Paper ID: 7531
student

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
New Materials and Structural Concepts (4)

Author: Mr. Nai-liang Liu
China, liul-2001@163.com

Mrs. Huang Ying
Northwestern Polytechnical University, China, yingh@nwpu.edu.cn
Mr. Li Chunhua
Northwestern Polytechnical University, China, gonewinter@126.com
Ms. Yanmei Shi
Shenyang Liming Aero-Engine (Group) Co., Ltd., China, ymshi2010@126.com

STUDIES ON ABLATION-RESISTANT PROPERTIES OF INORGANIC NANO-PARTICLES HYBRID PHENOLIC RESIN

Abstract

Ablative thermal protection is a common thermal protection technology for recoverable spacecraft, which makes use of the decomposition, depolymerization, melting, evaporation, gasification or ionization of materials to transfer a large quantity of heat in order to ensure the safety of the internal device. The ablation-resistant properties of hybrid phenolic materials with 5wt% SiC, SiO2 and Al2O3 inorganic nano-particles were studied in this paper. Glass transition temperature (Tg) of hybrid phenolic materials with SiC, SiO2 and Al2O3 inorganic nano-particles which studied by differential scanning calorimetry (DSC) increased by 6.31, 1.35 and 4.93 separately. This indicated that adding inorganic nano-particles hindered movement of molecular chain. Moreover the Tg values were also raised. Activation energies of thermal decomposition of different kinds of materials were calculated by Kissinger and Flynn-Wall-Ozawa method. It was found that after adding inorganic particles activation energy of thermal decomposition in the first stage decreased slightly, which made post-curing reaction easier. The degree of decreasing was: SiO2>Al2O3>SiC. While in the third stage activation energy of thermal decomposition increased to improve heat resistance of materials at high temperatures. The degree of increasing was: Al2O3>SiC>SiO2. The average linear ablation rate of glass fiber reinforced pure phenolic, phenolic with SiC -hybrid, phenolic with SiO2-hybrid and phenolic with Al2O3-hybrid tested by oxygen-acetylene ablation were 0.210 mm/s, 0.178 mm/s, 0.194 mm/s and 0.166 mm/s separately. The morphologies of composite materials observed by scanning electron microscopy (SEM) after ablation showed that glass fiber were melted during ablation, which formed a compact insulating layer at the surface. The carbon layer ablated beside the decomposed aera kept the porous structure caused by ablation, which reduced thermal conduction.