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Testing Piezoelectric Sensors in a Nuclear Reactor Environment

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Several Department of Energy Office of Nuclear Energy (DOE-NE) programs, such as the Fuel Cycle Research and Development (FCRD), Advanced Reactor Concepts (ARC), Light Water Reactor Sustainability, and Next Generation Nuclear Power Plants (NGNP), are investigating new fuels, materials, and inspection paradigms for advanced and existing reactors. A key objective of such programs is to understand the performance of these fuels and materials during irradiation. In DOE-NE's FCRD program, ultrasonic based technology was identified as a key approach that should be pursued to obtain the high-fidelity, high-accuracy data required to characterize the behavior and performance of new candidate fuels and structural materials during irradiation testing.

The radiation, high temperatures, and pressure can limit the available tools and characterization methods. In this work piezoelectric transducers capable of making these measurements are developed. Specifically, three piezoelectric sensors (Bismuth Titanate, Aluminum Nitride, and Zinc Oxide) are tested in the Massachusetts Institute of Technology Research reactor to a fast neutron fluence of 8.65×10^{20} n/cm². It is demonstrated that Bismuth Titanate is capable of transduction up to 5×10^{20} n/cm², Zinc Oxide is capable of transduction up to at least 6.27×10^{20} n/cm², and Aluminum Nitride is capable of transduction up to at least 8.65×10^{20} n/cm².