Paper ID: 38743
oral

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations (IP)

Author: Prof. Oleg Alifanov
Moscow Aviation Institute, Russian Federation

Prof. Valery Cherepanov
Moscow Aviation Institute (State Technical University), Russian Federation
Prof. Aleksey V. Nenarokomov
Moscow Aviation Institute, Russian Federation
Mr. Sergey Budnik
Moscow Aviation Institute, Russian Federation
Mrs. Margarita Salosina
Moscow Aviation Institute (National Research Institute, MAI), Russian Federation

THE STUDY ON MATERIALS THERMAL PROPERTIES AND OPTIMAL DESIGN FOR SOLAR PROBE THERMAL PROTECTION

Abstract

Investigations of the Sun and the solar area are interested for the understanding of the physical processes causing the most powerful consequence of solar activity associated with the solar corona and the solar wind and their impact on the Earth and near-Earth space. Currently, in Russia there is a project "InterhelioProbe", in which the spacecraft for research in the immediate vicinity of the Sun should be created . The research program includes a study on the solar atmosphere dynamics,solar wind parameters, solar flares, magnetic fields in its polar regions and the formation of the solar cycle. The structures and systems of solar probe will be exposed to high intensity radiation heat at orbit perihelion. The thermal control device strategy is based on using a special screen that protects the spacecraft from the impact of the flow of direct solar radiation, strict requirements to the spacecraft orientation relative to the Sun and organization of controlled heat dissipation. The materials included in the solar probe heat-shielding screen should have a high melting temperature and low speed of sublimation under vacuum; low density combined with high strength, stiffness, resistance to vibration and impact of space factors. Taking into account these requirements, the following materials could be used for the heat shield of solar probe: the carbon-carbon composites based on carbon-based fillers and carbon matrix; carbide-carbon material obtained by impregnating of two- or three-dimensional structure of carbon skeleton by refractory metal carbides; light heatproof materials based on ceramic fibers; highly porous cellular materials based on metal, ceramic or glassy carbon. Reticulated vitreous carbon obtained by thermal degradation of polyurethane foam after its pre-reticulation and impregnation of phenol-formaldehyde resin is promising for use in solar probe heat screen mesh is glassy. The material has high rigidity, low mass density and low thermal conductivity. One of the main tasks, which determine the prospects of use of this material is to determine its thermal properties over a wide range of temperature changes. The work is devoted to development of methods and algorithms for optimal selection of the thickness of layers of the multilayer thermal protection along with the geometric parameters of the structure of the heat-shielding materials. Thus, the algorithm for determining the thermal characteristics of highly porous fibrous and cellular materials depending on their structure is included in the traditional for the thermal design problem on determining the number of layers and thicknesses of multi-layer insulation.