NRC·CNRC

INTEGRATED ULTRASONIC TRANSDUCERS

Embedded Ultrasonic Sensors for mining equipment health monitoring

The integration of sensors for real-time condition monitoring of critical equipment systems and processes can generate substantial cost savings in maintenance, failure prevention and process control operations. Conventional ultrasonic sensors monitor the wear, corrosion and cracks of specific structures, but current size, fragility and cost limit their usability for on-line monitoring. To alleviate these limitations, the NRC has developed a new generation of ultra-thin integrated ultrasonic transducers.

"PAINTED-ON" ULTRASONIC TRANSDUCERS

The NRC's new ultrasonic transducers are composed of thin piezoelectric film used for embedded and integrated installations. Combined with recent developments in electronic miniaturization, power consumption and wireless communication for ultrasonic applications, the NRC's "painted-on" ultrasonic transducers can be efficiently used to extensively monitor health of equipment and structures. These thin and robust sensors are suitable for predictive maintenance applications of equipment that is heavily affected by wear and corrosion, such as those found in mining, oil and gas, and power generation industries.

HIGH PERFORMANCE TRANSDUCERS

Compared with other types of commercial ultrasonic transducers, the NRC's "painted-on" ultrasonic transducers offer comparable signal strength at room temperature, plus the capability to generate purer longitudinal waves. Furthermore, these transducers possess the following beneficial characteristics:

- Extended temperature coverage
- Ultra-low profile (sub-millimetre)
- Applicable to curved surfaces
- Robust

BENEFITS OF THE NRC'S ULTRASONIC TRANSDUCERS

Conformal and low profile for convenient integration

The fabrication process allows a thin layer of a porous piezoelectric material (for example PZT) to be conveniently sprayed onto a metallic foil to form a flexible ultrasonic transducer which can then be bonded to a flat or curved surface structure (e.g., pipe) to be monitored. The piezoelectric layer can also be sprayed directly on the structure to become an integrated ultrasonic transducer (IUT). A low profile of tens to hundreds of microns could allow a transducer to be embedded conveniently in a structure for structural health monitoring (SHM) without compromising the integrity of the structure.

Photo: Piezoelectric ceramic (white) sprayed on steel foil.

Uncompromised performance in wide frequency and temperature ranges

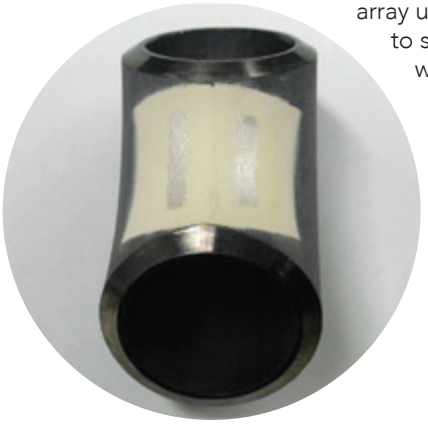
Depending on the acoustic attenuation and the geometry of a structure to be monitored, diagnostic ultrasound of a specific frequency range is usually preferred to others. The NRC's thin film transducers can be tailored to different non-destructive evaluation and SHM needs in a frequency range from 1 MHz to 40 MHz by controlling piezoelectric film thickness and in a temperature range from -60 °C to +800 °C.

Low fabrication cost and proven reliability

The porous microstructure of the NRC's thin film ultrasonic transducers allows wide band ultrasound signals to be generated without the need of an absorbing backing layer, resulting in a significant reduction in transducer fabrication cost and an increased reliability associated with a much simpler transducer structure. Prolonged aging as well as mechanical and electrical fatigue tests have shown that the NRC's thin film transducers can provide decades of service life.

High customizability

IUTs can also be fabricated as arrays to be used with existing well-developed phased array ultrasonic inspection systems to scan the interior of a structure without moving the transducers. They are particularly useful in situations where transducers are permanently mounted for inspection of locations with difficult access due to either space restriction or high operational temperatures.



Different types of acoustic waves usually have different sensitivities to a certain defect or material property change. The NRC's piezoelectric film can be deposited onto a wedge surface to make a high temperature wedge transducer for generation and/or detection of preferred non-longitudinal type acoustic waves through mode conversion to suit different inspection needs.

LET'S WORK TOGETHER

The NRC engages with clients in the development, testing and introduction of new technologies for industrial applications. Contact us to find out how, together, we can advance the deployment of Integrated Ultrasonic Transducers.

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