Detection of Defects in C/C Composite Aircraft Brake Disks by Using ACUT

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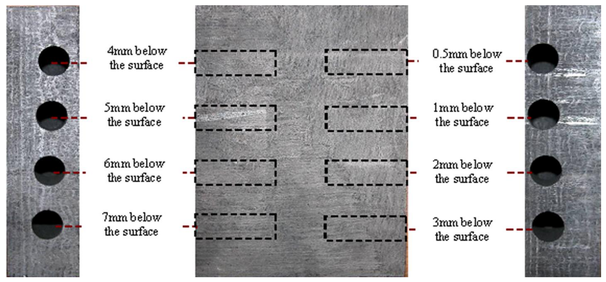
INTRODUCTION

- The objective of this study was to conduct a feasibility study using air-coupled ultrasonic testing (ACUT) to detect defects in various commercial Carbon-Carbon (C/C) composite aircraft brake disks.
- C/C composites are widely used in the aerospace, brake, and structural applications where thermal shock resistance and a low coefficient of thermal expansion are often required.
- Defects within C/C composite brake disks basically consist of delaminations, inclusions, fiber breakage, voids, and impact damage.
- ACUT is one of the Non-destructive Evaluation (NDE) tools for defect detection and material characterization for various C/C composites.

MATERIAL DESCRIPTION

a

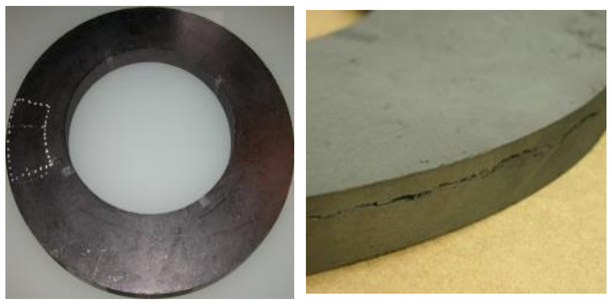


- CAFS non-heat treated C/C composite brake disk sample
- Different sets of phantom defects (12.7 mm diameter flat bottom holes from the side) at varying depth from the top surface of the sample

b

- Commercial C/C composite resin as-molded brake disks
- Prepared by hot pressing chopped carbon fibers in phenolic resins
- Diameter of 292 mm and thickness of 33 mm
- Large porosity defect visible

c



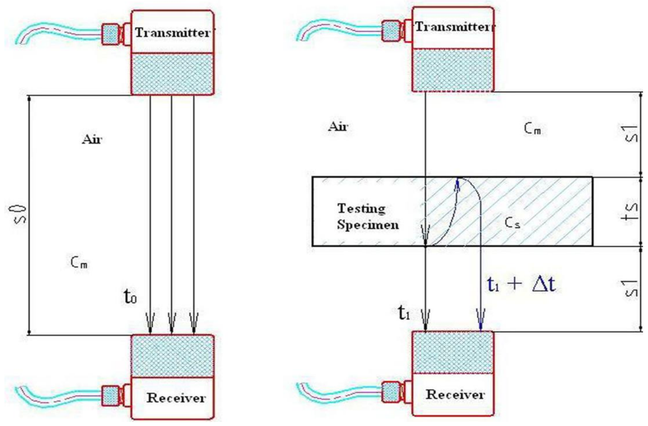
- MABS heat treated (HT) C/C composite aircraft brake disk
- Delamination defects clearly visible
- Diameter of 450.8 mm and thickness of 20 mm

d

- Honeywell heat treated (HT) C/C composite aircraft brake disks
- Did not have any visible defects
- Diameter of 476.2 mm and thickness of 23.5 mm

