Adaptive Ultrasonic Imaging for Phased-Array Inspection of Laser Brazed Joints Using Inverse Methods

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Laser brazing offers several advantages over other high-volume joining techniques, most notably a lower thermal input compared to welding, avoiding loss of strength of the substrate material and minimizing part distortion. In the automotive industry, the quality of brazed joints is currently determined by visual inspection, followed by destructive cross sectioning, adding considerable cost to the production of some parts. Therefore, a non-destructive technique that allows for the measurement of the internal joint geometry and the presence of possible imperfections is highly desired. To achieve robust, non-destructive inspection of brazed joints, the development of an ultrasonic 1-D phased-array technique capable of compensating for the variations in joint geometry that are typical in production was undertaken. Post-processing of ultrasonic full matrix data using the total focusing method, which allows for secondary corrections to be applied after an image is formed, was performed. For joints in which the brazed surface is highly curved, typical corrections, which rely on changes to the phase delay of the wavefront, were found to be inadequate for proper imaging and characterization. To overcome this deficiency, amplitude corrections were needed, in addition to phase delay corrections, in order to increase the focal ability of the system. Moreover, these added corrections were implemented in a manner that didn't interfere with a real-time characterization of joints. In this presentation, we describe the theory upon which the technique is based, alongside a comparison to the ultrasound inspection techniques used in industry today.