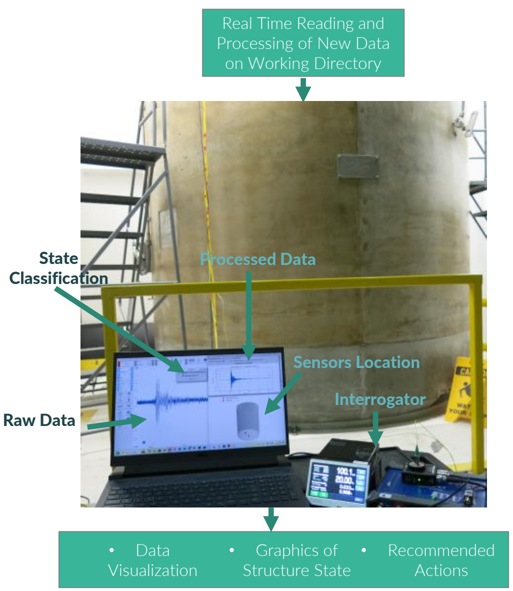
NATIONAL ENERGY TECHNOLOGY LABORATORY

PITT Sensor Technologies Updates and Overview

Commercialization and Technology Transfer Activities : Ultrasonic Photonics

Field Demonstration at Hanford Research Canister Facility, Richland, WA



Inside Real Cask Tests

- **Fiber routing through canister vents and verification**
- **Temperature Profile and thermal inertia inside cask**
- **Quasi-distributed acoustic source localization**
- **Sensitivity to acoustic events exterior to cask**

Selection for Upcoming Demonstration at Idaho National Lab June 2nd, 2026


INL Idaho National Laboratory

HOME ABOUT RESEARCH PARTNERSHIPS NE

NEWS RELEASE

Center for Used Fuel Research selects two technologies for demonstration of automated used nuclear fuel canister monitoring

By INL Media Relations

June 2, 2026

(IDAHO FALLS, Idaho) – The U.S. Department of Energy's Center for Used Fuel Research has selected Guidedwave and Sensible Photonics to advance to the final phase of a selection process to demonstrate acoustic emission technologies for automated monitoring of used nuclear fuel dry storage canisters.

The selections address a critical industry need related to used nuclear fuel storage. Nuclear utilities are required under U.S. Nuclear Regulatory Commission regulations (10 CFR Part 72) to maintain aging management programs for all used nuclear fuel storage systems. Current inspections at on-site used nuclear fuel storage facilities are performed periodically and require deploying specialized equipment for each inspection cycle. Automated and continuous monitoring and inspection approaches could streamline aging management activities and reduce operational burdens for used nuclear fuel management.

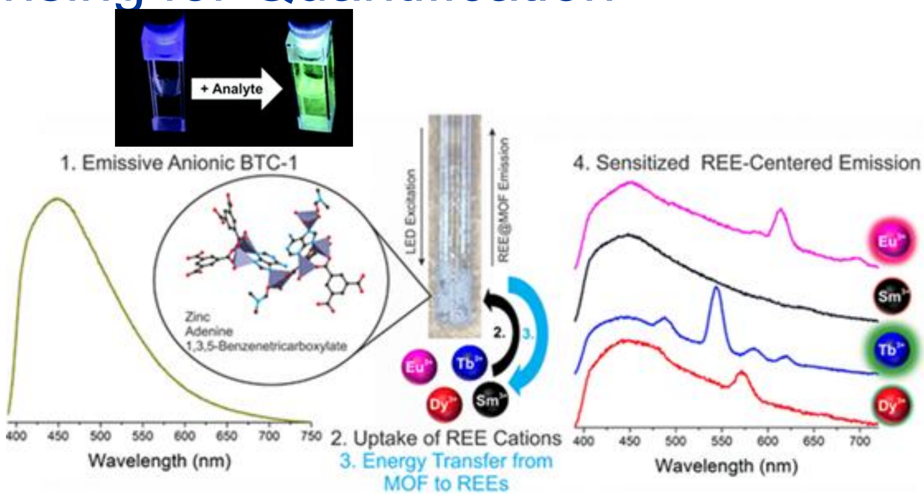
[Center for Used Fuel Research selects two technologies for demonstration of automated used nuclear fuel canister monitoring - Idaho National Laboratory]

PITT Sensor Technologies Updates and Overview

Commercialization and Technology Transfer Activities : eMission Critical Sensor

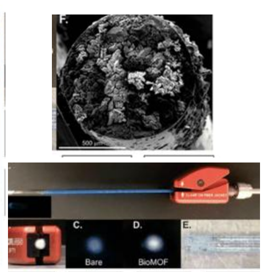
Emission-Based Fiber Optic Sensing for Quantification

University of Pittsburgh
NATIONAL ENERGY TECHNOLOGY LABORATORY



eMission Critical Sensor

2025 R&D 100 WINNER



U.S. DEPARTMENT OF ENERGY | Fossil Energy and Carbon Management

Real-Time Sensing for Critical Material Prospecting and Processing

New INSITES Consortium – Formal Partnership Opportunity

INSITES Consortium Ecosystem and Business Model...

- INSITES Membership
- Federal Proposals
- Industry Projects
- Others (e.g. Foundations)
- Major Centers (NSF, DOT, DOE)

Core Capabilities
Distributed Sensing & Networking
AI-Based Analytics & Digital Twins
Domain Specific Physics & Science

UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING COLLABORATION WORKSHOP
NATIONAL ENERGY TECHNOLOGY LABORATORY
NATIONAL ACADEMY OF ENGINEERING

Annual Stakeholder Workshop with NETL

National Science Foundation
U.S. DEPARTMENT OF ENERGY
ARPA-I ADVANCED RESEARCH PROJECTS AGENCY • INFRASTRUCTURE
UNIVERSITY OF PITTSBURGH INSITES
Pitt Research

Diversified Portfolio and Business Model for Longevity and Impact

www.engineering.pitt.edu/INSITES **Email:** insites@pitt.edu

Summary

- Distributed fiber optical sensors and passive wireless sensors enhanced with AI-enhanced data analysis to build an in-situ, multi-parameter, distributed, and cost-effective sensor network, as well as quantum sensor technologies.
- Functionalization using a wide range of sensing materials to achieve high sensitivity, selectivity, and fast response, including MOF, polymers, metallic films, and nanocomposites.
- Multi-parameter sensing:

  Gas: CO_2, CH_4, H_2, O_2, CO, and other gases;

  Chemical: pH, corrosion, water condensation, ionic strength, salinity, REE;

  Physical: strain, temperature, vibration, acoustic, magnetic field
- Artificial intelligence-enhanced sensor network with ubiquitously embedded sensors will ultimately achieve desired visibility across the critical infrastructure.
- Broad applications include natural gas infrastructure, power grid, power generation, carbon capture and storage, hydrogen infrastructure, nuclear spent fuel, environmental monitoring, etc.

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PITT Poster Presentation Slide Summaries

UPitt Infrastructure Sensor Collaboration (UPISC)
Annual Workshop
June 2 and 3, 2026

Contact: **Piervincenzo Rizzo**
Email: **pir3@pitt.edu**

UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

Load Rating Analysis of T-beam Bridges

Majid Eshraghi[1], Piervincenzo Rizzo[2], Fabio Matta[3]
[1] Ph.D. Student, Department of Civil and Environmental Engineering, University of Pittsburgh, Pittsburgh, PA 15261, USA.
[2] Professor, Department of Civil and Environmental Engineering, University of Pittsburgh, Pittsburgh, PA 15261, USA.
[3] Professor, Department of Civil and Environmental Engineering, University of South Carolina, Columbia (SC), USA.

INTRODUCTION

Load rating analysis (LRA) quantifies the safe live load carrying capacity of an existing bridge. When one or more structural components have an insufficient rating, limitations such as lane restriction, speed limit, weight posting, or closure, are imposed on the asset.

LRA identifies the bridge controlling structural component (one with the lowest rating factor (RF)), which determines the overall rating of bridge.

The **inventory rating** determines a live load that can be allowed indefinitely; the **operating rating** determines the maximum live load a bridge can carry.

A bridge with an RF ≥ 1.0 at both levels does not require posting. If operating-RF ≥ 1.0 and inventory-RF < 1.0, the bridge may not safely carry a state's legal loads, often requiring a weight limit. When RF < 1.0 at both levels, the bridge must be posted and further evaluated.

Three LRA methods exist: Allowable Stress Rating (ASR), Load Factor Rating (LFR), and Load and Resistance Factor Rating (LRFR).

LRA is governed by 2D analyses that inherently simplify the three-dimensional (3D) load distribution behavior of real structures, often yielding overly conservative RFs and unnecessary operational restrictions.

METHODOLOGIES

Demonstrate and quantify the conservatism of 2D analyses versus 3D accurate modeling for **three T-beam bridges**.

