U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Clean. Reliable. Nuclear.

Versatile Acoustic and Optical Sensing Platforms for Passive Structural Monitoring

Advanced Sensors and Instrumentation Annual Webinar

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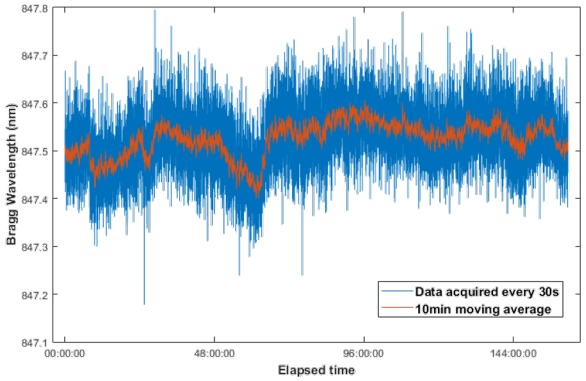
Project Overview

- Goal
  - To develop an acoustic based sensing system capable of monitoring phenomena such as strain, temperature, pressure and corrosion to better evaluate the health of structural components in nuclear facilities
- Objective
  - Design and construct fused silica and single crystal sapphire sensing systems based on acoustic fiber Bragg gratings (AFBGs) and benchmark performance with optical fiber Bragg grating (OFBG) sensors
- Participants (2020)
  - Virginia Tech (University Lead), Oak Ridge National Laboratory (ORNL)
- Schedule
  - Granted no-cost, one-year extension (9/30/2021)
    - Delayed completion of M3CA-17-VA-VT-0702-0414 (previously 6/30/20) inability to access ORNL due to COVID-19 protocols

Accomplishments

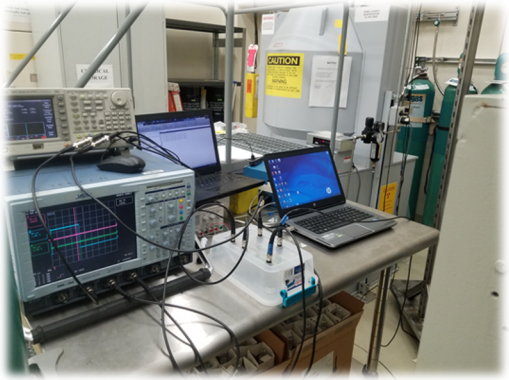
- M3CA-17-VA-0702-0412: Radiation Exposure Testing of Fused Silica Based Acoustic Fiber Bragg Grating Sensors
  - Completed on time (12/31/2019)
- M2CA-17-VA-VT-0702-0413: Construction and Testing of the Sapphire Based Acoustic Fiber Bragg Grating Sensing System
  - Completed on time (6/30/2020)
- M3CA-17-VA-VT-0702-0414: Radiation Exposure Testing of the Sapphire Acoustic Fiber Bragg Grating Sensing System
  - Delayed due to COVID access restrictions at ORNL (6/30/2019)
  - Prototype sensing system was successfully installed on 9/24/20 and currently operating at ORNL
- M3CA-17-VA-VT-07020415: Laboratory Scale Performance Testing of Acoustic Based Fused Silica and Sapphire AFBG Sensing Systems
  - Completed on time (9/30/20)
- *One peer reviewed publication, one accepted for publication, two currently under review*

