

## AIR COUPLED ULTRASONIC INSPECTION OF METALLIC COMPOSITES



NDE is widely used in the quality evaluation of various structures used in space exploration. Composites are actively replacing metallic structures due to their high strength-to-weight ratio. Composites used include CFRP or GFRP plates, aluminum honeycomb with CFRP faces plates, aluminum honeycomb with aluminum faceplate, aluminum honeycomb with solar panels, etc.

Manufacturing defect-free components in space applications plays a vital role in making the explorations successful.

Due to the hygroscopic nature or for those components which are inspected in the multiple stages of

manufacturing which do not allow water/ couplant ingress the choice is non-contact testing.

Air-coupled Ultrasonic inspection is one of the most widely used non-contact non destructive testing procedures.

In this application note, air-coupled UT of two critical components is discussed.

1. Inspection metal to rubber bonding.
2. Inspection of Aluminum honeycomb sandwich structure.

### Inspection of metal to rubber bonding

The solid propellant rocket uses solid propellants for producing the desired thrust to the satellite launch vehicles. This rocket has a multi-layer rubber lining inside which acts as an insulation for the high energy generated inside the chamber. The rubber insulation inside the casing is adhered to the metal casing to withstand the high temperature developed during the ignition of propellant fuel. The presence of any de-bond is undesirable resulting in local hot spots.

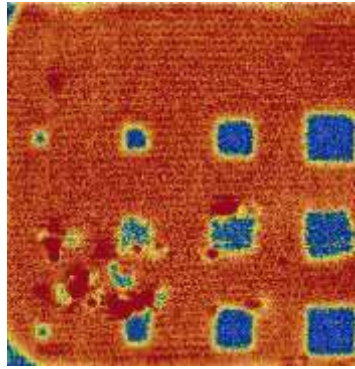
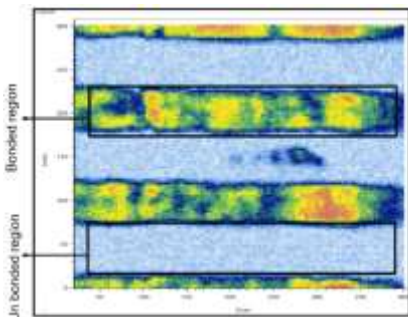
This testing is carried in through-transmission mode where two separate probes are used, one as transmitter and the other as a receiver.

A 10-axis automated system is designed and manufactured for this application with a twin tower design concept. Each tower consists of 5 axes. 3 linear axes (X, Y, Z), 2 angular axes (Pan and Tilt movement of probe). This system is capable of scanning complex geometries with contour following capability.

A mockup of the sample used for the inspection is shown below. The sample is a part of the solid propellant rocket in which the rubber layer adheres to the steel casing. The unbonded regions are artificially made at certain locations.



The Inspection results (C-scan Image) is as shown below:



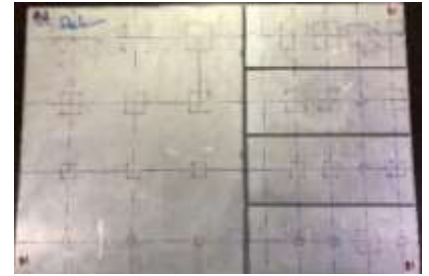
As seen in the C-scan image the unbonded region between the rubber and casing is imaged

### Inspection of aluminum honeycomb sandwich structure

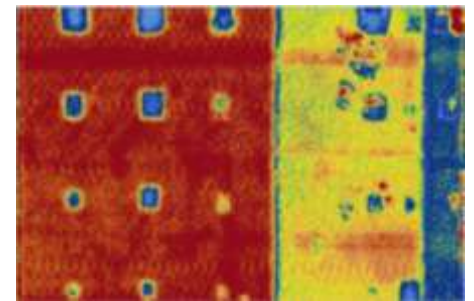
Adhesively bonded sandwich structures, with their advantages of lightweight, design flexibility, high specific stiffness, and specific strength, are attractive structural components and are therefore widely used in aviation, space, and marine applications. The face sheet (skin) and core of sandwich structures can encompass a myriad of materials, both composite and metallic. Metallic sandwich structures, especially aluminum face sheets over aluminum honeycomb are widely used in aircraft and satellite structures. These structures after manufacturing need to be checked for any unbonded region between the adhesion layer, the surface plate, and core.

Air coupled inspection technique in through-transmission mode is used for detecting the defects.

The sample shown below has artificially created delamination's in multiple thickness faceplates.



The C-scan image of the sample is shown below with delamination's imaged.



As per the inspection results and C-scan data, the delamination's are very well imaged using air-coupled inspection.

The dual-tower ultrasonic manipulator has complex contour following capability by teach-in and CAD import options. The software supports a multitude of ultrasonic instruments with all the UT parameters having direct access from the computer. The acquired data can be imaged in 3D with advanced data algorithms like pulse compression and signal processing algorithms.

# Air Coupled Ultrasonic Inspection of Metallic Composites- Application Note

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Application Note

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