INL/EXT-22-65738-Revision-0

Passive Peak Temperature Monitors

January 2022

Malwina A Wilding, Lance A Hone, Kurt L Davis, Austin D Fleming, Kiyo T Fujimoto

Changing the World's Energy Future

Idaho National Laboratory

INL/EXT-22-65738-Revision-0

Passive Peak Temperature Monitors

Malwina A Wilding, Lance A Hone, Kurt L Davis, Austin D Fleming, Kiyo T Fujimoto

January 2022

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

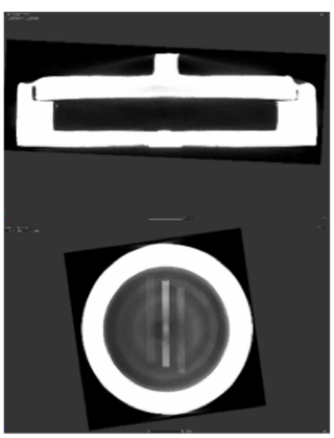
Passive Peak Temperature Monitors

PI: Malwina Wilding – Idaho National Laboratory
Collaborators: Lance Hone, Kory Manning, Kurt Davis, Austin Fleming, and Kiyo Fujimoto – Idaho National Laboratory

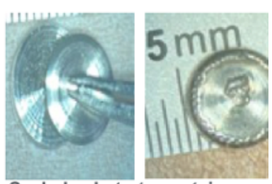
Project Description: Passive temperature monitors have been used for many decades in irradiation testing experiments, but further innovations to these technologies will advance the state of the art by leveraging new equipment and methods initiated in FY 2020. A previously purchased optical dilatometer will be benchmarked against traditional resistivity methods for determining the post-irradiation evolution of silicon carbide temperature monitors. In addition, advanced manufactured passive temperature melt arrays (i.e., melt wires) will be optimized for miniaturization and for affording higher resolution than traditional quartz-encapsulated melt wires. These innovations have already attracted interest from stakeholders wanting to expand their passive temperature monitor deployment options.

Impact and Value to Nuclear Applications: Passive monitors provide a practical, reliable, and robust approach to measuring irradiation temperature during post-irradiation examination, while requiring none of the feedthroughs/leads found in current, more complex real-time temperature sensors. They were chosen for their proven history of deployment by stakeholders; and require continued development and characterization to ensure successful integration with program schedules and objectives.

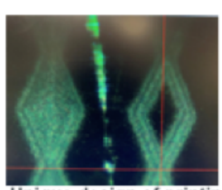
Recent Results and Highlights: The first highlight is the development of packaging processes for printed melt wire arrays with improved geometries and higher peak temperature resolution. A new and unique encapsulation design for advanced manufactured melt wires was optimized for a welding process that can produce inert-atmosphere encapsulation. Also, this new and unique design for printing melt wires improves wire sensitivity, thus also enhancing x-ray-computed tomography resolution in order to better evaluate encapsulated materials. The second highlight is the comparative assessment of optical and resistivity measurement methods for evaluating silicon carbide temperature monitors. The optical dilatometry measurement method has multiple advantages over the resistivity measurement method (e.g., an automated process requiring minimal setup time) thanks to a vacuum treatment that removes any oxidation issues and reduces the processing time for each silicon carbide sample.



CT scan of printed Sn, Zn and Al melt wires



Sealed substrate container ca
of inert-atmosphere encapsul



Unique design of printing material to enhance melt wire sensitivity

Optical Dilatometry Method for Processing Silicon Carbide Temperature Monitors.