YTTERBIUM SILICATE ENVIROMENTAL BARRIER COATINGS PREPARED BY A NOVEL SLURRY SPRAYING-REACTIVE SINTERING TECHNIQUE

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Environmental barrier coatings (EBC) are known to protect SiC_f/SiC composites used in the combustion chamber of gas turbine engine from water vapour attack. Ytterbium silicate EBCs deposited via conventionally used technique like air plasma spray undergo phase separation on deposition because of the high temperatures involved and are also susceptible to crystallization induced cracking. To overcome these shortcomings, in the present work, ytterbium silicate EBCs were developed by using a novel slurry spraying and reactive sintering technique. A well dispersed Yb_2O_3 slurry was sprayed on silicon substrate (bond coat material) using an in-house developed slurry spray system. The coatings were heat treated in air to sinter as-sprayed Yb_2O_3 and to encourage the formation of silicates via a solid-state reaction between SiO_2 and Yb_2O_3. The coatings were made by varying processing parameters like particle size of the starting powder (micron/ nanosized), solvent (terpineol / terpineol with ethanol), heating temperature (1100°C-1400°C) and time (2 h-50 h) for identifying a favourable processing window. The slurries showed shear thinning behaviour which is suitable for spraying application. The scratch hardness of the sintered coatings was evaluated using ASTM D3363. It was observed that the coatings made with nanoparticles of ytterbium oxide and sintered at temperatures close to 1400°C exhibited better scratch resistance than those of commercial ytterbia powder. The cross-section SEM showed 20-40 μm thick uniformly sprayed well adhered coatings. The presence of ytterbium disilicate and monosilicate was confirmed through EDS and XRD analysis. The coatings made with Yb_2O_3 nanoparticles slurry showed greater tendency towards formation of silicates at lower temperatures. The most favourable set of parameters were identified from the preliminary characterization and thicker coatings were made by using Yb_2O_3-terpineol slurry and were sintered at 1400°C for 10 h. Cross-section SEM revealed 150-200 μm thick, homogeneous, well adhered coatings. EDS confirmed the presence of monosilicates and disilicates at the interface. This multiphase EBC approach with equilibrium interfaces and graded functionalities offers a trade-off between properties as the disilicates have a close CTE match with the Si bond coat/ SiC composite while the monosilicates have better water vapour resistance. Ytterbium oxide top coat, as confirmed through top surface XRD, serves as an additional water vapour resistant layer. Reactive sintering technique eliminates the need for multiple spraying.