A lead-free piezoelectric ultrasonic transducer for high-temperature operation

High-temperature, lead free piezo-materials for on-stream ultrasonic testing

Overview

In view of upcoming changes in legislation restricting the use of lead (Pb) in piezoelectric ceramic materials, Ionix have undertaken a development project with an industrial consortium to deliver alternative, lead-free materials to the ubiquitous lead zirconate titanate (PZT) for specific applications, including ultrasonic flow, level sensing and corrosion monitoring.

Presented here is an ultrasonic non-destructive testing transducer, manufactured with one of the output materials of the project, designed for use in high-temperature environments

Key deliverables

- A novel lead-free piezoceramic has been developed and **successfully deployed in to a high-temperature ultrasonic transducer**
- Alternatives to lead-based piezoelectric materials are available for extreme environment ultrasonic systems, **mitigating risk of new products from changes in legislation**

+44 (0) 1484 505 859
contact@ionix.at
ionixadvancedtechnologies.co.uk

The Challenge

There were a number of challenges around the material development for on-stream ultrasonic transducers which required a solution.

- No commercially available high-temperature lead-free materials existed with an activity >50 pC/N, which limits the applicability of the materials for ultrasonic generation and receive sensitivity.
- The material is required to be able to be withstand 500 °C for extended periods of time for operation in industrial environments such as Energy, Oil and Gas and Nuclear.
- The material is required to be "plug and play" with current materials – allowing for the use of existing manufacturing methods and processes, as well as compatibility with off-the-shelf gauges and electronics.

The Solution

- Ionix developed a unique high temperature piezoceramic, S1, which operates up to 550 °C long-term with similar material properties to Ionix current HPZ 580 material, but contains no lead, or rare earth metal oxides making for a sustainable, future proof supply chain.
- A piezoelectric element of S1 was assembled into Ionix standard HotSense HS582i ultrasonic transducer designed for corrosion surveys and mapping of on-stream plant.
- The transducer offers similar sensitivity and acoustic characteristics similar to that of a standard HotSense transducer, with a minor increase in the gain required for measurement.
- The transducer was able to be successfully calibrated, and used to accurately measure thickness of a 38 mm block of aluminium at 300 °C using a commercial, off-the-shelf ultrasonic thickness gauge.

Figure 1: (left) a photograph of HotSense HS582i probes assembled with lead-free materials. (right) ultrasonic testing being completed with an off-the-shelf gauge, with continuous contact to an aluminium block at 300 °C.