Arcjet Testing of Woven Carbon Fabric Seams for Adapative Deployable Entry Placement Technology

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Abstract - This paper describes arcjet testing and analysis that demonstrates the viability of stitched seams that join gores of three-dimensional woven carbon fabric for multi-use in the Adaptive Deployable Entry Placement Technology (ADEPT). ADEPT is an umbrella-like entry system that is folded for stowage in the launch vehicle's shroud and deployed in space prior to reaching the atmospheric interface [1]. A key feature of the ADEPT concept is a lower ballistic coefficient for delivery of a given payload than seen with conventional, rigid body entry systems. The benefits that accrue from the lower ballistic coefficient include factor-of-ten reductions of deceleration forces and entry heating. The former enables consideration of new classes of scientific instruments for solar system exploration while the latter enables the design of a more efficient thermal protection system. The carbon fabric base lined for ADEPT has a multi-use in that itserves as the thermal protection system and as the "skin" that transfers aerodynamic deceleration loads to the umbrella-like substructure. The viability of carbon fabric for ADEPT based on arcjet testing has been described previously[2]. The capability to join gores of the carbon fabric, robust to the combined aerothermal and mechanical loading experienced during atmospheric entry is enabling for ADEPT. This paper includes the following: (1) An overview of the novel carbon-thread stitched seam that was subjected to arcjet testing, tensile load testing and other analysis. (2) Computational Fluid Dynamic (CFD) simulations used in the design of the arjet test article, (3) tests that proved creep of the seam joined to carbon fabric is not an issue, (4) a description of the method used to infuse the seam with phenoloic (5) arcjet test results and (6) tensile strength test results. Taken together, these results demonstrate the viability of carbon thread stitched seams for use in ADEPT vehicles. This work is highly significant to the success and possible adoption of ADEPT for future NASA missions.

Fig 1. Photograph of arjcet test article with seam joining two pieces of carbon fabric during load conditioning.

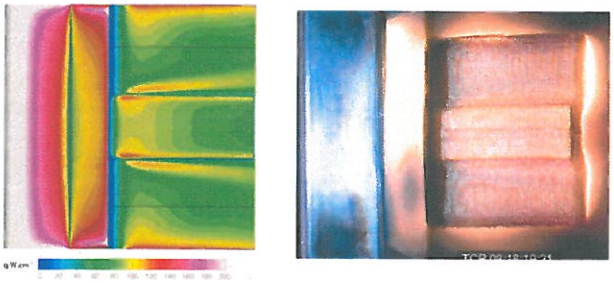

Fig 2. Left – Pretest CFD simulation of arcjet test and Right - Still from High Definiton Video taken during test. Flow from left to right. Excellent prediction of the observed flow was obtained.

References

[1] Smith, B., et.at., *Venus In Situ Explorer Mission Design using a Mechanically Deployed Aerodynamic Decelerator.* IPPW-10, San Jose State Univeristy, June 17-21, 2013.

[2] Arnold, J. O., et.al., Arcjet Testing of Woven Carbon Cloth for Use on Adaptive Deployable Entry Placement Technology, IPPW-10, San Jose State Univeristy, June 17-21, 2013.