

Project 4

Reliable material characterisation methods for Thermal Protection System (TPS) critical ablative materials

Objectives

Carbon-phenolic materials require very specific methods to determine their specific heat capacity (c_p). Due to their low density, it is difficult to maintain sufficient mass of the sample and contact with the carrier. They also respond with strong internal decomposition by pyrolysis to thermal heating, making their analysis complex, and requiring multiple experiments to investigate the virgin and charred status. A test approach is proposed.

Measurement Techniques

- Differential Scanning Calorimetry (DSC)
- Simultaneous Thermal Analysis (STA / TG-DSC)

Measurement Property

- Specific heat capacity (C_p) from ambient to 1000 °C

Background

Carbon-phenolic ablators are one of the most chosen material candidates for the heat shields of spacecraft. The wide required temperature range and the strong internal pyrolysis processes make a

temperature-dependent characterization a difficult task. Specific heat capacity and pyrolysis enthalpies especially are tightly coupled parameters, resulting on low reliability of material-property related data.

A recent Technology Readiness Program (TRP) between the European Space Agency (ESA) and von Karmen Institute (VKI) had the goal to “Test the capabilities, analyse interference sources and propose improvements of carbon-phenolic material characterization techniques for definition of an updated standardized test protocol allowing reliable and repeatable material properties extraction.”

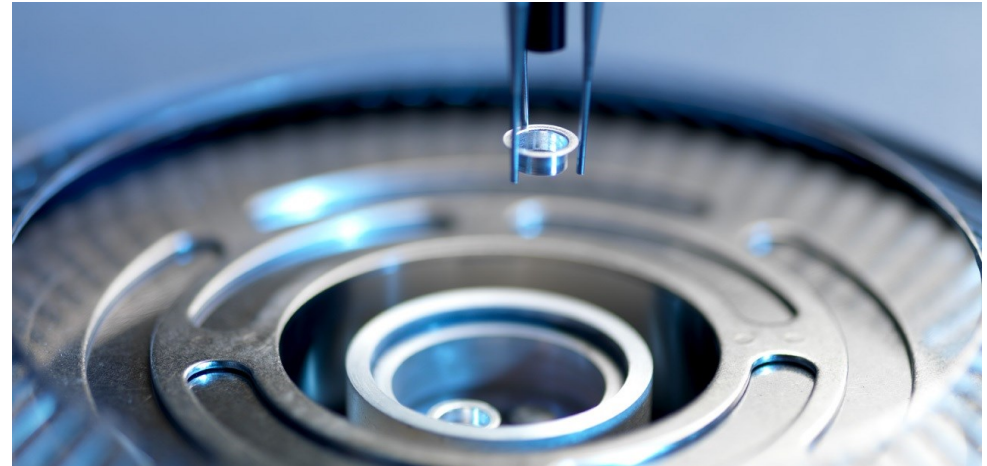
Standardisation Needs

A pre-standardisation method for both DSC and STA measurements for analysis of specific heat capacity c_p and pyrolysis enthalpy h_{pyro} was an outcome of this study. A validation study was conducted involving limited collaborators and now being extended globally.

Work Programme

- Material procurement and sample preparation by VKI

Call for Participation



- Distribution of disc geometry samples (5 mm diameter / 1 mm thickness).
- Data management

Deliverables and Dissemination

- VAMAS Technical Report with refined measurement protocol, and codes of practice for determination of specific heat capacity c_p and enthalpy of pyrolysis h_{pyro} of pyrolyzing carbon-phenolic materials.
- Dissemination through publications, conferences, and presentations at the space agencies.
- Several international research groups exist for detailed simulations of the material response of the materials, with great interest in the research outcome.

Funding

Participants fund their own involvement in the project. Materials for the interlaboratory comparison will be supplied by VKI.

Register your interest



For more information:

Project Lead
Dr Bernd Heber
Von Karmen Institute, Belgium
bernd.heber@vki.ac.be

Chair , TWA 43 (Thermal Properties)
Sam Gnaniah
NPL, UK
sam.gnaniah@npl.co.uk