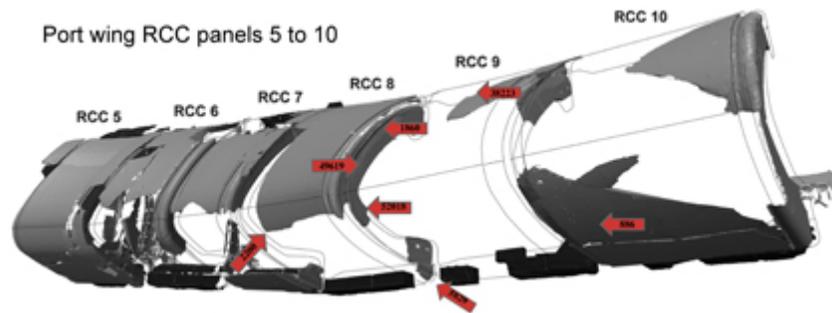


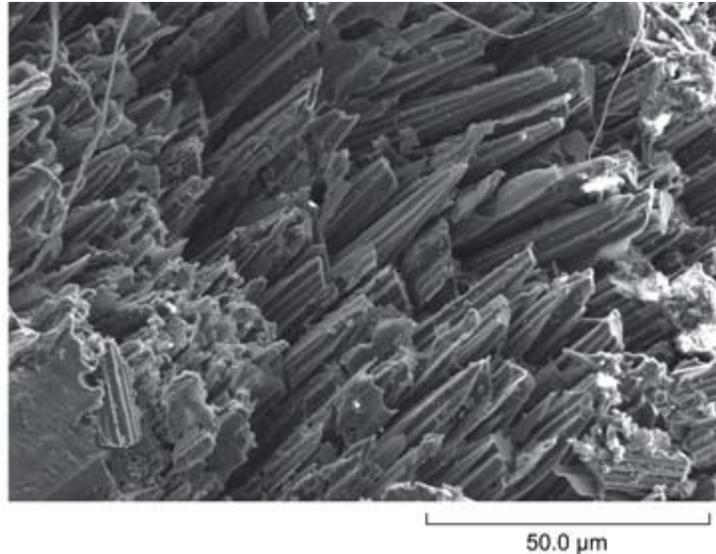
# Followup to Columbia Investigation: Reinforced Carbon/Carbon From the Breach Location in the Wing Leading Edge Studied

Initial estimates on the temperature and conditions of the breach in the Space Shuttle Columbia's wing focused on analyses of the slag deposits. These deposits are complex mixtures of the reinforced carbon/carbon (RCC) constituents, insulation material, and wing structural materials. Identification of melted/solidified Cerachrome insulation (Thermal Ceramics, Inc., Augusta, GA) indicated that the temperatures at the breach had exceeded 1760 °C.



*Sample locations in recovered RCC.*

For the present study, a series of samples were removed from the RCC at the breach location of the recovered Columbia wing leading edge, as shown in the preceding illustration. Some knife-edge surfaces of the RCC exposed relatively clean carbon/carbon. From these surfaces, further information on the conditions of the accident could be extracted. Microscopy at the NASA Glenn Research Center revealed the mode of attack of the hot oxidizing gases. The following photomicrograph illustrates the “pointed” morphology characteristic of the oxidation of carbon fibers.



*Electron micrograph of carbon/carbon taken near the breach showing an oxidation pattern.*

A second set of samples was studied at Sandia National Laboratories. Sandia has developed a novel technique to look at carbon chars and determine temperatures from Raman spectroscopy. The Raman spectra consist of two characteristic peaks at 1350 and 1600  $\text{cm}^{-1}$ . The magnitude and peak shape correlate with the size of the crystalline domains in the carbon chars. These, in turn, correlate with exposure temperatures in standards. Lower exposure temperatures yield nanocrystalline graphite, whereas higher temperatures yield larger graphite crystals. Comparison with standards indicates that the temperatures on some of the recovered RCC fragments may have been greater than 2700  $^{\circ}\text{C}$ . These results provide new evidence of the upper temperature limits experienced at the breached wing leading edge of Columbia.

**Find out more about this research:** <http://www.grc.nasa.gov/WWW/EDB/>

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