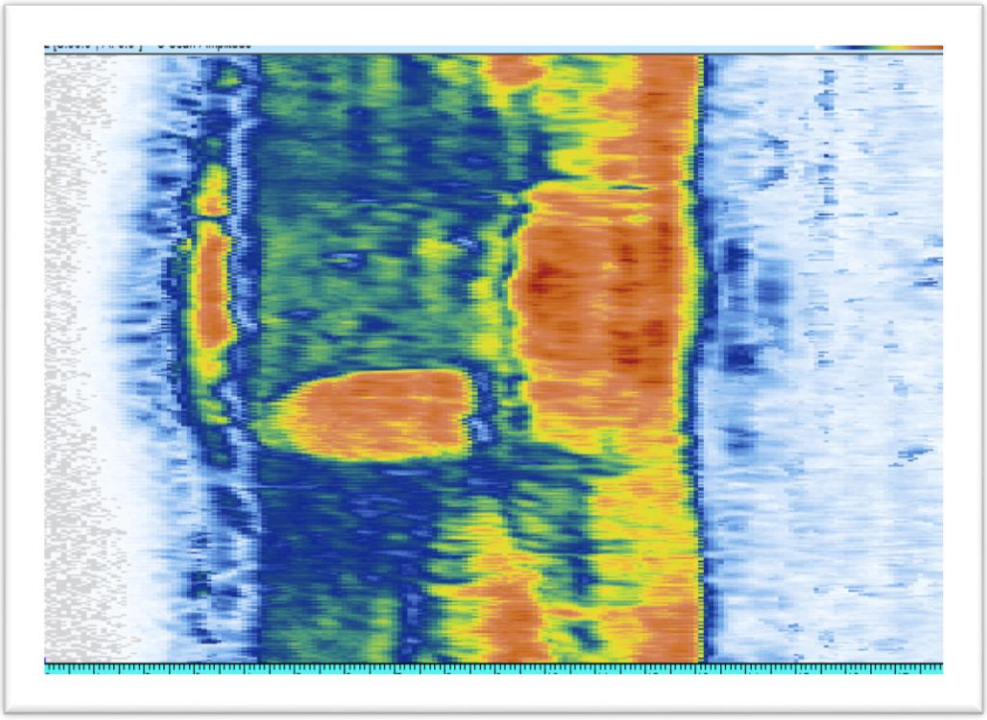

EVALUATION OF WELD QUALITY BETWEEN DISSIMILAR METALS USING IMMERSION ULTRASONIC TESTING

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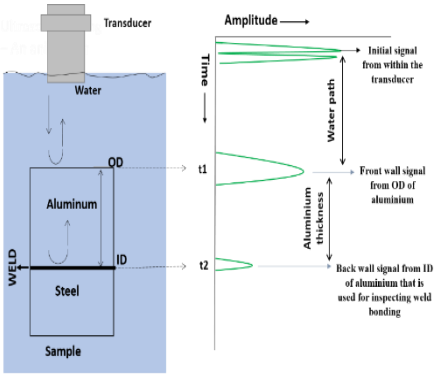
Welding of dissimilar metals is being extensively used in many industrial applications. In the automotive sector, the use of lighter metals is considered an effective way of reducing vehicle weight for decreasing fuel consumption. Efforts are being made to replace the steel structures with aluminum-stainless steel structures. Aluminum alloys are the desirable lightweight metal choices due to their high specific strength, good ductility, sound corrosion resistance, and good machinability for the hybrid automobile structural component. But the challenges lie in the welding of these dissimilar metals. The conventional fabrication process results in the formation of brittle Fe-Al intermetallic compounds. These intermetallic compounds impart brittleness to the welded joint due to their low-stress intensity factor and high crack propagating rate.

Magnetic pulse welding (MPW) is one of the modern-day, state-of-the-art 'solid-state welding' processes, which emits almost zero emission of any harmful radiation or fumes. The magnetic pulse welding forms a metallurgical bond between two surfaces with help of high impact force rather than fusion. It is non-contact type welding in which the magnetic pressure of the magnetic field accelerates the workpieces to move towards each other and subsequently join the metal surfaces by localized melting because of collision. Although the MPW is considered the most effective for welding dissimilar metals, the rapid solidification of the metals, the grain refinement of the steel side, and grain coarsening of the Al side have resulted in a weak bond. Immersion UT is performed on these joints for evaluating unbonded areas in the weld. This helps in optimizing the welding parameters for defect-free weld-joint.

(a)

The welded aluminum-steel sample

Ultrasonic immersion scanning is widely accepted as a technique for detecting the unbonded region in the weldment. The pulse-echo method is used for evaluating the unbonded region. The inspection setup is made as shown in the figure.



