National Aeronautics and Space Administration
Glenn Research Center

Return To Flight

Refractory Metal Wrap

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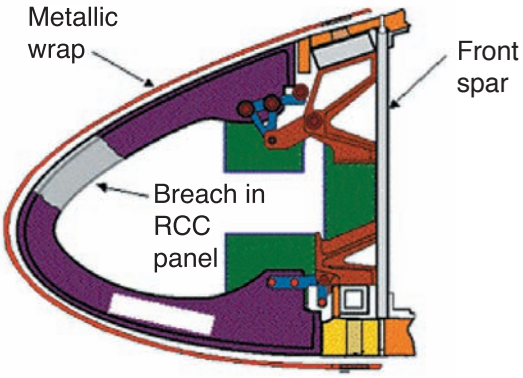
Application of a refractory metal sheet over a mockup of SS panel 9.

Because damage to the leading edges of the Space Shuttle (SS) was identified as the cause of the Columbia accident, on-orbit repair concepts are of particular interest in returning the Shuttle to flight.

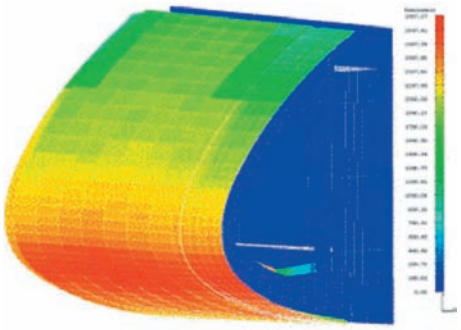
One possible idea for the on-orbit repair of the reinforced carbon-carbon (RCC) leading edges is an overwrap concept that would use a metallic sheet flexible enough to conform to the contours of the orbiter and robust enough to protect any problem area from catastrophic failure during reentry. The metallic overwrap concept is attractive due to its versatility as well as the ease with which it can be included in a "repair kit." Some technical challenges need to be overcome before this can become part of the flight kit.



A schematic of the overwrap concept.

Reentry of the orbiter into Earth's atmosphere imposes extreme requirements on repair concepts. Temperatures can exceed 1650 °C (3002 °F) for up to 15 minutes in the presence of an extremely oxidizing, and therefore damaging, plasma environment. Materials chosen for this application will need to be evaluated with respect to high-temperature capability, resistance to oxidation, strength, coefficient of thermal expansion, and thermal conductivity. A picture depicting a schematic of the overwrap concept is found to the left. Below is a picture depicting the temperature profile across panel 9 of the Shuttle during orbiter reentry.

Refractory metals, which by definition have a melting temperature greater than 2000 °C (3632 °F), are candidates for a flexible overwrap repair concept. This class of metals exhibits high strength in addition to the ability to withstand extreme temperatures. The significant problem with these materials, however, is their high propensity for oxidation. Coatings are critical for the success of a refractory metal leading-edge repair. A silicide coating is applied to the metallic candidate(s) in an effort to improve the durability of the repair concept through the oxidizing reentry environment. However, because these coatings are inherently brittle and crack as the overwrap is conformed to the leading edges, Glenn Research Center engineers are working on further improvements to this concept.



Temperature profile across SS panel 9 during reentry.

Several design issues remain before a metallic overwrap can be considered as a reliable repair concept. Expansion differences with the RCC and attachment of the overwrap to the shuttle panels are two of the hurdles still being worked.