ENGINEERING APPROACH

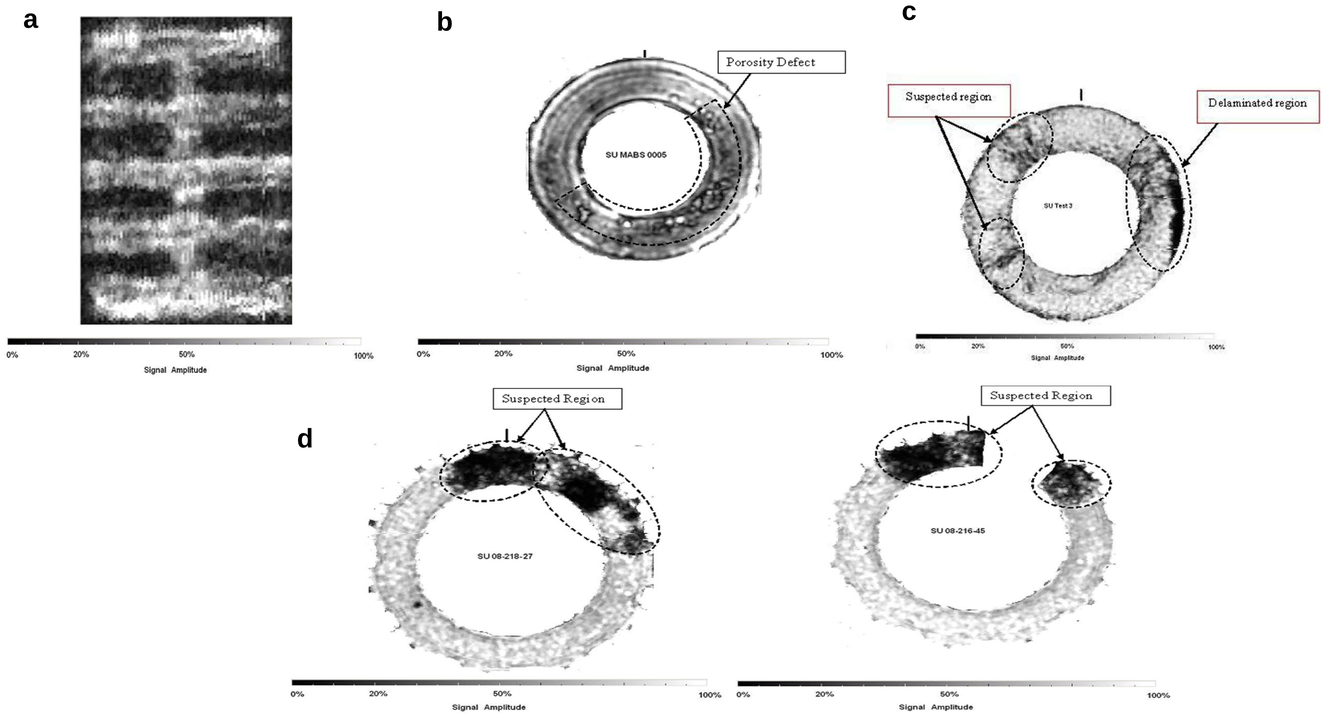
- The through transmission configuration was utilized for all the tests that were conducted at Airstar Inc.
- The testing was performed by using two flat type Airstar air-coupled transducers at 125 KHz with the scan increment of 2 mm and a resolution of 2 mm.
- The system was calibrated before testing each different specimen in order to obtain accurate results.
- All test samples were placed into cut out holes in the Styrofoam to reduce the amount of signal by-passing from the specimens.



Through-Transmission Configuration

Airstar ACUT Test Setup

ACUT TEST RESULTS



C-scan Amplitude Image Results for Carbon-Carbon Composite Brake Disks

CONCLUSIONS

- The C-scan ACUT results revealed the embedded and visible defects in all commercial aircraft brake disks.
- Defect areas are represented by dark shade of grey colors which reflect 0% signal amplitude.
- Artificial defects were also clearly detectable in the C-scan image results of 125 kHz.
- Suspected regions may be the regions with embedded defects, delaminations, foreign materials, high porosity or may have been caused by carbon fiber orientation which further needs to be quantified.
- Calibration is essential for each ACUT measurement.

ACKNOWLEDGEMENT

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Intelligent Measurement & Evaluation Lab