Create high-fidelity finite element (FE) models to perform a static analysis of these bridges under real-case scenario to recognize over-conservative postings.

Compare the FE results with the 2D-based RFs and distribution factors (DF) reported in the inspection reports of those bridges.

Determine the controlling failure mechanisms.

Evaluate the effect of damage on RFs and DFs.

METHODOLOGIES

Task 1: Create the FE models of three bridges under:

- as built scenario (based on standardized plans),
- current condition (based on available bridge inspection reports),
- additional damage with respect to the current condition,
- current condition with 20% lower concrete compressive strength and reinforcement yield stress.

Task 2: Structural analysis (for each of the above scenarios)

Task 3:

- Perform the LRA for the above scenarios and compare the results with the 2D LRA found in the latest inspection reports
- Verify punching shear
- Compute load distribution factors and compare with 2D values.

Harbor Creek Township Bridge

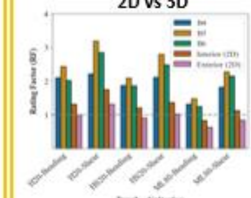
Sugar Creek Borough 1703 Bridge

Sugar Grove Township Bridge

PRELIMINARY RESULTS & PERSPECTIVES

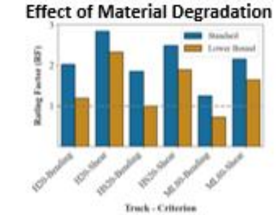
Sample Results for Sugar Groove Township Bridge:

2D vs 3D



More than 70% increase in RFs with respect to current estimation based on conventional 2D analysis.

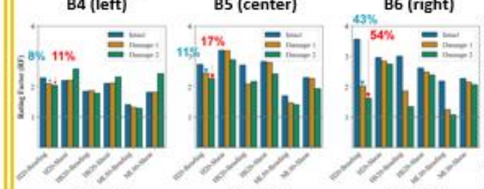
Effect of Material Degradation



33-57% decrease in bending & 13-24% decrease in shear RFs.

Effect of Damage on beams:

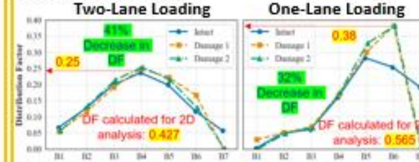
B4 (left) B5 (center) B6 (right)



Severe damage to B7 in *Damage 1* scenario led to significant decrease in RFs of other beams, particularly the adjacent beam (B6).

Distribution Factors:

Two-Lane Loading One-Lane Loading



The obtained DF from 3D FE modeling is significantly lower than the DFs calculated from AASHTO relations.

Severe damage to beams substantially changes the DFs.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the support provided by the University of Pittsburgh's IRISE Consortium.

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Email: **harbert@pitt.edu**

NATIONAL ENERGY TECHNOLOGY LABORATORY

Dark Fiber DAS for Urban Infrastructure Monitoring: From Stanford Pilot to Pittsburgh Deployment

Pengdi Zhang [3], Prince Panta [2], Khurram Naeem [2], Haipeng Li [4], Tieyuan Zhu [5], Paul R. Ohodnicki [2], Mohamed Hamdallah [1], William Harbert
[1] Geology & Environmental Science [2] Mechanical Engineering & Materials Science · University of Pittsburgh · [3] National Energy Technology Laboratory · [4] Department of Geophysics, Stanford University · [5] Department of Geophysics, Pennsylvania State University

Background & Motivation

- **Aging urban infrastructure**
  - Bridges, pipelines, roads, light rail, water mains all rest on shallow subsurface materials
  - Foundation stiffness changes drive infrastructure-failure risk
- **Dark fiber as a city-wide sensor**
  - DAS converts a single fiber into thousands of virtual seismic sensors
  - ϕ-OTDR: 5–10 m spatial resolution, up to 40 km range, 1 Hz – 10 kHz
  - Already buried beneath every major city — no new trenching
- **Urban "noise" as a seismic source**
  - Traffic, rail, construction generate continuous broadband energy
  - Enables Passive MASW where geophones are impractical

GOAL: *Convert existing Pittsburgh dark fiber into a high-density subsurface observatory for infrastructure resilience.*

Pittsburgh Deployment Plan

- **Target corridor: 1–10 km dark-fiber loop**
  - Oakland-to-Downtown service area
  - DAS interrogator available at Energy Innovation Center
  - Access negotiated with City of Pittsburgh & INSITES partners
- **Three ground-truth sites**
  - Bridge deck, high-traffic intersection, quiet residential zone
  - 3-axis accelerometers + GPS clocks calibrate fiber strain
  - Edge-compute nodes log labels for ML event classification
- **Three-phase implementation (9–12 months)**
  - Phase 1: secure fiber, tap-test fiber-to-GPS mapping
  - Phase 2: intensive acquisition + ground-truth deployment
  - Phase 3: labeled "Steel City" dataset — routine noise vs. labeled anomalies and uncertainty.

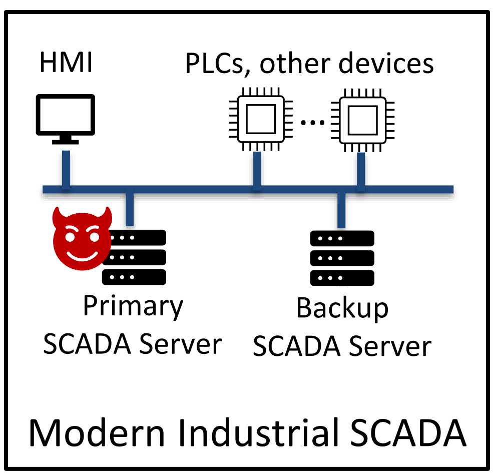
Contact: **Amy Babay**
Email: **babay@pitt.edu**

From Legacy to Resilient: Digital Twin-Based Transition for Industrial Control Systems

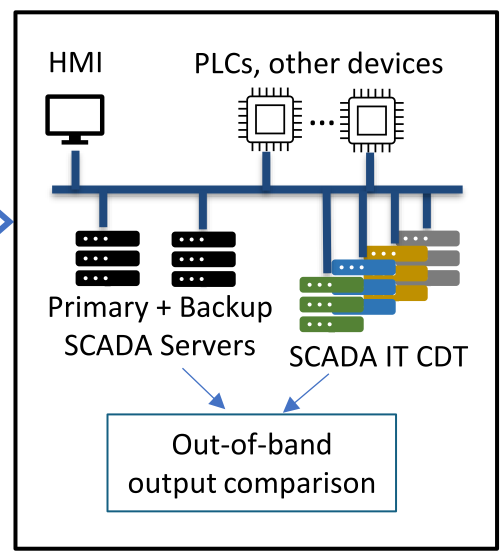
Huzaifah Nadeem [1] & Amy Babay [1,2]
[1] Department of Computer Science, [2] Department of Informatics and Networked Systems

Intrusion-Tolerant Cyber Digital Twins (IT CDTs) will enable us to transition today's vulnerable SCADA systems to intrusion tolerant architectures

Today's systems are vulnerable to cyberattacks

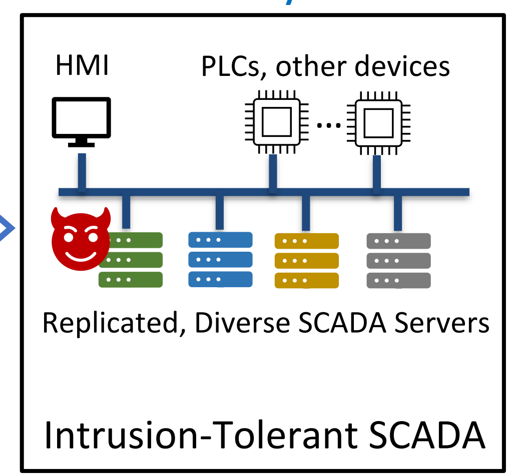


Intrusion-Tolerant CDTs offer a path to transition



Out-of-band output comparison supports *intrusion detection* in the near term

We know how to build more resilient systems



"Network-Attack-Resilient Intrusion-Tolerant SCADA for the Power Grid"
A. Babay, T. Tantillo, T. Aron, M. Platania, and Y. Amir, *IEEE DSN*, 2018

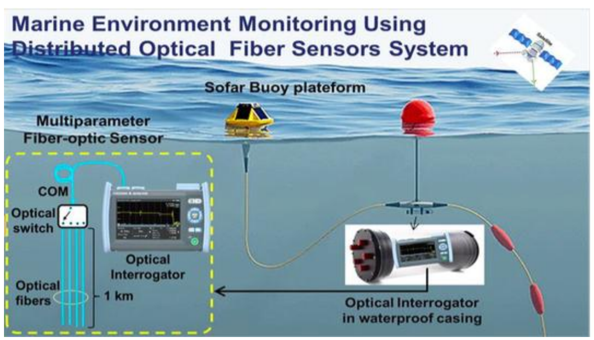
Contact: **Paul Ohodnicki**
Email: pro8@pitt.edu
Devika Mohan, MSE PhD

