

Air Coupled Ultrasonic Imaging of Honeycomb panels A Dhvani Research Application Note



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NDT OF AEROSPACE COMPONENTS

NON-CONTACT AIR COUPLED ULTRASOUND NDT SOLUTION

Air Coupled Ultrasonic Inspection is a new noncontact ultrasonic inspection method used for specimens which cannot be subjected to water couplant, due to its hygroscopic nature and those whose face skin is very delicate, on which application of pressure is not advised in the case of contact testing.

Advances in material science had led to the development of more reliable and light materials like composites and honeycomb structures which are used in aircrafts and spacecrafts.

Owing to the importance in testing the integrity of these components, air coupled ultrasonic is widely accepted as a

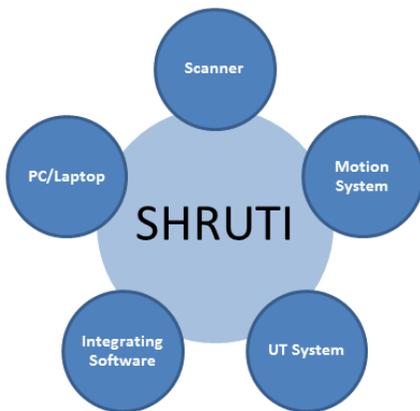
testing method for the aerospace components.

SHRUTI[®] (Scanning High Resolution Ultrasonic Testing and Imaging) is a DHVANI RESEARCH developed customizable, automated, multi-axis robotic scanner. Along with an air coupled ultrasonic inspection instrument, advanced data analysis (*extut*[®]) and image analysis package (*imagine*[®]), SHRUTI provides for the easy inspection of samples and components. Owing to the very less transmission coefficient of ultrasound in air when compared to the water the preference is always given for the immersion scanning, However if the interaction with water causes a

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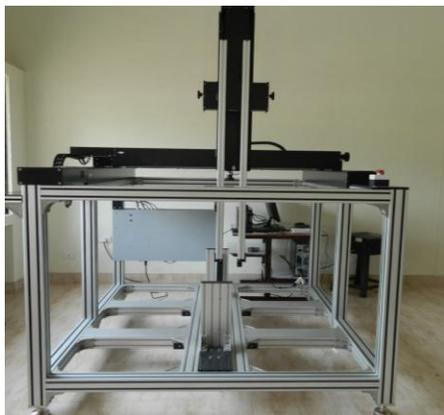
change in the material property of the sample there is no choice but to avoid water and to go for other techniques. Other techniques include contact inspection which involves human intervention which contributes a huge tolerance factor and involves a lot of time and effort. Moreover most likely a report involving manual intervention is always looked upon with least interest as the probability of getting it wrong is very high. This points out to a feasible solution which is a non-contact inspection without involving water as a couplant, completely automated with automatic defect report generation and Histogram analysis of Defect data.

SHRUTI[®] (Scanning High Resolution Ultrasonic Testing and Imaging) offers very high resolution image 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. Components of flat, cylindrical, and complex shapes can be imaged.



Robust Hardware

A typical scanning system is shown below for scanning



large flat honeycomb panels..

Advantages Of Air Coupled UT

Air coupled ultrasonic technology employs efficient transduction using multi-layered piezo-electric design principles, narrow band resonant pulsing, high power and high gain, etc. to compensate for the significant losses that are encountered at the transducer-air and the air-component interfaces. This approach has been demonstrated for imaging internal features of material that have relatively low acoustic impedances, such as composites, polymers, wood, fabric, paper, etc. Due to the relatively small wavelength in air, adequate spacial resolution can be achieved, even at the low frequencies used in air coupled ultrasound (50-500 kHz).

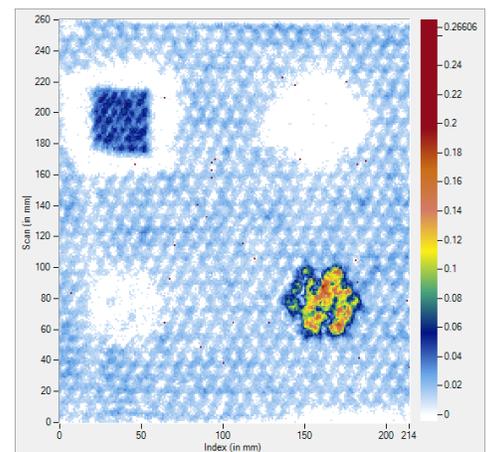
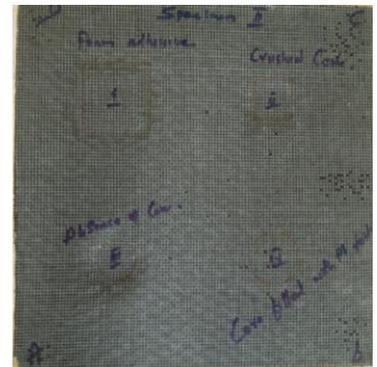
In addition, recent work at IIT Madras has shown that by using guided ultrasonic waves that have relatively low impedances, even metallic components of sufficiently small thickness can be inspected. In addition, the guided ultrasonic waves allow for the rapid coverage of large area for inspection and can also evaluate regions that are not easily accessible for inspection. The use of "turning" modes that was discovered at IIT Madras now allows for the detection and sizing of delaminations and disbonds in layered structures.

