S C Sharma, J Material Sci Eng 2015, 4:4
http://dx.doi.org/10.4172/2169-0022.C1.026

Development of light weight thermal protection system (TPS) for high heat flux regions of atmospheric reentry space vehicles

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A carbon based structure namely reinforced carbon composite (RCC) coated with oxidation-resistant SiC coating, remains the first choice for the high heat-flux regions of thermal protection system (TPS) namely nose-cone and other leading edges of an Atmospheric Reentry Space Vehicle. However, RCC has two areas which call for further improvement: (i) its density of about 2000 kg/m3 imposes penalty for space application, and (ii) its good thermal conductivity makes it a poor heat insulator material for TPS application. A porous carbon foam addresses to both these issues. While, the porous structure ensures very low levels of density, it also imparts excellent thermal insulation characteristics. At the same time struts or ligaments of the foam, by virtue of being made of carbon, impart very good thermal shock resistance to the foams. Carbon foams were processed to yield varying density in the range of 0.110 to 0.232 g/cc. Foams were carbonized at 1000^{o}C and 1900^{o}C. TPS behavior of the carbon foam was evaluated in terms of its thermo structural integrity and its response to the designed heat flux profile. Thermal response was first computed for 10, 20 and 30 mm thick SiC coated C-foam TPS panels of different density and thermal conductivity using Fourier heat conduction expression. Back-wall temperature of the TPS panels of equal thickness but of different density, varied within a narrow temperature range. However, TPS panels made of 1900^{o}C carbonized foam which showed appreciably (36%) more thermal conductivity as compared to 1000^{o}C carbonized foam, recorded noticeably higher back-wall temperature. Computed thermal response was subsequently validated using the Kinetic Heat Simulation test on the processed foams. Foam panels sandwiched by SiC coated carbon based face sheets on both the sides are under processing to evolve a tiled structure for TPS applications.

Biography

S C Sharma obtained his PhD from University of Kerala and is presently leading the materials development program of Indian Space Research Organization (ISRO) as Director, Materials & Metallurgy Group, VSSC. He is also serving as Associate Project Director (TPS), Reusable Launch Vehicle (RLV-TD) and in this capacity, guiding the development of entire set of Thermal Protection Systems for this prestigious project of ISRO. Additionally, as Dy. Project Director, Scientific Payloads, Space Capsule Recovery Project (SRE) he is looking after the development of various national and international experiment modules for SRE. He has published 86 technical papers in reputed national & international journals and also has 37 presented papers and 20 invited lectures to his credit. He is recipient of "Metallurgist of the Year Award" of Ministry of Steel and Mines, Govt. of India, and "Distinguished Alumnus Award–2014" of Indian Institute of Technology, Roorkee, India. He has been a Visiting Scientist at German Aerospace Establishment, Cologne, Germany. Currently, he is also Chairman, of Indian Institute of Metals, Trivandrum Ch., the foremost professional body of material scientists in India.

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