Distributed fiber optic pH sensing for marine environment monitoring

Devika Mohan [1], Tulika Khanikar [1], Alexander Shumski [2,3], Khurram Naeem [1], Ruishu Wright [2], and Paul R. Ohodnicki [1]
[1] Department of Mechanical Engineering and Materials Science, University of Pittsburgh, PA, USA
[2] National Energy Technology Laboratory, Pittsburgh, PA, USA; [3] NETL Research Support Contractor, Pittsburgh, PA 15236, USA

Increase in atmospheric CO_2 → Disturb ocean CO_2-carbonate equilibrium system → Increase in dissolved CO_2 → Ocean acidification

1% uncertainty in carbonate ions
→ Uncertainty of ~0.003pH units
10% uncertainty in carbonate ions
→ Uncertainty of ~0.02pH units

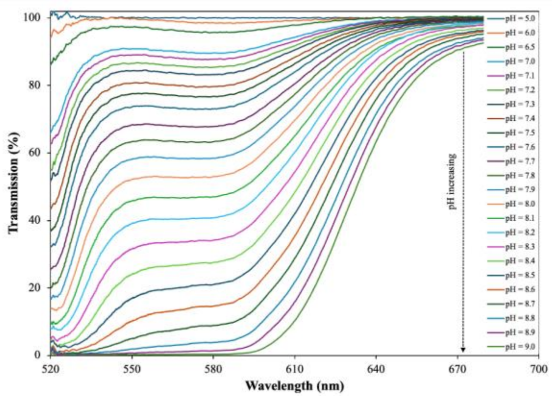


- Fiber optic chemical sensing demands functionalized analyte specific coatings that convert chemical information to detectable optical or mechanical properties

Optical fiber based pH sensing

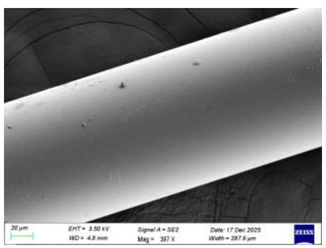
Sensing layer: Indicator dye immobilized organically modified silica

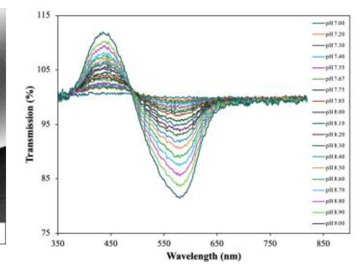
Transmission change with pH variation of seawater



✓ Optical fiber pH sensor demonstrated < ±0.1pH sensitivity in seawater and the optimized layer was successfully coated coating system over >1m length on optical fiber using a reel-to-reel

1m long coated optical fiber surface and transmission-based pH response





Future directions:

- Optically sensitized and modified silica with NIR absorption for feasibility with commercial OTDR wavelengths (850nm or 1300nm)
- Sensing layer optimization for pH sensing precision of < ±0.05 pH units along with compatibility and long term stability in seawater

Acknowledgements: U.S. Department of Energy ARPA-E, University of Pittsburgh, National Energy Technology Laboratory, SOFAR

Contact: **Paul Ohodnicki**
Email: pro8@pitt.edu
Jahid Chowdhury, MSE MS

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UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING
COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

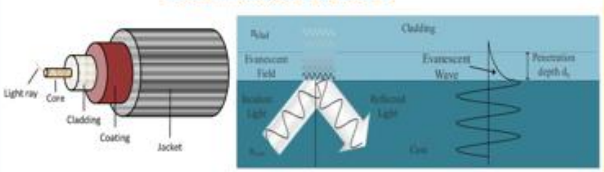
Adsorption-Driven Optical Fiber CO_2 Sensing with Thin-Film Coatings

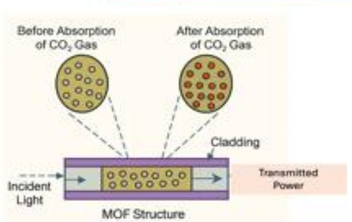
Jahid Inam Chowdhury[1], Tulika Khanikar[1], Khurram Naeem[1], Paul R. Ohodnicki, Jr.[1]
[1] University of Pittsburgh, PA, USA

INTRODUCTION

Optical fiber-based gas sensors are a promising platform for remote and distributed CO_2 monitoring, but practical deployment requires sensing layers that provide strong, repeatable signals without sacrificing optical stability. In this work, we develop composite thin-film coatings on optical fibers that translate gas uptake into a broadband, intensity-coded transmission/loss change through evanescent-field interaction. By combining materials design, systematic characterization, and physics-based optical modeling, we establish how coating composition and microstructure govern optical throughput, sensitivity, and distributed-readout compatibility.

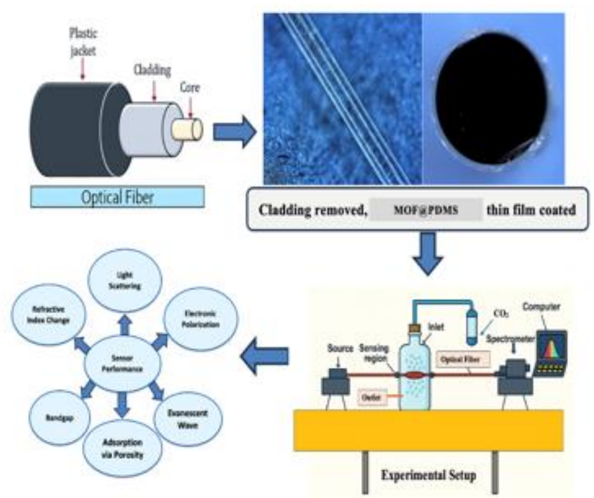
METHODOLOGIES



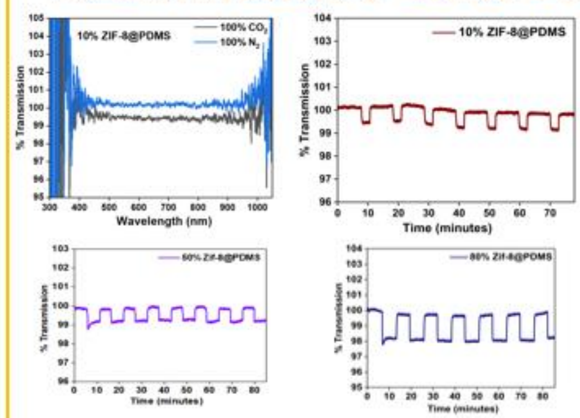


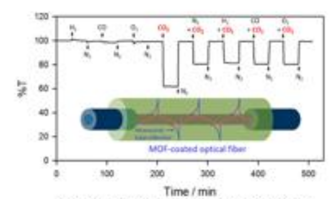
METHODOLOGIES

- Particle Synthesis
- Characterizing the particle morphology
- Thin Film preparation
- Measuring the Optical constants for the film
- Run Experiment



PRELIMINARY RESULTS & PERSPECTIVES





Reference: *ACS Sens.* 2018, 3, 2, 386–394

ACKNOWLEDGEMENT

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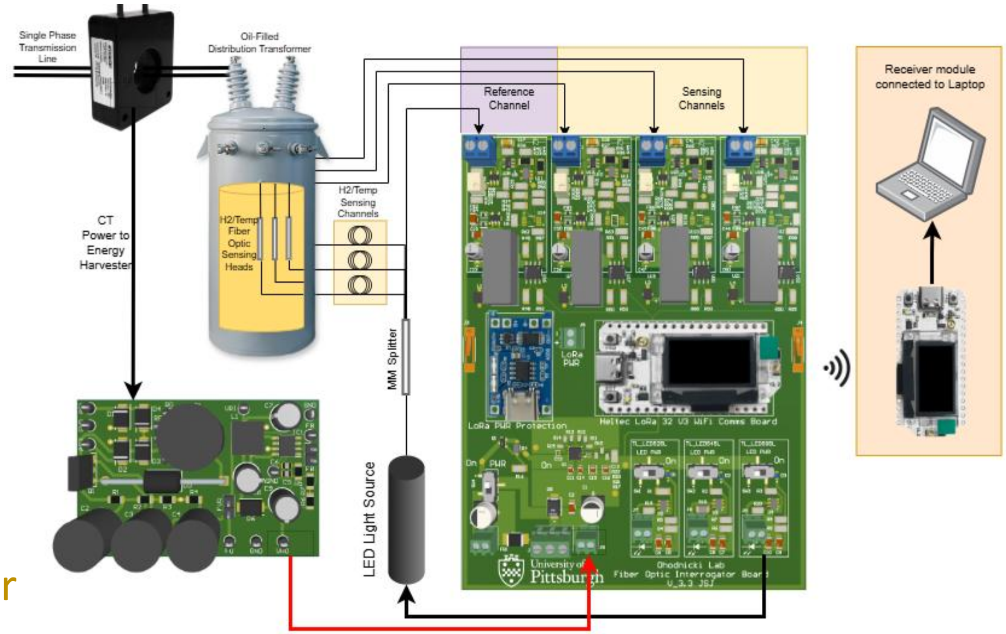
ARPA-E Award No. DE-AR0001839 (Funding Opportunity DE-FOA-0002989)

