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#4-15 Interest of optimizing the response of a high-temperature ultrasonic transducer by integrating a porous aluminum backing element for detection of structures immersed in liquid sodium.

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With the emergence of major applications in harsh environments, the scientific and industrial community expresses a real need for developing a range of instrumentation dedicated to monitor, control, and check resistance to ageing and damage of a large panel of structure. In nuclear domain, there are needs in the frame of instrumentation of Material Testing Reactors (MTR) and of the new generation of nuclear reactors and power plants but also in the field of nuclear reactors cooled by optically opaque liquid heavy metals such as sodium, lead and lead-bismuth for visualization or telemetry. Ultrasonic transducers are particularly well adapted to address this issue. Up to date, only a few prototypes of ultrasonic transducers exist.

A conventional ultrasonic transducer is generally constituted of several layers: an active element (piezoelectric disc), a backing element, one or more quarter-wave matching layers, all acoustically coupled. The backing element is of first importance as it controls the sensitivity and broadens bandwidth via its acoustic impedance, increasing the temporal resolution of the reflected echoes. It is therefore important to find new backing materials suitable for manufacturing high-temperature ultrasonic probes.

Thanks to the use of a specific backing material produced by uniaxial pressing of an aluminum powder containing a small amount of wax followed by sintering, we designed an ultrasonic prototype transducer dedicated to continuous high temperature experiments. The first experiments were tested with a 1-centimeter-thick steel sample. The probe is a homemade Cerium-modified NBT based 10 MHz. This sensor, with a thickness of 5 mm, tested from room temperature up to 350℃, turned out to be entirely consistent with what one might expect for echographic time-resolved measurements. We also managed to determine temperature-dependent velocity propagation equations consistent with the literature.

Because the small sensor thickness, it can be used in a variety of experiments in difficult environments where space is limited or when the medium is opaque : measurement in sodium reactors was envisaged. The response of the sensor with and without backing was modelled for the visualization of metal structures immersed in liquid sodium. The modification of the sensor bandwidth and therefore the length of the echoes allows better temporal separation of the objects.

Primary authors: CHABANOL, Gregory (IES, Univ Montpellier / CNRS); Dr LAUX, Didier (IES, Univ Montpellier / CNRS); Dr ROSENKRANTZ, Eric (IES, Univ Montpellier / CNRS); PAVEYRANNE, Aubin (IES, Univ Montpellier / CNRS & CEA/DES/IRESNE/DTN/STCP/LETH); Dr BAUDRY, Florian (IES, Univ Montpellier / CNRS); Dr FERRANDIS, Jean-Yves (IES, Univ Montpellier / CNRS)

Presenter: Dr FERRANDIS, Jean-Yves (IES, Univ Montpellier / CNRS)

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