

Non-Destructive Evaluation of Aerospace Composites

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Introduction

To use comparative evaluation of Ultrasonic Testing (UT) and Infrared Thermography (IRT) to find the most efficient method of testing aerospace composites by detecting Teflon sheets to resemble defects. Areas of evaluation are:

- Time required for testing of composite material
- Quality of the image produced from testing method
- Resolution of image
- Pixel/millimeter ratio

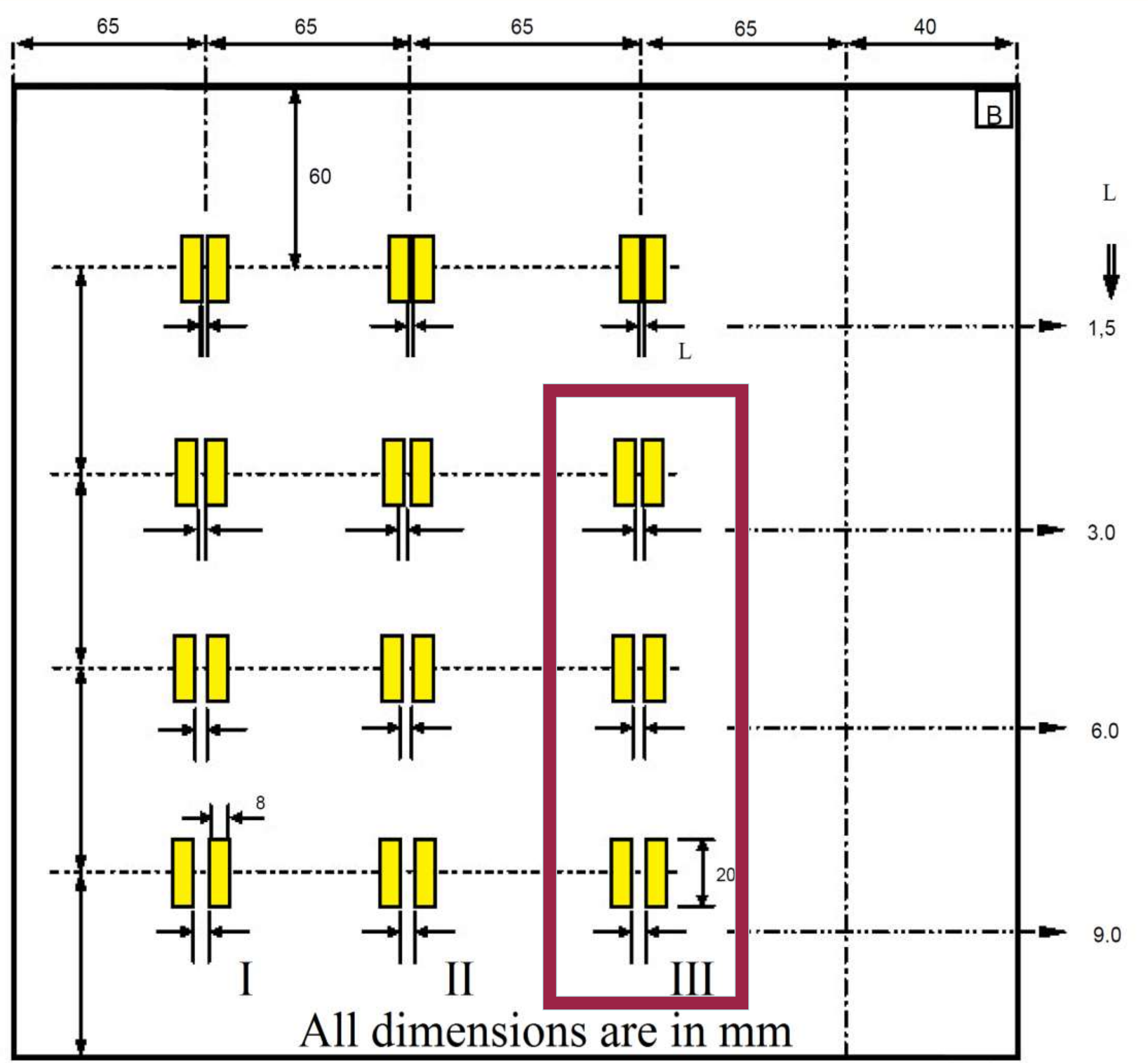
Methods & Testing

Ultrasonic testing was conducted with an immersion system filled with room temperature water. The aerospace composite sample was raised from the bottom of the tank by 1mm and scanned with a 5MHz transducer with a 2in focal length. The scan was prepared using the program DWC Scan ran on a Windows 98 computing system.

Infrared Thermography testing consisted of using a Mikron infrared camera to determine the change in heat of the Teflon in the aerospace composite. The composite was covered with a aluminum metal casing, inside of which were four halogen lights, two of which were actually used in the experiment. The sample was preheated and cooled, then heated for eight seconds and cooled for eight seconds, with the MiKroSpec RT program capturing the video of the change in temperature.

