Request for Information: Compliant or Flexible Carbon Based Substrates for Space Applications

PLEASE NOTE: This is a request for information only and does not constitute a commitment, implied or otherwise, that NASA Ames will take procurement action in this matter. Further, neither NASA Ames nor the Government will be responsible for any cost incurred in furnishing this information. NASA is issuing this Request for Information to gain a better understanding of industry capabilities and to assess the current state of the technology. Responses to this RFI are to be submitted by 12:00 noon Pacific Time, June 24, 2011. Electronic responses, in either Microsoft Office or Adobe (PDF) format, are preferred.

RFI Description and Requirements

The National Aeronautics and Space Administration (NASA) invites you to submit a response to this inquiry, to assist in planning for the development of Compliant or Flexible Carbon Based Substrates to be used in spacecraft Thermal Protection Systems (TPS) for future NASA exploration missions.

NASA Ames Research Center (ARC) is actively pursuing concepts and opportunities for technology development. Specifically this includes new approaches to TPS development and manufacturing. During service TPS materials can experience surface temperatures exceeding 3000 °F as a result of exposure to hypersonic, aerothermal heating during atmospheric flight. We are interested in gaining a better understanding of industrial capabilities to assist us in the development, maturation and incorporation of Compliant or Flexible Carbon Based Substrates into TPS systems either as a stand alone material or combined with other constituents. Designing with rigid (strain to failure ≈ 1%) TPS has challenges including the need to use a tiled configuration, which thereby requires developing appropriate gap fillers and use of a relatively stiff and heavy carrier structure which can have surface areas of the order of 10s of square-meters. Employing conformal/flexible TPS, capable of wrapping around the gentle curvature of a spacecraft, will alleviate some of the design issues faced in the application of a tiled rigid heat shield.

Compliant or Flexible Carbon Based Substrate materials (including but not limited to carbon felts) information sought includes, but is not limited to:

1. Ability to manufacture large area substrates. Provide current maximum dimensions for substrate, including thickness. Describe the application for which this material was used.
2. What is the maximum thickness you currently manufacture? Given that a thickness of 2” or greater may be needed for TPS applications, describe whether and what kind of facility modifications would allow you to achieve thickness of 2-3” if not currently produced. Are there any limitations to the maximum thickness

that can be manufactured practically? If so what drives those limitations? Is there a break point where continued increase in thickness drives a significant cost increase? If so what is that thickness and why?

3. Provide some indication of costs and schedules for modifications of current facilities to increase thickness to 2-3" if not currently achievable.
4. Provide strain to failure values for the stand-alone substrate, if available. For your values how is strain to failure defined?
5. Ability to join or stitch substrates. Provide details of approach, seam design, any properties on joining approaches for your proposed substrate that have been measured.
6. Purity of the carbon substrate material (provide chemical composition if available and approach to increase purity for a TPS application if applicable).
7. Other proposed substrate materials (other than carbon) that you believe suitable for TPS applications.
    a. Describe the ability to blend carbon and polymeric fibers within a felt. Are there limits to the ability to blend carbon and polymeric fibers that require modification to equipment, constrain thicknesses and/or sizes?
8. Provide all available properties on the substrate material including, physical, thermal, mechanical.
9. Provide the density range currently achievable. What is the uniformity of the density in a given substrate product? Can you tailor the density of the material? If so what are the costs/challenges with tailoring the density? Do you have the ability to vary the density of the substrate within a single piece? Are there cost effective means to increase the materials uniformity?
10. Ability of substrate to drape over a gentle radius of curvature. If draping is not possible is there an alternative approach proposed to allow the substrate to conform?

ARC is interested in understanding the state-of-the-art of these architectures. Upon review of the written responses to this RFI, NASA may conduct site visits or informational meetings with industry to further discuss their substrates and capabilities.

This RFI will consider materials at any technology readiness level, as defined in Appendix A below.

Guidelines for RFI Response

The specific objective of this RFI is to request information identifying and describing capabilities and approaches to making Compliant or Flexible Carbon Based Substrates at any TRL (as defined in Appendix A). Comments/responses are requested to the following topics below.

1. Capability Description

Describe the current Compliant or Flexible Carbon Based Substrates manufacturing capability (with reference to the capabilities sought in the RFI description above), include experience with scale up or attachment (to join two carbon substrates together,

or to a solid surface). For each capability referred to in the RFI description, provide an estimated TRL (as defined in Appendix A; if unknown, state “unknown”. If available, provide all material property values (measured or inferred) and testing methods in place to evaluate Compliant or Flexible Carbon Based Substrates materials.

2. Other information

If available, provide any study results or current capabilities you have but are not mentioned in the RFI description data that you think pertinent to advancing Compliant or Flexible Carbon Based Substrates in space applications.

In addition to the information requested above, describe the extent to which existing proven manufacturing approaches can be leveraged to minimize technical and schedule risk to a space program.

All information received in response to this RFI that is marked Proprietary will be handled and protected accordingly. As applicable, NASA will likely provide Proprietary information to its support service contractors who are under an obligation to keep third-party Proprietary information in confidence. By submitting a response to this RFI, the responder is deemed to have consented to release of Proprietary information to such NASA support service contractors. Responses to the RFI will not be returned.

Appendix A. TPS Technology Readiness Level Guidelines

TRL	Guidelines
TRL-1	Basic principles observed and reported.
TRL-2	Technological concept and/or application formulated, lab samples made, environment for possible application defined.
TRL-3	Analytical and experimental critical function and/or characteristic proof-of-concept, initial test; i.e., arc jet, thermal cycling demonstrate proof-of-concept.
TRL-4	Component and/or breadboard validation in laboratory environment; detailed testing of materials at temperature and under appropriate atmosphere.
TRL-5	Component and/or breadboard validation in relevant environment, such as arc jet for thermal and structural test at temperature environment.
TRL-6	System/subsystem model or prototype demonstration in a relevant environment (ground or space) subjected to adequate testing to demonstrate flight readiness.
TRL-7	System prototype demonstration in a space environment.
TRL-8	Actual system completed and “flight qualified” through test and demonstration (ground or space).
TRL-9	Actual system “flight proven” through successful mission operations.