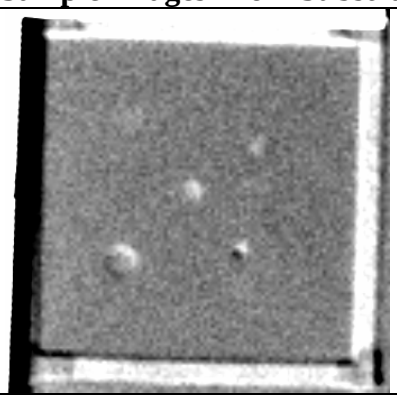
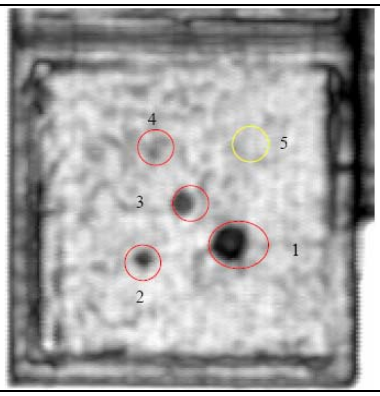
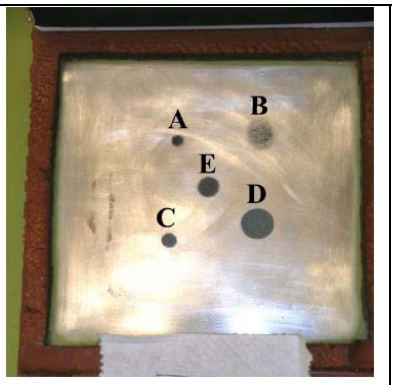
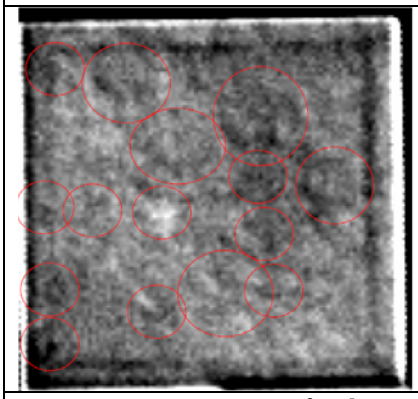
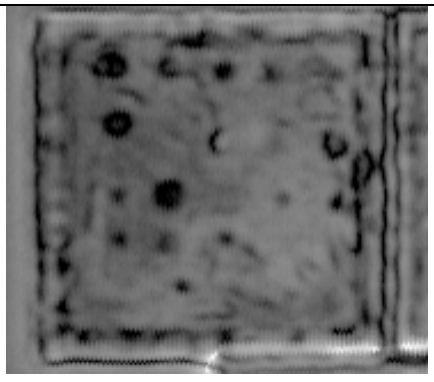
NDE METHODS FOR SPACE SHUTTLE HIGH TEMPERATURE REUSABLE SURFACE INSULATION TILES

Objective: Find nondestructive evaluation methods suitable for detecting bond line defects in Space Shuttle High Temperature Reusable Surface Insulation Tiles.

Technical Methodology/Approach:

- Prior to the Columbia accident the tiles had been assumed un-inspectable and production controls were assumed adequate for safe flight
- Sought out and acquired an NDE tile test panel to evaluate potential NDE methods
- In-house research activities, worked on a non-interference basis with RTF, leveraging on the advances made from developing NDE for ET SOFI
- Panel sent to over a dozen different NDE vendors to test a variety of techniques
- Methods which have been found to work the best on the tile panel included microwave imaging, backscatter radiography, terahertz imaging and shearography
- Corrosion under tile has become the leading issue

Sample Images From Substrate Corrosion Research:

<table>
<tr><td>  </td><td> 
</td><td> 
</td></tr>
<tr><td>55 Kv, 11.6 mA, 1.1 mm focal spot</td><td></td><td>Training sample</td></tr>
<tr><td>  </td><td>  </td><td> 
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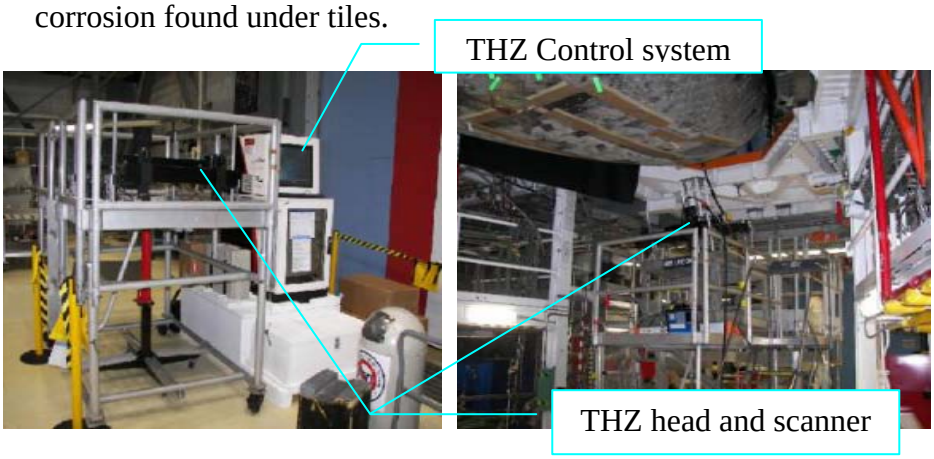
<tr><td>55 Kv, 40 mA, 5.5 mm focal spot</td><td>FFT at 125 GHz</td><td>“Blind” test sample</td></tr>
<tr><td>BSX
Slow (1 hr/ft2)
Poor Detection</td><td>THZ
Quick (0.5 hr/ft2)
Adequate Detection</td><td></td></tr>
</table>

NNWG Funded Research:

- Consolidate the existing NDE data and provide recommendations to the Shuttle Process Review Board on a plan for maturing these methods
- Leverage the recently acquired capabilities in microwave imaging, backscatter radiography, terahertz imaging and shearography NDE that NASA possesses to further refine these promising techniques
- Continue to investigate candidate methods
- Cooperative HRSI tasks agreement with LaRC and KSC
- Efforts focused on NDE detection of corrosion under tile

Activities:

- Tile substrate corrosion detection
  - Test panels provided by KSC USA NDE to evaluate NDE methods for substrate corrosion
  - Evaluated with BSX, THZ, mm-wave and X-ray Laminography
  - Selected THZ for field trials at KSC
  - EMI testing performed on MSFC THZ system to allow operation near an Orbiter at KSC
  - Sent MSFC THZ system and support personnel to KSC "Hanger N" to facilitate in-field trial of system for corrosion detection on T35 test article
  - MSFC THZ system being used by KSC USA personnel to evaluate Orbiter tile bondlines (OV-104, Flight 29, STS-122; OV-105, Flight 21, STS-123 and OV-103, Flight 35, STS-124). In all cases no NDE indications of corrosion and no corrosion found under tiles.



- Investigated gap filler detection with BSX and THZ
- Updated HRSI methods list
  - Digiray – X-ray laminography
- Built up next generation BSX system

Customers: The potential customer for this task will be primarily the Space Shuttle, but future vehicles using HRSI type thermal protection systems would also benefit from this work.

Metrics: Develop of a set of NDE methods applicable to detecting bond line defects in HRSI tile. Perform basic experimental testing to demonstrate the proficiency of each method.

Products: A tool box of NDE methods for inspecting the bond line of HRSI tile including a data pack to substantiate the results.
Methods were transferred to KSC and project is complete.

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