Accomplishments

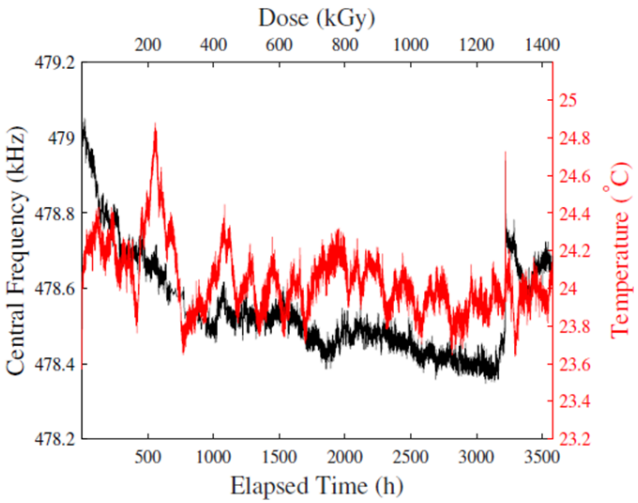


Real-Time Monitoring of Single Crystal Sapphire OFBGs

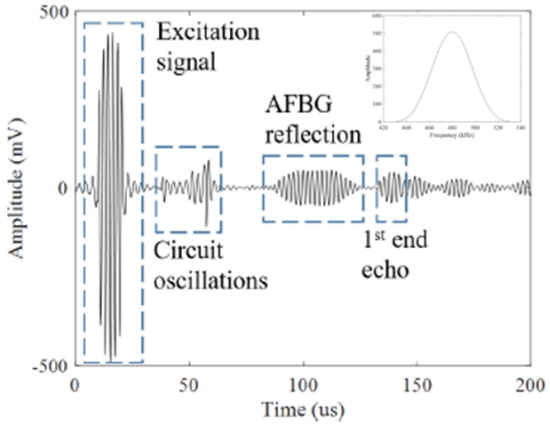
Gamma Radiation Exposure Testing of Prototype AFBG Sensing Systems



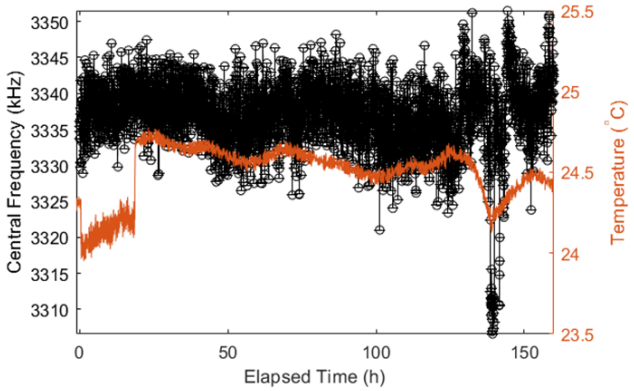
AFBG and OFBG Sensors Installed and Operating in the Gamma Irradiator at ORNL



Real-Time Long-Term Monitoring of Fused Silica AFBG Sensor and Thermocouple



Time Domain Spectrum of Fused Silica AFBG Sensor



Real-Time Monitoring of Single Crystal Sapphire AFBG Sensor and Thermocouple

Technology Impact

- *The successful demonstration of the first-of-a-kind, low-cost, fully-distributed, multi-parameter sensing platform will contribute to the advancement of 3D sensor network monitoring solutions for nuclear energy systems.*
  - *The versatile and commercially viable sensing system fills the gap between low cost electronic sensors and high-performance fiber optic sensors.*
- *The research products generated from this project will provide technologies that support the efficient and clean energy production necessary for energy independence.*
  - *The diverse and multi-disciplinary research setting provides both faculty and students with the opportunity to cultivate a broad and diverse skillset that will provide benefit to the nuclear sciences, as well as the overall scientific community.*
- *Technology has been successfully demonstrated in a simulated laboratory environment (TRL=5) and well positioned for pilot/full scale system validation in a relevant environment (TRL=6,7)*

Conclusion

- *Accomplishments for the third project year*
  - *Successfully deployed and operated a prototype fused silica based AFBG sensing system in the gamma irradiator at ORNL*
  - *Designed and constructed sensing system based on single crystal sapphire AFBG sensors*
  - *Successfully deployed and operated a prototype single crystal sapphire AFBG sensing system in the gamma irradiator at ORNL*
  - *Demonstrated the performance of prototype fused silica and single crystal sapphire AFBG temperature sensing systems up to 1000ºC and 1300ºC, respectively.*
- *The accomplishments are consistent with the project goals, objectives and schedule.*

Questions?

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