Contact: **Paul Ohodnicki**
Email: pro8@pitt.edu
Jacob Jones, ECE MS

Low-Cost Fiber Optic Interrogator and Energy Harvesting Technologies for Power Grid Sensing Applications

Jacob Jones, Shovan Shrestha, Jacob Wendt, Sean Mains
Alexander Braun, Yang-Duan Su, Brandon Grainger, Paul Ohodnicki

- **Low-Cost Temperature & Chemical Interrogator System**
  - Monitors distribution transformer health
  - Drives and Measures local fiber optic sensors
  - Wireless communication for remote sensing
- **Energy Harvester System**
  - Harvests EMF energy from AC conductor using current Transformer
  - Provides power to Interrogator system during operation



Layout of Interrogator/E-Harvester System

UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

Contact: **Paul Ohodnicki**
Email: pro8@pitt.edu
Shovan Shrestha, COE MS

Edge Enabled Transformer Health Diagnostics and Fault Detection

Shovan Shrestha [1], Jacob Jones [1], Yang Duan [2], Jingtong Hu[1], Paul R. Ohodnicki[2],
[1] ECE, University of Pittsburgh, [2] MEMS, University of Pittsburgh

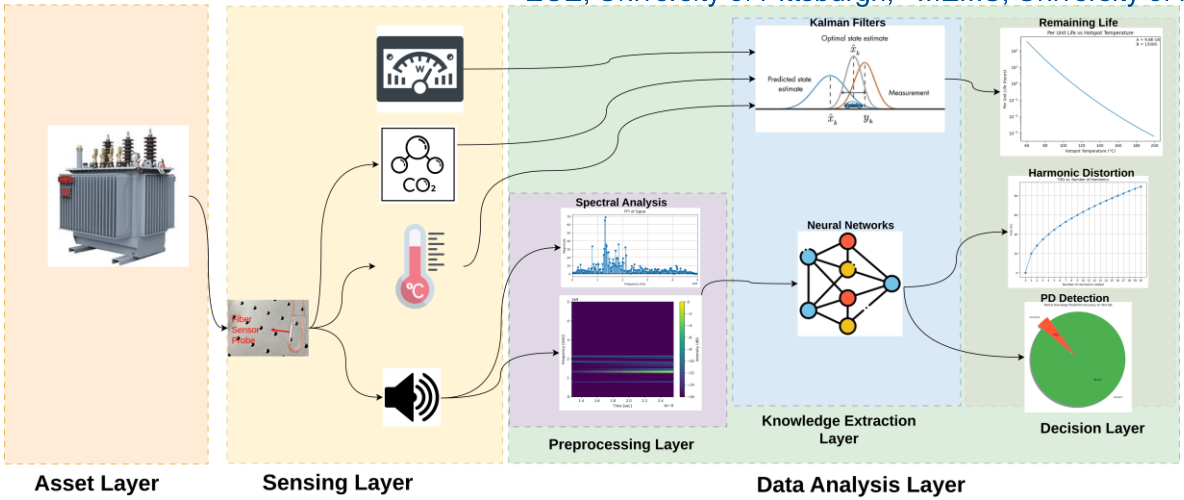


Fig: Asset Monitoring Overview

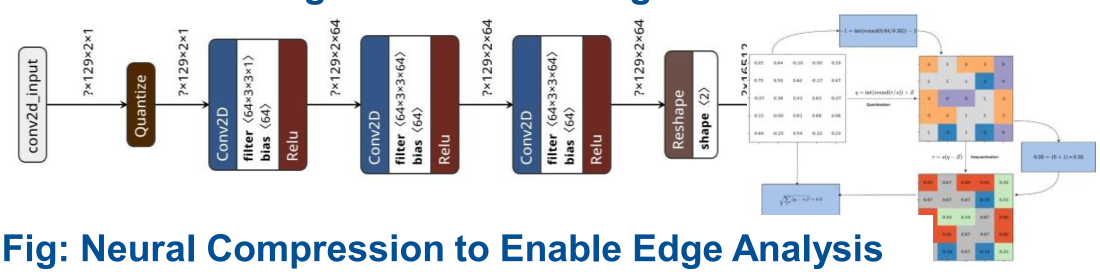


Fig: Neural Compression to Enable Edge Analysis

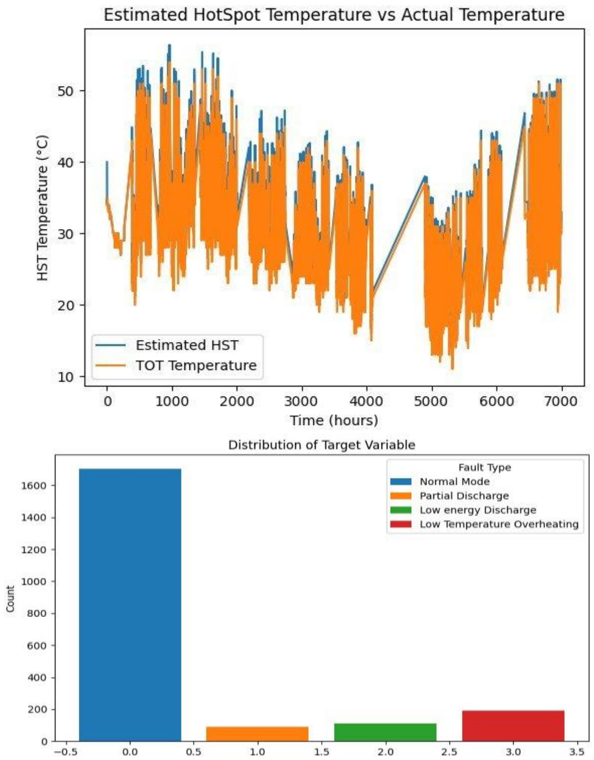


Fig: Temperature Sensing(Top) and Gas Sensing Results(Bottom)

UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING COLLABORATION WORKSHOP

Contact: **Paul Ohodnicki**

Email: pro8@pitt.edu

Enrico Sarcinelli, ME PhD

Distributed Fiber Optics for Ultrasonic Guided Wave NDE for Spent Nuclear Fuel Canister and Buried Pipes

Enrico Sarcinelli[1], Pengdi Zhang[1], Khurram Naeem[1], Prince Panta[1], Kayte Denslow[2], Marie Gillespie[3], Ryan Meyer[4], Paul Ohodnicki[1]

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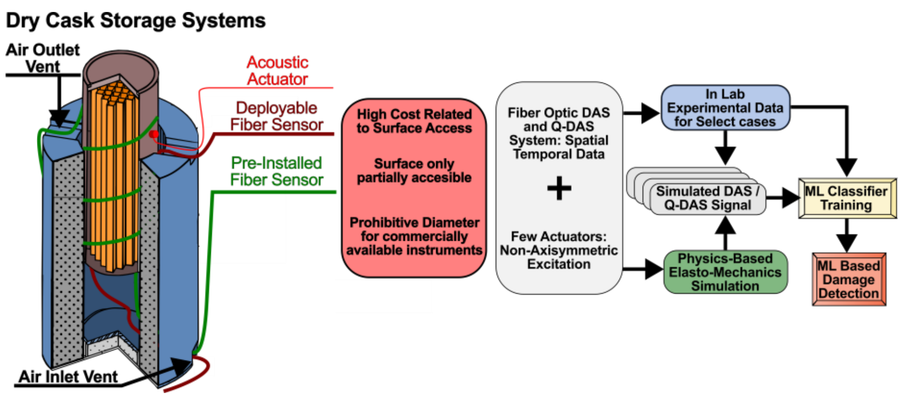
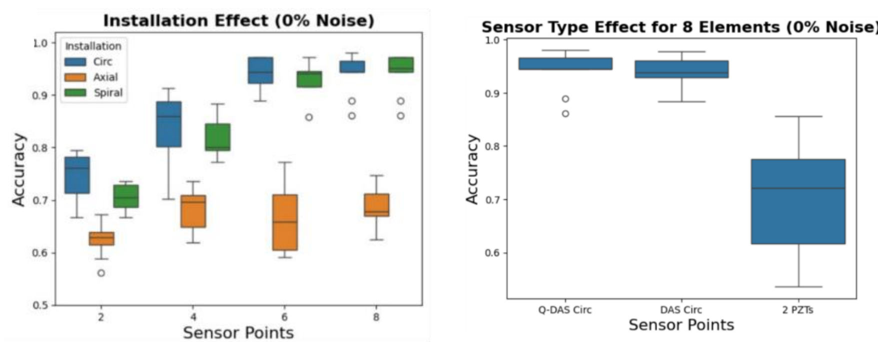
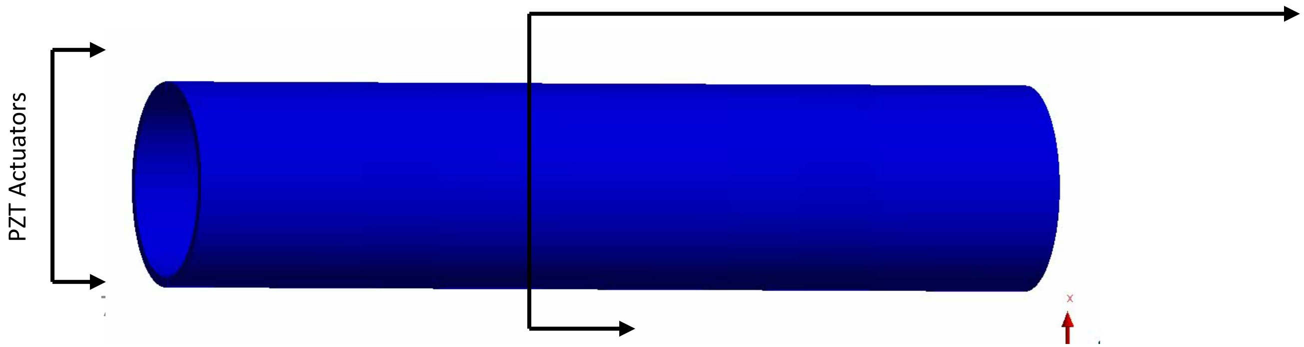
Stainless-Steel Canister Monitoring System Overview

