High temperature focused EMAT arrays

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Non-destructive testing (NDT) is an incredibly important, but hidden, area of research. Ultrasound is a key NDT inspection tool. Recent research has led to significant developments in different inspection procedures, such as using non-contact ultrasonic transducers, for example electromagnetic acoustic transducers (EMATs). High temperature EMATs enable inspections to be done while systems such as power stations are in use, removing the need for a costly shut-down. They typically use water cooling, enabling inspection at temperatures of up to 1000°C. Recent research has shown that EMATs which do not require water cooling can also be produced, with operating temperatures of up to 650°C possible [1]. These have been built to generate a shear wave, with reflections from the back face of a sample used for thickness gauging. This is a standard measurement – however, there is significant promise for using focused EMAT arrays to perform more complicated high temperature inspection [2].

This project will produce a EMAT array, consisting of multiple channels, that can be operated at high temperatures without the requirement for water cooling. The inspection modality and wavemode choice will be guided by industrial needs, with the potential for using Rayleigh, Lamb, shear-horizontal or bulk waves, depending on the defect position and type. The ability to perform the higher resolution imaging possible using an array, albeit with a small number of elements, at high temperature, will cause a step-change in NDT. By using EMATs it will also be possible to inspect using different wavemodes generated using the same array, and combine results from each inspection together using data fusion.

This PhD will develop equipment, and focus on new data processing and data fusion methods, creating a next generation inspection system that is greater than the sum of its parts. The ultrasound group works closely with industry through the Centre for Industrial Ultrasonics (CIU) based at Warwick and the FIND-CDT. You will be expected to present your results to industry, as well as preparing work for publication in journals such as Applied Physics Letters and NDT & E International.

References:

1. N Lunn, S Dixon and MDG Potter, High temperature EMAT design for scanning or fixed point operation on magnetite coated steel, NDT&E International **89** pp 74-80 (2017)
2. L Xiang, D Greenshields, S Dixon and RS Edwards, Phased electromagnetic acoustic transducer array for Rayleigh wave surface defect detection, IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, **67**(7) pp 1403-1411 (2020)