Gradient SiBCN Ceramic Coating for Anti-oxidation Protection of Carbon-carbon composites

Xiang Guo,[a,] Zhen Guo,[a] Zongbo Zhang,[b,*] Caihong Xu, [b,*] Mengzhong Cui,[a,*]

[a]College of Chemistry & Chemical Engineering, Yantai University, Yantai 264005, China

[b]Institute of Chemistry, Chinese Academy of Sciences, Beijing 100190,China

zongbo@iccas.ac.cn; caihong@iccas.ac.cn; mzcui@ytu.edu.cn

Abstract:

Carbon-carbon(C/C) composites, an important high-temperature structural material, face the severe problem of oxidation only above 500℃. Coating technology with ultra-high temperature ceramics (UHTCs) have been proved to be highly effective to improve the oxidation resistance of C/C composites. Currently, the main coating techniques for C/C composites include pack cementation, plasma spraying, polymer derived ceramic coatings and so on. Among them, polymer derived ceramic coatings have gained more and more attention due to its easy for implementation, no need for special equipment and low sintering temperature. However, the technique of polymer derived ceramic coating usually needs multiple casting-sintering cycles to densify the prepared coating, which requires ultra long operation time thus affect its real application. In this paper, we present a novel strategy to fabricate gradient SiBCN composite coating with just one casting-sintering cycle by adopting polyborosilazane ceramic precursor as the main raw material, well controlling the viscosity of the polyborosilazane-filler slurry and a low temperature pre-oxidation treatment.

The microstructure morphology, elements composition, thermal performance, and anti-oxidation property of the ceramic coating have been investigated. The coating surface macro appears uniform, no cracks, while microscopic loose and porous, as shown in Fig.1. The coated C/C composite exhibits excellent anti-oxidation property with weight loss of only 0.06% after oxidation at 1500°C for 30min. Due to the gradient structure, the coating shows no crack and no peeling off after 8 cycles of thermal shock from 1500°C to room temperature. The XRD analysis showed that the surface of the coating was oxidized to form a zirconium silicate material, thereby preventing oxygen from further penetrating and achieving the oxidation resistance (Fig.2). All above of the results indicate that SiBCN ceramic coating has high potentials for anti-oxidation protection of C/C composites.

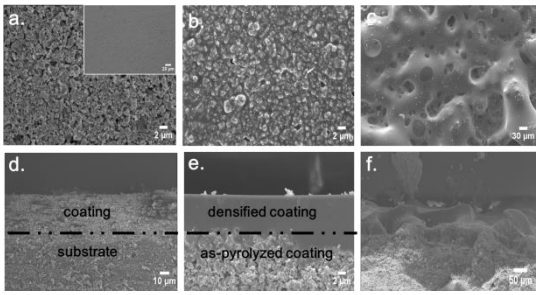

Fig.1 SEM images of SiBCN ceramic coating:a as-pyrolyed(surface); b, pre-oxidized at 900°C for 30min(surface);c oxidized at 1500°C for 30min (surface); d, as-pyrolyed(section); e, pre-oxidized at 900°C for 30min(section);f, oxidized at 1500°C for 30min (section).

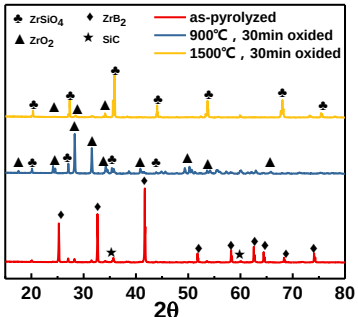

Fig.2 XRD spectra of ceramic coating , pre-oxidized the coating at 900°C for 30min and the coating after oxidation of 1500 °C for 30min.