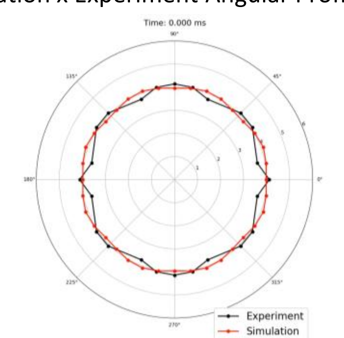


Investigation of Different Fiber Optic Sensor Installation Schemes on AI damage Identification Performance





Simulation x Experiment Angular Profile



UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING COLLABORATION WORKSHOP

Contact: **Paul Ohodnicki**

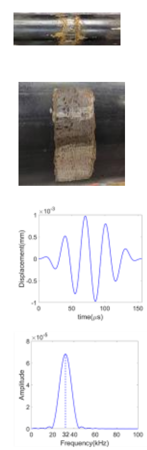
Email: pro8@pitt.edu

Prince Panta, ME PhD

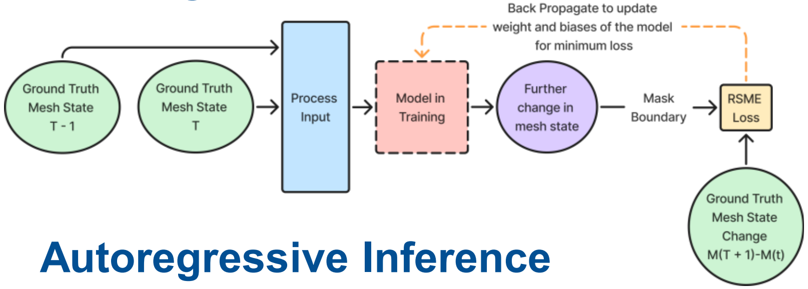
Learning Spatiotemporal Ultrasonic Guided Wave Propagation in Pipes with Deep Learning Surrogates

Prince Panta [1], Enrico Sarcinelli [1], Pengdi Zhang [2,3] , Khurram Naeem [1] , Sandeep R. Bukka [2,3] , Ruishu Wright [2], and Paul R. Ohodnicki [1]

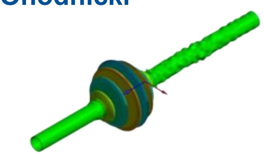
Experimental Setup

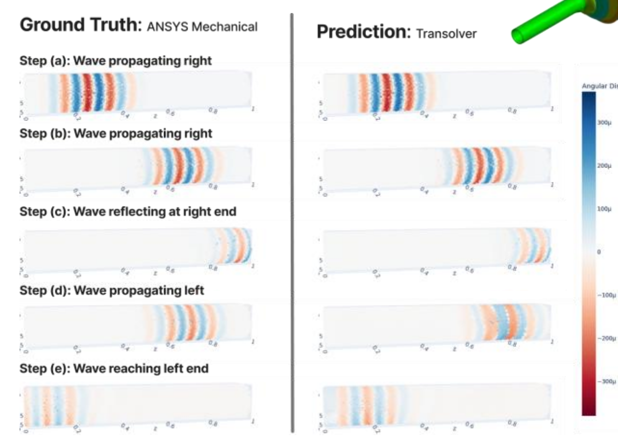


Training Method

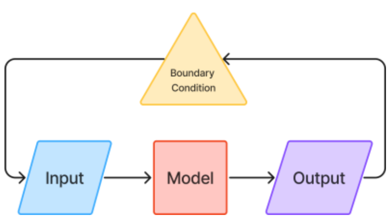


Rollout Results

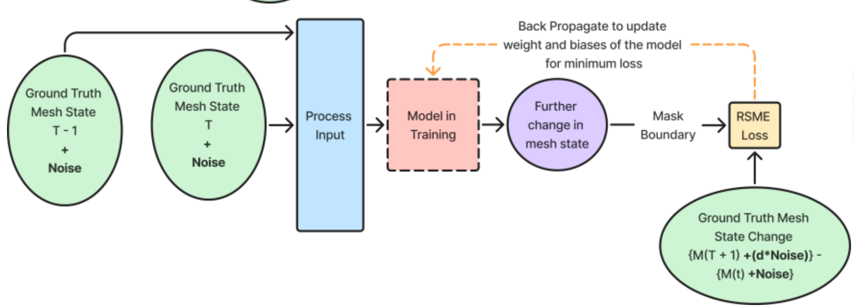


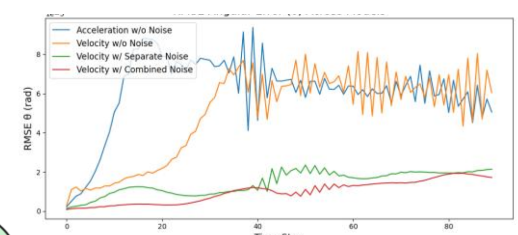


Autoregressive Inference



Noise Injection and Rollout Stabilization





UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

Contact: **Khurram Naeem**
Email: **khn16@pitt.edu**

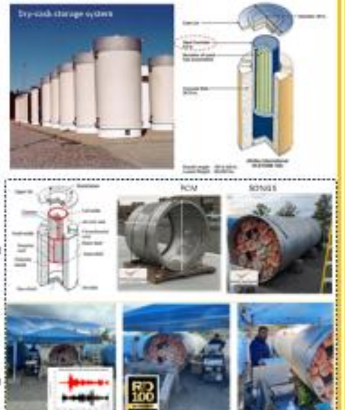
NATIONAL ENERGY TECHNOLOGY LABORATORY

Guidedwave Fiber-optic Acoustic NDE of Nuclear Spent Fuel Canister: Field Test Results

Khurram Naeem[1], Enrico Sarcinelli[1], Kayte Denslow[2], Matthew Prowant[2], Ryan Meyer[3] and Paul Ohodnicki[1]
[1] Department of Mechanical Engineering & Materials Science , University of Pittsburgh, PA 15216, USA
[2]Pacific Northwest National Laboratory, Richland, Washington 99352, USA
[3]Oak Ridge National Laboratory, 1 Bethel Valley Rd, TN 37830, USA

INTRODUCTION

- **Aging Spent Fuel Storage infrastructure**
  - Dry-cask storage system (DCSS) technology provide onsite safe, passive, and long-term storage of high-level radioactive spent fuel (waste) at the Nuclear power plant.
  - DCSS houses **Spent Fuel Canisters** made of stainless steel or other corrosion-resistant alloys with polished welds, filled with inert gas , air-tight sealed.
  - Canister undergo temperature cycles, radiation and mechanical stress over the years causing fatigue and other structural issues
  - Any degradation in the canister integrity could result in radiation leakage.
- **Needs**
  - NDE and SHM methods for structural integrity monitoring
  - Sensing technology for long term monitoring that can operate in harsh radioactive conditions.
  - Permanently deployable sensors: easy to retrofit in the canister surface
- **Ensure structural integrity by**
  - Leaks detection of inert gas generate acoustic emission, surface vibrations waves
  - Damage detection by launching guidedwave in the structure and capturing echoes from defects and material anomaly.

