

Techniques and Tools of NASA's Space Shuttle Columbia Accident Investigation

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Keywords: accident investigation, spacecraft, spectroscopy, metallurgy

The Space Shuttle Columbia accident investigation was a fusion of many disciplines into a single effort. From the recovery and reconstruction of the debris, Figure 1, to the analysis, both destructive and nondestructive, of chemical and metallurgical samples, Figure 2, a multitude of analytical techniques and tools were employed.

Destructive and non-destructive testing were utilized in tandem to determine if a breach in the left wing of the Orbiter had occurred, and if so, the path of the resultant high temperature plasma flow.

Nondestructive analysis included topometric scanning, laser mapping, and real-time radiography. These techniques were useful in constructing a three dimensional virtual representation of the reconstruction project, specifically the left wing leading edge reinforced carbon/carbon heat protectant panels. Similarly, they were beneficial in determining where sampling should be performed on the debris.

Analytic testing included such techniques as Energy Dispersive Electron Microprobe Analysis (EMPA), Electron Spectroscopy Chemical Analysis (ESCA), and X-Ray dot mapping; these techniques related the characteristics of intermetallics deposited on the leading edge of the left wing adjacent to the location of a suspected plasma breach during re-entry.

The methods and results of the various analyses, along with their implications into the accident, are discussed, along with the findings and recommendations of the Columbia Accident Investigation Board. Likewise, NASA's Return To Flight efforts are highlighted.

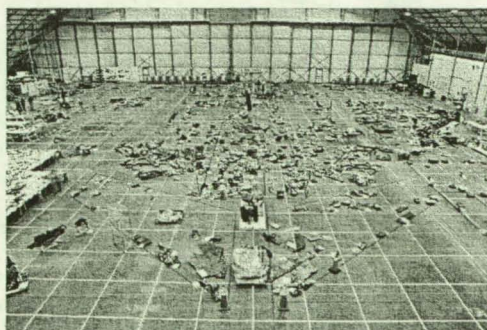


Figure 1. Columbia Reconstruction Hangar. The debris represents approximately 3% of the total debris recovered and includes metallic structures, reinforced carbon-carbon composites, and ceramic heat insulation tiles [1].

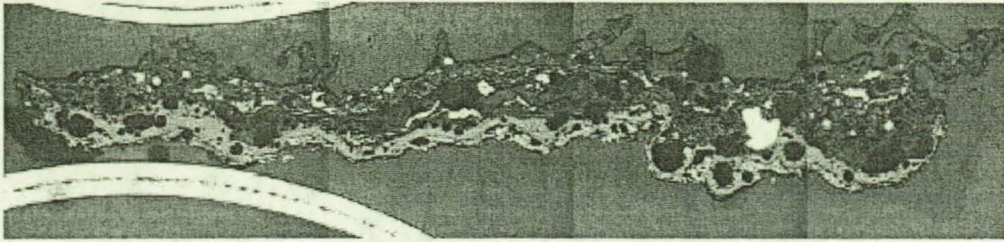


Figure 2. Materialographically-prepared cross-section of a slag deposit from LH Panel 8 [2]. Note higher-z metallic deposits in lighter-z metallic matrix. Magnification: 8X

1. KSC-03PD-1673 (05/22/2003), NASA/Kennedy Space Center photo archive.
2. Virginia Cummings, Peter Marciniak, NASA/Kennedy Space Center