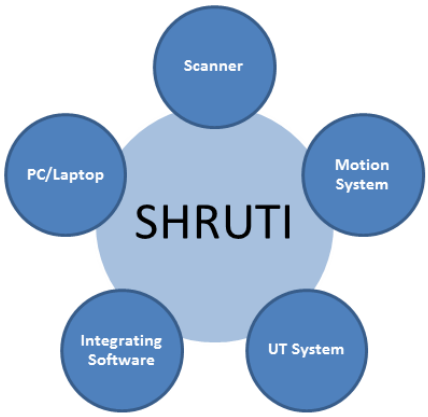
(a) (b)

Inspection procedure and A-scan signal

In the non-welded region (defect region), sound energy reflects more after hitting the bottom surface of the aluminum (back wall echo). The amplitude of the back wall echo from aluminum will be evaluated for qualifying the weld quality. A high back wall echo from the interface is treated as a weak joint. A weak reflection from the interface is treated as a good joint.

The system used for the inspection is **SHRUTI®**. Scanning High-Resolution Ultrasonic Inspection System is an indigenously developed customizable, automated, multi-axis robotic scanner. Along with ultrasonic probe, advanced data analysis (***extut®***) and image analysis packages SHRUTI facilitates easy inspection of samples and components. The cycle time required for scanning a component will take 10 minutes with a good resolution C-scan image.

SHRUTI® offers very high-resolution images of the test coupon with very high scanning speeds. The complete instrument control is through the software. Skelton of the system is being built from lightweight aluminum extrusions which are upgraded to Stainless Steel for heavy-duty applications. All the electrical connections are rugged and properly routed following industrial standards offering very durable and reliable running.

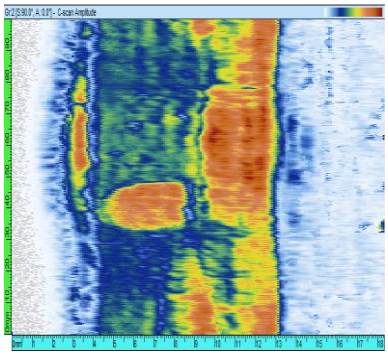


ROBUST SOFTWARE

The system employs rugged servo motors for motion requirements and had industrial standard safety interlocks.

Typical Immersion Ultrasonic scanning system

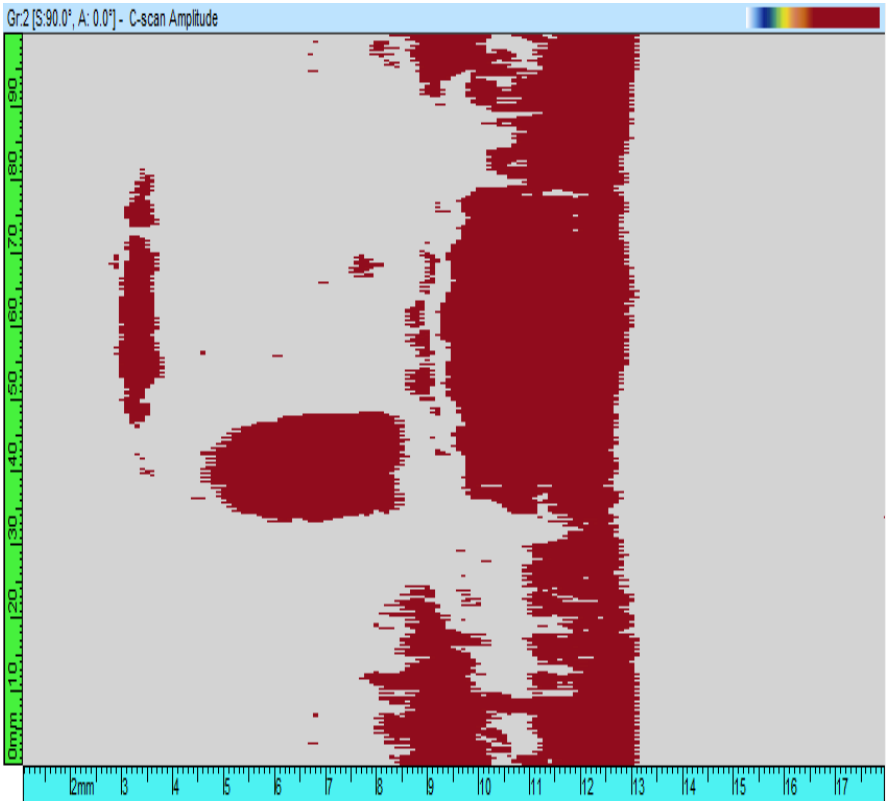
The C-scan image showing the unbonded region of the weldment is shown below



Evaluation of Weld Quality between Dissimilar metals using Immersion Ultrasonic Testing- Application Note

A Dhvani Research Application Note

Chennai, INDIA



Inspection C-scan image showing the area of unbonded region (in red). The vertical axis is the circumferential axis of the cylinder and the horizontal axis is the length of weldment.

For more information, please contact:

info@dhvani-research.com

+91-44-6646-9880

No.10 Veeramamunivar street,
C.B.I Colony 2nd main Road,
Kandanchavadi, Chennai 600096 - India.

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