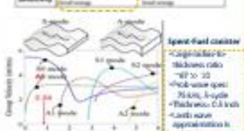


Structural specifications of the nuclear canisters

Type of canister	Length (inch)	Outside diameter (inch)	Wall thickness (inch)
PCM	60	67	0.5
SONGS	196	67	0.5

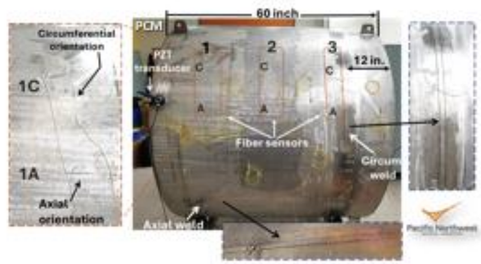
FIBER-OPTIC BASED ULTRASONIC NDE

- **Fiber optic acoustic sensor**
  - Lightweight / embeddable in composite material, Environmental ruggedness/ chemically inert
  - Popular optical fiber sensors architecture:
    - Interferometer, and Fiber Bragg grating (FBG)
  - Ultrasonic acoustic range > 500 kHz ; qualitative monitoring
  - Large dynamic range > 50 dB
  - Quasi-distributed Acoustic Sensing (qDAS): 2-4 channels
- **Acoustic NDE methods**
  - Impact, Acousto-ultrasonic (AU) , and Acoustic Emission (AE)
  - Depends on material and structural parameters (e.g., thickness, size of structure), probe Guidedwave (type, frequency).
- **Ultrasonic Guidedwave – Lamb waves**
  - Propagate through thin, plate-like structures with free boundaries, such as sheet metal, pipe walls, or composite panels
  - Enables long-range Non-Destructive Evaluation (NDE) and Structural Health Monitoring (SHM)
  - Lamb waves classified into Symmetric (S) modes and Antisymmetric (A) modes; lowest-order A0 and S0 are the most widely used modes.

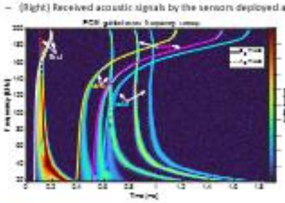


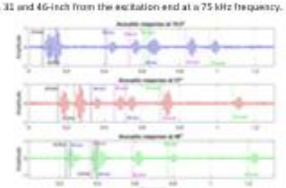
PRELIMINARY RESULTS

- **Field deployment of the fiber sensors on Partial Canister Mockup at PNNL**
  - In nuclear waste management, a **Partial Canister Mockup (PCM)** is a structural prototype used to test the monitoring systems of spent nuclear fuel canisters.
  - Three pairs of Fiber Sensors (axial and circumferential orientation) were deployed at three positions on the PCM.
  - Active Guidedwave PZT transducer for launching Lamb waves was employed on Left end.

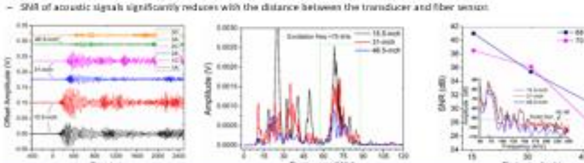


- **Semi-Analytical model results for Lamb wave approximation in PCM**
  - The large radius-to-thickness ratio of the PCM wall (R/t ≈ 67 >> 10, well above the quasi-planar threshold) permits the local wall geometry to be treated as an equivalent flat plate for guided Lamb wave analysis.
  - (Left) We computed time–frequency amplitude density map obtained from the **Semi-analytical Dispersion-based model** of Lamb GW propagation for a sensor positioned at 15-inch.
  - (Right) Received acoustic signals by the sensors deployed at ~15, 31 and 46-inch from the excitation end at a 75 kHz frequency.



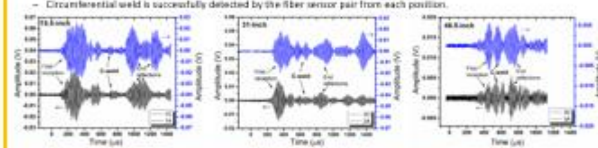


- **Measured results**
  - Raw Acoustic profiles captured by the pair of fiber sensors from different positions.
  - SNR of acoustic signals significantly reduces with the distance between the transducer and fiber sensor.

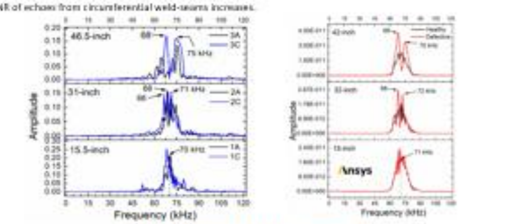


WELD-SEAM DETECTION IN PCM

- **Experimentally measured results in time domain**
  - Pair of Fiber sensors captured acoustic profiles of PCM from three positions of ~15, 31, and 46 inches from the excitation end.
  - Circumferential weld is successfully detected by the fiber sensor pair from each position.

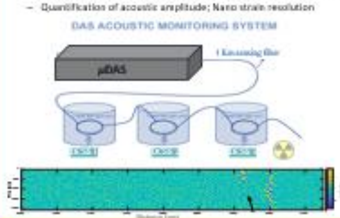


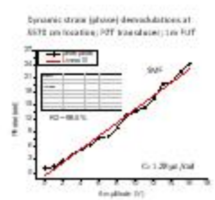
- **Measured results vs Numerical Simulation results in frequency domain**
  - Power spectra of acoustic profiles from experiment and simulation confirm the dominant frequency split as the SNR of echoes from circumferential weld-seams increases.



FUTURE DIRECTION

- **Acousto-ultrasonic NDE of multiple spent fuel canister using custom Coherent DAS**
  - Range: 500- 1000m at 1m resolution, acoustic bandwidth 50-100 kHz
  - Quantification of acoustic amplitude; Nano strain resolution





ACKNOWLEDGEMENT

- Nuclear energy university program (NEUP), Project # 21-24310
- Sensible Photonics, DOE FY2024 Phase-I STTR DE-SC0025055
- Pacific Northwest National Laboratory (PNNL), WA

SENSIBLE PHOTONICS NEUP U.S. Department of Energy Pacific Northwest U.S. DEPARTMENT OF ENERGY

Overview of NETL Posters 2026

UPitt Infrastructure Sensor Collaboration (UPISC)
Annual Workshop
June 2 and 3, 2026

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UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING
COLLABORATION WORKSHOP

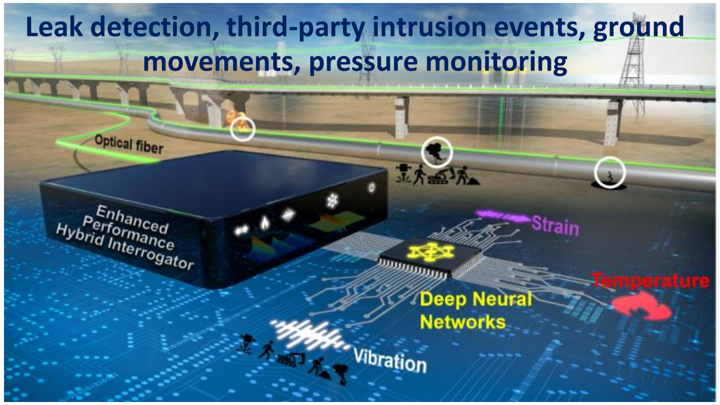
NATIONAL ENERGY TECHNOLOGY LABORATORY

AI/ML-Enabled Advanced Distributed Optical Fiber Sensors

Nageswara Lalam[1,2]; Hari Bhatta[1,2]; Sandeep Bukka[1,2]; Matthew Brister[1,2]; Pengdi Zhang[1,2]; Paul Ohodnicki[3]; Ruishu Wright [1]

Distributed fiber optic sensor interrogators integrated with deep neural network:

- ❖ Brillouin optical time domain analysis (BOTDA).
- ❖ Phase-sensitive optical time domain reflectometry (phase-OTDR).
- ❖ Optical frequency domain reflectometry (OFDR).
- ❖ Single-mode–multi mode–single-mode (SMS) fiber acoustic sensor.



