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#4-48 Validation of an acoustic sensor for characterizing fission gas releases under harsh conditions up to 350℃ and 120 bar, for integration in experimental loops at the Jules Horowitz reactor.

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For several years, the IES laboratory has been working in collaboration with the CEA on the development of acoustic instrumentation in the nuclear field. Within the framework of this collaboration, the IES acoustic team is developing a miniaturized gas composition sensor for in situ measurements of gas composition in material testing reactor. The first experimental evidence of an acoustic measurement to perform a gas composition measurement date back to 2010 with the REMORA 3 experiment, which measured the release of fission gas from fissionable fuel. This experiment was carried out in the OSIRIS reactor located at CEA Saclay center in France. The installation allowed the devices to be tested under irradiation at 150℃, which corresponded to the maximum operating Curie temperature allowed by PZT element. But the new sensors presented in this paper will be able to operate up to 350 degrees. This performance is possible by the utilization of a modified Bismuth Titanate piezoelectric (NBT). NBT family has been confirmed for the piezoelectric ceramic which is deposited by serigraphy on alumina. Glass-ceramic such as MACOR® is used for the fabrication of the acoustic cavity and the reflector. These choices were motivated by the low thermal expansion of these materials taken individually, their resistance to the radiative fluxes and their maximum operating temperature well higher than 300℃. Particular attention has been paid to the complete assembly of the sensor, including gluing of the various components and electrical connections.
In the present communication, we focus on the experiment carried out in a pressure vessel located at the CEA Saclay center in January 2024. This facility allowed to test the acoustic sensors up to 350℃ and 120 bar with different types of gas mixtures (from pure He to mixture with 20% of Xenon). Two types of measurements were performed: electrical impedance and acoustic signals were monitored by an appropriate instrumentation. Two sensors were simultaneity tested. The results made it possible to estimate the ageing and the evolution of the performance of the sensors during a few days. The first results showed some slight alteration of the acoustic performance of the sensor after a total of 79 hours of experimentation but measurements are still possible. At 350℃ and a pressure higher than 70 bar in gas mixture, the sensor emitted acoustic waves and showed the possibility of performing a reliable in situ gas composition measurement.
These experiments allowed us to validate the concept and design of this high temperature device before final validation tests under irradiation in 2025.

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