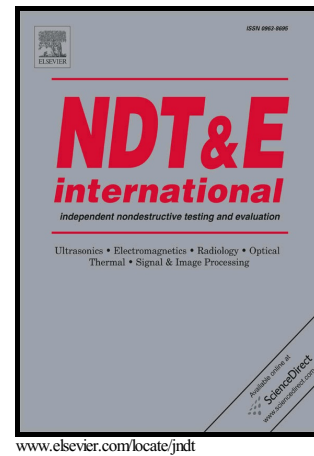


Multi-coil focused EMAT for characterisation of surface-breaking defects of arbitrary orientation

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PII: S0963-8695(17)30111-1
DOI: <http://dx.doi.org/10.1016/j.ndteint.2017.02.005>
Reference: JNDT1845

To appear in: *NDT and E International*

Received date: 27 September 2016
Revised date: 16 February 2017
Accepted date: 17 February 2017

Cite this article as: C.B. Thring, Y. Fan and R.S. Edwards, Multi-coil focused EMAT for characterisation of surface-breaking defects of arbitrary orientation *NDT and E International*, <http://dx.doi.org/10.1016/j.ndteint.2017.02.005>

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Multi-coil focused EMAT for characterisation of surface-breaking defects of arbitrary orientation

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Abstract

Electromagnetic Acoustic Transducers (EMATs) are a useful ultrasonic tool for non-destructive evaluation in harsh environments due to their non-contact capabilities, and their ability to operate through certain coatings. This work presents a new Rayleigh wave EMAT transducer design, employing geometric focusing to improve the signal strength and detection precision of surface breaking defects. The design is robust and versatile, and can be used at frequencies centered around 1 MHz. Two coils are used in transmission mode, which allows the usage of frequency-based measurement of the defect depth. Using a 2 MHz driving signal, a focused beam spot with a width of 1.3 ± 0.25 mm and a focal depth of 3.7 ± 0.25 mm is measured, allowing for defect length measurements with an accuracy of ± 0.4 mm and detection of defects as small as 0.5 mm depth and 1 mm length. A set of four coils held under one magnet are used to find defects at orientations offset from normal to the ultrasound beam propagation direction. This EMAT has a range which allows detection of defects which propagate at angles from 16° to 170° relative to the propagation direction over the range of 0 to 180° , and the set up has the potential to be able to detect defects propagating at all angles relative to the wave propagation direction if two coils are alternately employed as generation coils.

Keywords: Ultrasonics, EMAT, Focusing, Rayleigh wave, Surface-breaking defects

1. Introduction

Ultrasonic surface waves, and in particular Rayleigh waves, have been shown to be an effective tool for the detection of surface breaking defects, including rolling contact fatigue (RCF) [1] and stress corrosion cracking (SCC) [2]. Rayleigh waves are generally used in one of two modes of operation; looking for reflections returned by surface breaking defects [3], or measuring variations in the transmitted signal traveling from a generation to a detection trans-

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