This technique has also been found to be applicable for the inspection of complex shaped components.

Applications

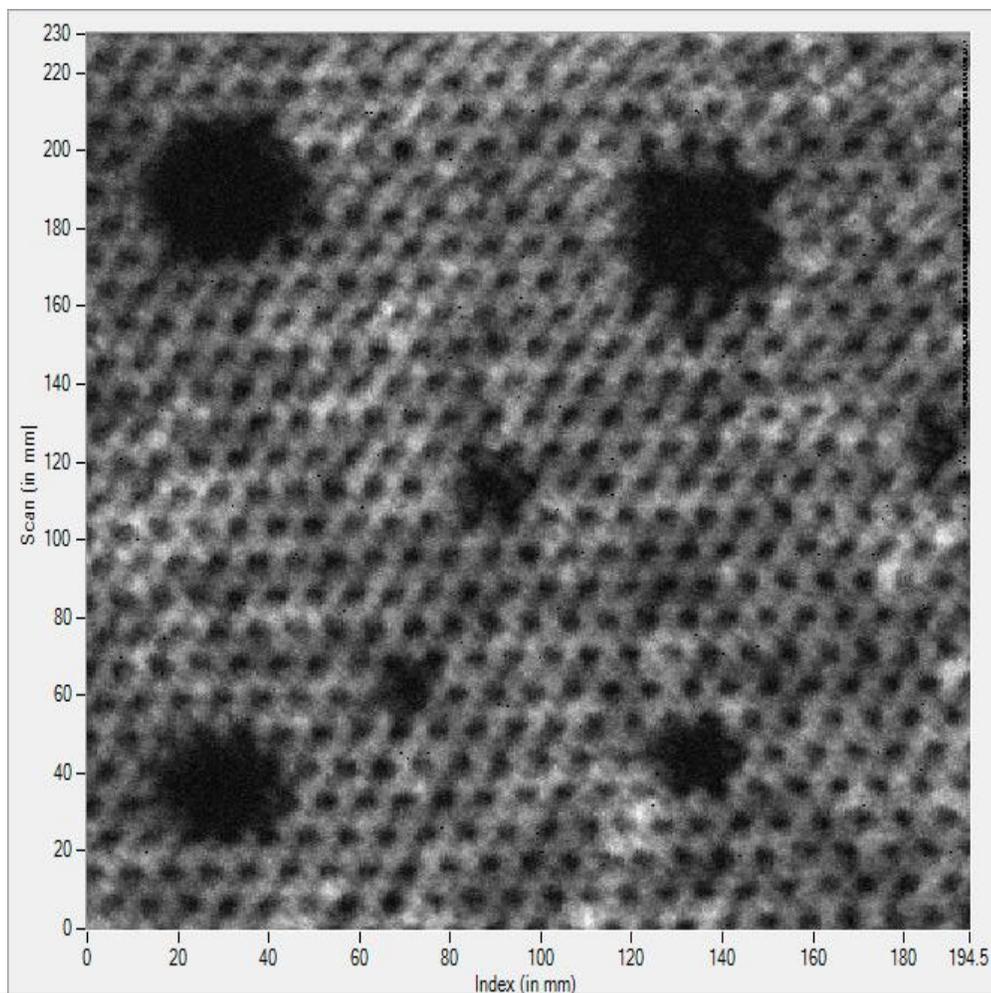
TYPICAL AIR COUPLED UT IMAGES

The air coupled UT imaging technique employed on a composite-aluminum-composite honeycomb sample as shown below was imaged at 120 kHz ultrasonic frequency using a through transmission technique in a non-contact mode. The scanning resolution was maintained at 0.3 mm x 0.3 mm. A focused probe was used for both transmitted and receiver. The sample had several programmed defects in the core as well at the interface between the composite skin and the honeycomb core. The amplitude C-scan image of this sample is shown in the result below. Here, high transmission amplitudes are RED in color and the low transmission amplitudes are White in color. All of the defects in the sample were imaged and the honeycomb structure was also imaged successfully. The size of the defects were measured using the automated image analysis software (Imagine[®]) to within 10% of the actual defect size.



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Chennai, INDIA



Typical Air-Coupled Ultrasonic Image obtained on a Solar Cell bonded to a Honeycomb panel with programmed defects in the honeycomb structure.

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