Accepted Manuscript

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PII: S1359-8368(18)31776-1

DOI: 10.1016/j.compositesb.2018.07.057

Reference: JCOMB 5824

To appear in: *Composites Part B*

Received Date: 3 June 2018

Revised Date: 24 July 2018

Accepted Date: 29 July 2018

Please cite this article as: Ding J, Yang T, Huang Z, Qin Y, Wang Y, Thermal stability and ablation resistance, and ablation mechanism of carbon–phenolic composites with different zirconium silicide particle loadings, *Composites Part B* (2018), doi: 10.1016/j.compositesb.2018.07.057.

Thermal stability and ablation resistance, and ablation mechanism of carbon–phenolic composites with different zirconium silicide particle loadings

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Abstract

$ZrSi_2$ modified carbon–phenolic (C-Ph) composites are prepared using different weight loadings of zirconium silicide particle by compression moulding. The thermal stability and ablation resistance of composites are investigated by thermal gravimetric analysis (TGA) and oxyacetylene torch test. Moreover, the phase composition and microstructure of ablated surface are characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), transmission electron microscopy (TEM) and selected-area electron diffraction (SAED). The results show that introduced $ZrSi_2$ particles result in an evident increase in the residual weights of C–Ph composites at high temperatures, and the enhancement in thermal stability under air atmosphere exhibits positive effects on improving the ablation resistance of C-Ph composites. The optimum $ZrSi_2$ weight loading for the improvement of ablation resistance in C-Ph composites is 5wt%. The linear and mass ablation rates of composites after modifying with 5wt% $ZrSi_2$ particles are reduced by 80.5% and 55.2%, respectively. This work provides an effective way to prominently improve the ablation performance of C–Ph composites, and it maybe become a backbone of thermal protection system in aerospace.

Keywords:

A. Polymer-matrix composites (PMCs);

B. Thermal properties;

D. Thermal analysis;