BOTDA

Sensing range = >100 km
Spatial resolution = <5 m
Measurable parameters:
static strain, temperature

ϕ-OTDR/DAS Patented

Sensing range = >10 km
Spatial resolution = <2 m
Measurable parameters:
acoustics, dynamic strain

OFDR

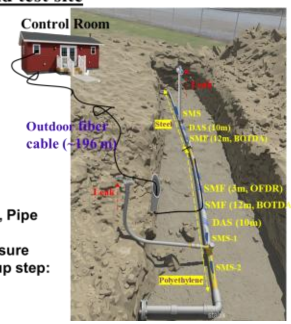
Sensing range = >100 m
Spatial resolution = <1mm
Measurable parameters:
static strain, temperature

SMS Patented

Frequency range= 1 Hz to 1.2 MHz
Resolution= <1 to 2 Hz

Schematic of the overall field test site

List of optical interrogators:
(i) BOTDA (Hoop strain)
(ii) Phase-OTDR/Q-DAS (Leaks, intrusions)
(iii) Multi-point fiber acoustic sensor (Leaks, intrusions)
(iv) Soil corrosion monitoring (Luna OFDR and transmission-based)



Pipe Material: Steel and Polyethylene, **Pipe Diameter:** Steel= 2'' OD, WT: 0.154'', Polyethylene = 2.3'' OD, WT:0.2'', **Pressure range:** up to 95 psi , **Pressure ramp-up step:** 10 psi, **Gas type:** Air

Field validated at underground natural gas pipeline

Accomplishments:

- NETL developed custom interrogators achieving high-sensing performances, including BOTDA, DAS, and SMS sensors.
- Employed the same laser at 1,480 nm to achieve 100-km interrogation with 5-m resolution in lab and field using RAMAN and EDFA amplification in BOTDA.
- Nano strain sensitivity was achieved using the quantitative DAS by implementing optical hybrid IQ demodulation.
- Real-time leak and third-party intrusion detection and classification were achieved using an AI classification model and web hosting the real-time sensor data.
- PCA-trained neural network framework was developed to find BFS estimation, which is more than 49 times faster than conventional curve fitting methods under similar conditions

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UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

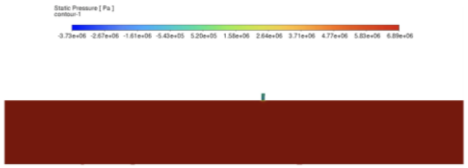
Pipeline Leak Detection Through Fluid-Solid Coupling Acoustics: Strain Signal Analysis and Optical Fiber Sensor Validation

Pengdi Zhang[1,2]; Sandeep Bukka[1,2]; Nageswara Lalam[1,2]; Prince Panta[3]; Paul Ohodnicki[3]; Ruishu Wright [1,*]
[1]National Energy Technology Laboratory, 626 Cochran Mill Road, Pittsburgh, PA 15236, USA; [2]NETL Support Contractor, 626 Cochran Mill Road, Pittsburgh, PA 15236, USA; [3]University of Pittsburgh, 3700 O'Hara Street, Pittsburgh, PA 15213, USA

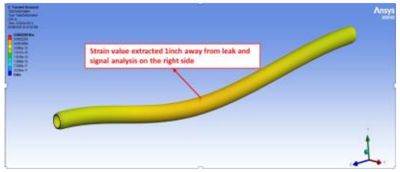
Motivation

At 100 psi line pressure, a 12.7 mm orifice produces an inlet-to-outlet pressure variation of only ~2,850 Pa — well below the ±690 kPa (100 psi) accuracy limit of typical pressure transmitters. Distributed Acoustic Sensing (DAS) via helically wound optical fiber offers an alternative signal channel: leak-induced pipe wall strain, detectable independently of static pressure

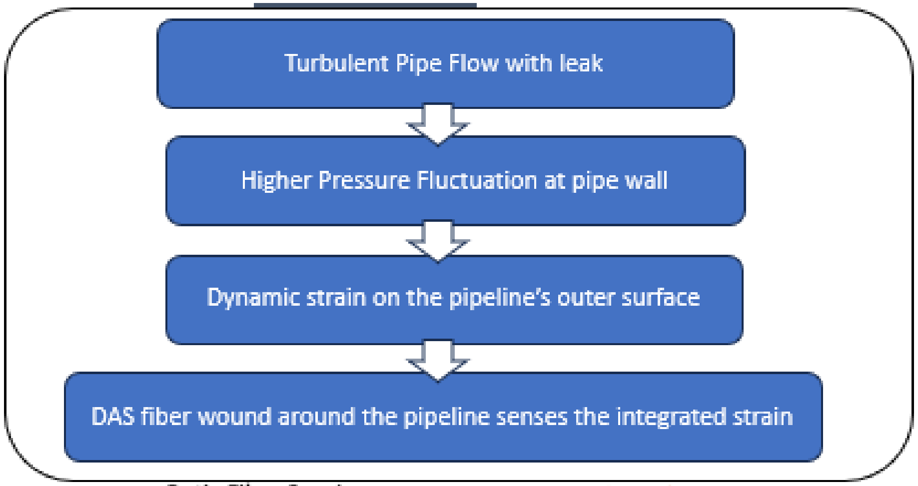
Pressure contour for transient simulation:

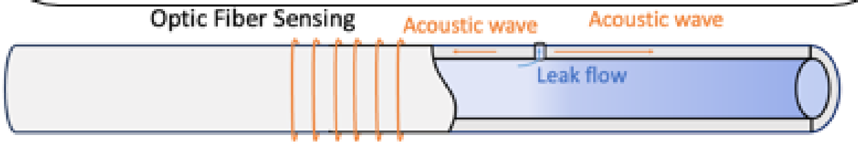


Pipe deformation on an exaggerated scale



Framework





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UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

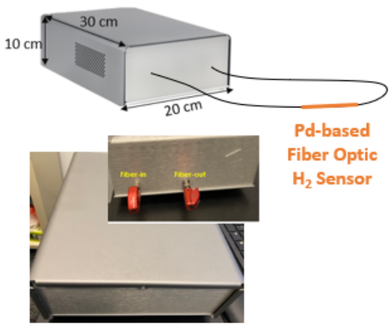
NATIONAL ENERGY TECHNOLOGY LABORATORY

Hydrogen Detection via a Low-Cost Prototype Fiber-Optic Sensing System

Daejin Kim[1,2], Nageswara Lalam[1,2], Swetha Dokala[1,2], Ruishu Wright[1]
[1]National Energy Technology Laboratory; [2]NETL Support Contractor, 626 Cochran Mill Road, Pittsburgh, PA 15236, USA

- **The low-cost prototype fiber-optic hydrogen sensing system was successfully developed at NETL.**
- **The prototype sensing system has demonstrated a stable hydrogen sensing response across 100% to 500 ppm concentrations of hydrogen.**

Low-Cost Prototype H_2 Sensing System



- **Custom-built, low-cost, compact, and ready for pilot-scale testing.**
- **Embedded microcontroller and user-friendly graphical user interface (GUI) Dashboard.**
- **Plug-and-play operation without external instrumentation.**
- **IoT-enabled smart sensor system**

- **Real-time sensor data visualization**
- **User-friendly interactive dashboard** for system control
- **Data logging and export options**
- **Remote access capability** via IoT platform to view live data and download historical records.

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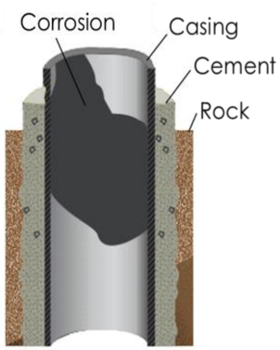
UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING
COLLABORATION WORKSHOP

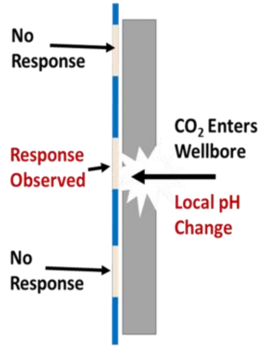
NATIONAL ENERGY TECHNOLOGY LABORATORY

High-Pressure, High-Temperature Subsurface pH Monitoring in Wellbore Conditions Using A Calcined Polymer Sensor Layer

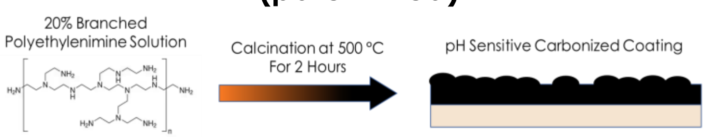
Alexander Shumski[1,2]; Daejin Kim[1,2]; Ruishu F. Wright[1]
[1]National Energy Technology Laboratory, 626 Cochran Mill Road, Pittsburgh, PA 15236, USA; [2]NETL Support Contractor, 626 Cochran Mill Road, Pittsburgh, PA 15236, USA

Subsurface Wellbore Monitoring: pH Sensing





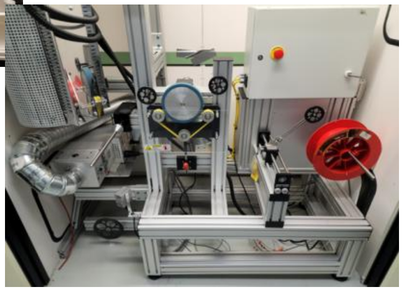
Simple fabrication of pH sensitive material (patent filed)



NETL Sensor Preparation and Test Capabilities

Pressurized Reactors

Reel-To-Reel Systems



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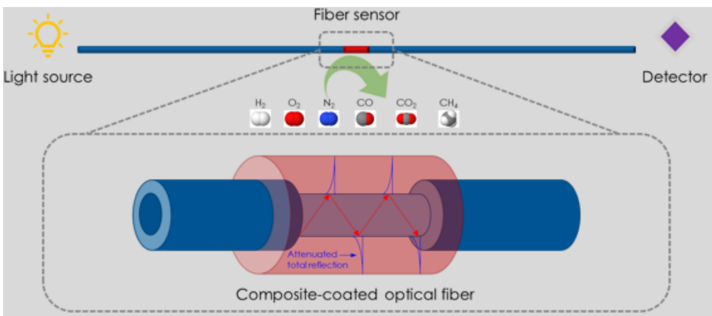
UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