Both testing methods' results were imported to MATLAB and analyzed with the "image tool" function. The images were separately viewed and the quantity of pixels of the Teflon dimensions were measured and an accurate ratio of pixels/millimeters was calculated.

Defect Map of Specimen

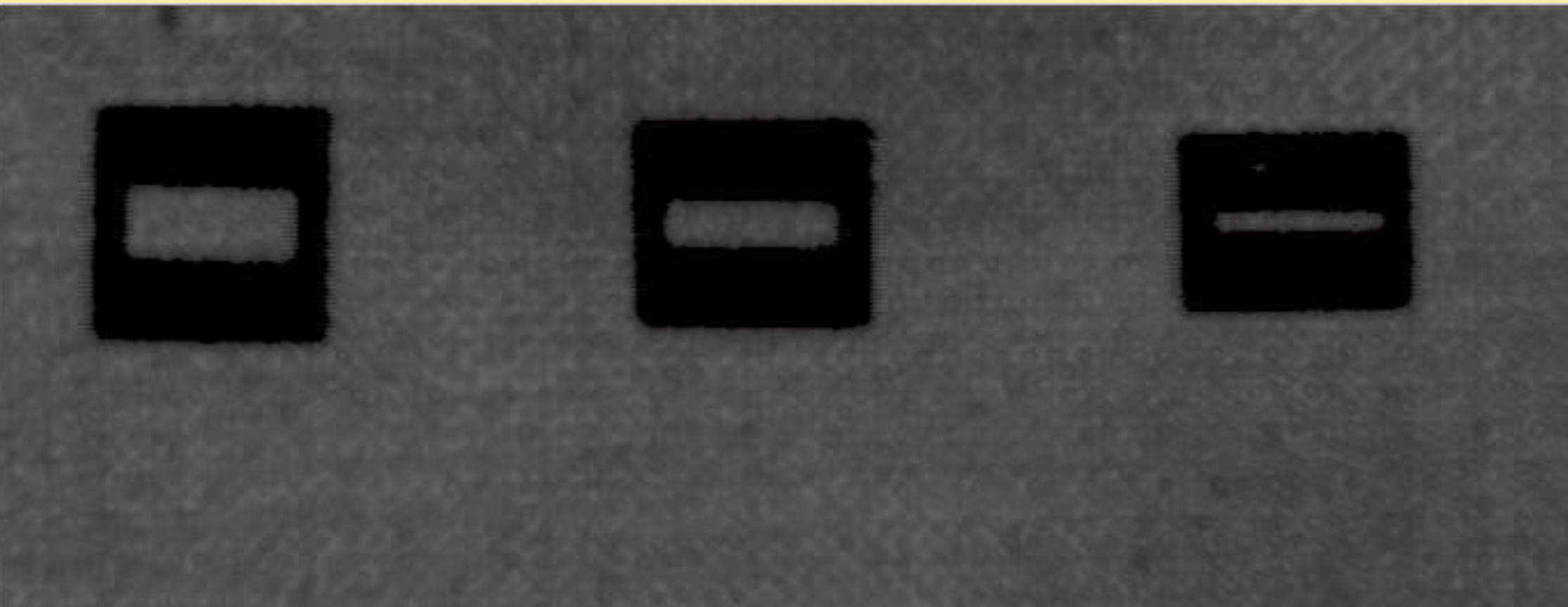


Region of Interest

Conclusion

- Ultrasonic testing proved to be more precise and clear in the resulting image scanning compared to infrared thermography
- Infrared thermography results can be view instantaneously or after 16 seconds if a more precise viewing is required, compared to ultrasonic testing taking nearly two full hours
- Ultrasonic testing provided double the amount of pixels per millimeter than infrared, allowing for sharper image quality

Ultrasonic Image



Results

The UT scan provides a precise edge to be used for measurement because of its increased resolution and pixel ratio. The actual scan proved to take some time due to the incrimination of the scan to 0.01inches and because of there only being a single sensor.

Results

| NDE Method | Time required for data acquisition | Image Quality | Resolution | Pixel/mm ratio |
|-----------------------------|------------------------------------|---------------|------------|----------------|
| Infrared Thermography (IRT) | 16 seconds | Fair | 240 x 320 | 1.86 |
| Ultrasonic Testing | 2 hours (7200 seconds) | Good | 689 x 264 | 4.17 |

References

- Li, S., Poudel, A., and Chu, T.P., "An Image Enhancement Method for Ultrasonic NDE of CFRP Panels," *Proceedings of 21st Annual Research Symposium and Spring Conference*, Dallas, TX, March 19-23, 2012, Session: Signal Processing.
- Poudel, A. and Chu, T.P., "Intelligent NDE Expert System for Aircraft Carbon/Carbon Composite Brakes Using Infrared Thermography and Air-Coupled Ultrasound," *Materials Evaluation*, Vol. 70 No. 10, pp.1219-1229, October 2012.

Infrared Image



Results

The IRT image is clearly less defined than the ultrasonic image, edges are significantly more blurred and the resolution is of a smaller size, preventing the pixel per millimeter ratio from being large enough to see precise definition. The IRT setup and data acquisition process was more timely than the UT scan.