Refractive Index-Based Optical Fiber Gas Sensors: Challenges and Opportunities

Jeffrey Culp[1,2], Matthew Brister[1,2], Alexander Shumski[1,2], Ruishu Wright[1]
[1]National Energy Technology Laboratory, 626 Cochran Mill Road, Pittsburgh, PA 15236, USA; [2]NETL Support Contractor, 626 Cochran Mill Road, Pittsburgh, PA 15236, USA



Advantages of RI-based Optical Fiber Sensors

- No power applied to sensing location
- Safe in flammable/explosive gases
- Remotely operable over long distances with low power demand
- Fast and reversible response
- Potentially low cost

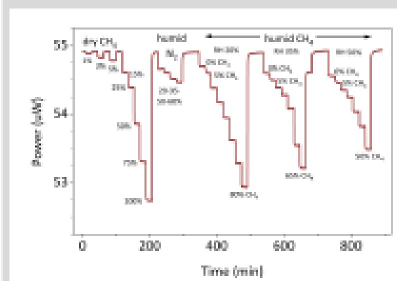
Challenges

- Temperature effects on refractive index and analyte adsorption
- Competitive adsorption / interference from humidity
- Fluctuations in source intensity over time

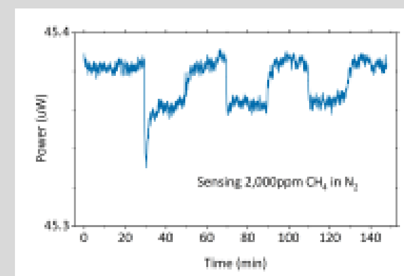
Solutions

- Hydrophobic coatings
- Complementary multi-sensor platform
- Reel to reel manufacturing compatibility

Development of CH_4 Sensors for Natural Gas Pipelines and Orphaned Wells Monitoring



Hydrophobic coatings for humid CH_4 sensing



Improved sensors with CH_4 sensitivity < 2,000 ppm

Improvements in sensor design have reduced moisture effects and lowered the detection limit for CH_4 to below 1%.

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UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

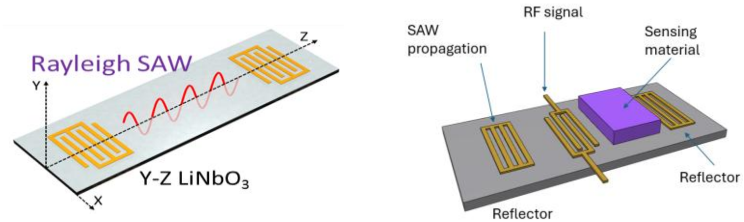
Low-cost Planar Structured Sensing Technologies for Methane Leakage Monitoring in Pipelines

Radha Bhardwaj[1,2]; David Battaglia[1]; Ruishu Wright[1]
[1]National Energy Technology Laboratory, 626 Cochran Mill Road, Pittsburgh, PA 15236, USA. [2] Oak Ridge Institute for Science and Education (ORISE), 100 ORAU Way, Oak Ridge, TN 37830, USA

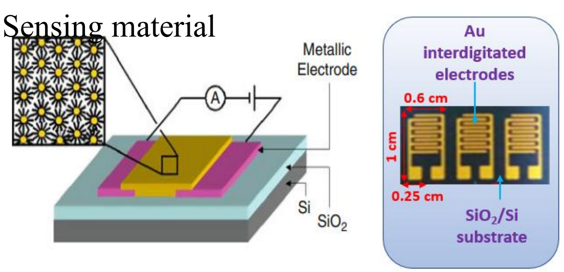
Motivation

- Gas monitoring systems are critical for industrial safety, and natural gas pipeline leaks. However, conventional monitoring technologies remain too expensive and complex for widespread deployment.
- To address this challenge, we present low-cost, continuous and real-time monitoring technologies including Surface Acoustic Wave (SAW) sensors, resistive sensors, and field effect transistor (FET) sensors to better identify, locate, and quantify methane leaks.
- **SAW Sensors:** Provide high sensitivity, rapid response times, and wireless capability.
- **Resistive or FET Sensors:** Offer low ppm detection, fastest, straightforward readout electronics, and high durability.

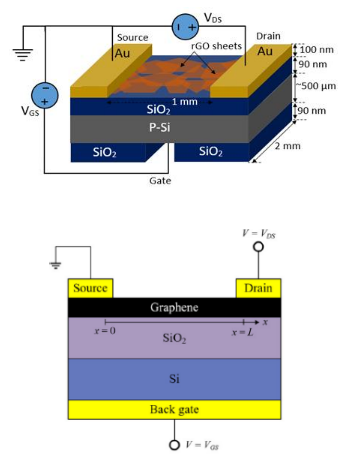
SAW Sensor



Resistive Sensor



FET Sensor



Sensing Materials and Platforms for Critical Metal Prospecting and Process Monitoring

Scott Crawford,[1] Ward Burgess,[1,2] Ariana Adkisson,[1] Claire Thomas,[1] Tessnim Mohammed,[1] and Ki-Joong Kim[1]
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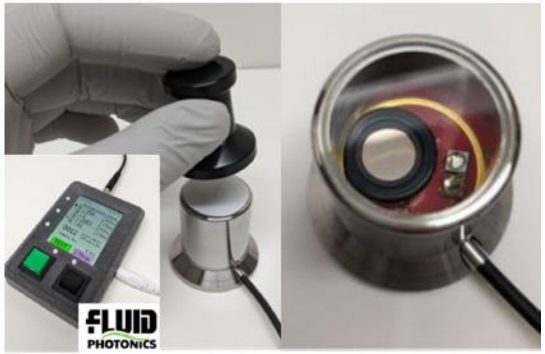
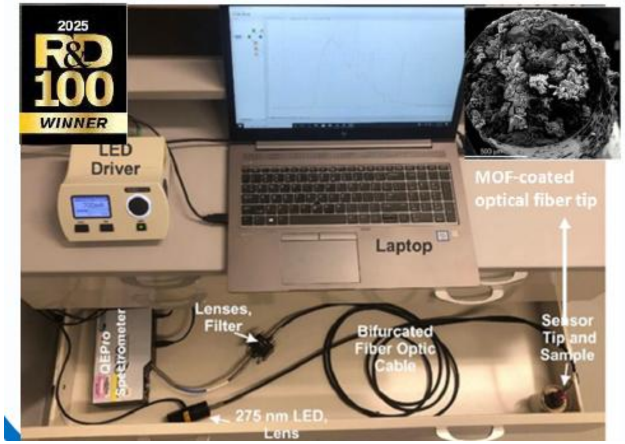
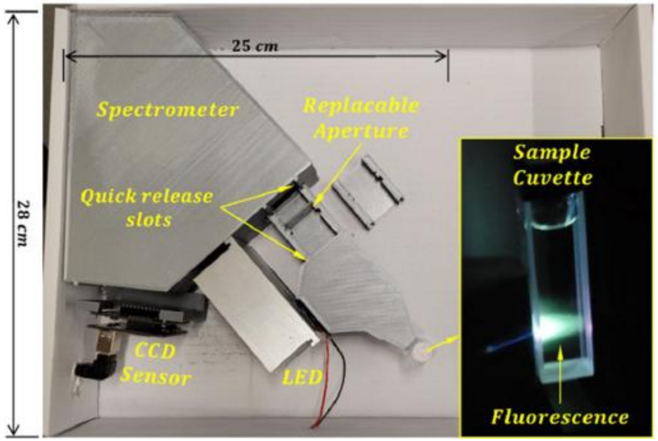
NETL and collaborators have developed a versatile suite of portable, low-cost sensor devices for analysis of liquid and test strip samples. These devices typically exhibit *similar performance to commercial systems at a significantly lower cost*. Platforms include a fiber optic sensor, with sensing material immobilized on a fiber tip (2025 R&D100 Award Winner), a compact spectrometer device compatible with cuvettes, and a portable analyzer for quantifying test strip luminescence. The devices are sufficiently portable for field transport.







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UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

Engineering Core-Clad Structures in Single-Crystal Sapphire Fibers via Dopant Segregation

Dolendra Karki[1], Gary Lander[1], Jun Young Hong[2], Paul R. Ohodnicki[2], Michael P. Buric[1]
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- Single crystal fiber (SC) superior to silica fiber in regard to stability under harsh conditions.
- Grow SC fiber via laser-heated pedestal growth (LHPG).
- Sol-gel coated fiber used in two-step LHPG process to create cladding layer.