MICROSTRUCTURE, PHASE FORMATION AND CYCLIC BEHAVIOR OF PVD-BASED Y-SILICATE ENVIRONMENTAL BARRIER COATINGS FOR SIC-SIC CMC

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Ceramic matrix composites (CMCs) are promising materials for components in the hot section of gas turbines and are already applied in the latest generation of aero-engines. They can withstand higher service temperatures than the currently used Ni-based superalloys. However, SiC-SiC CMCs possess an insufficient oxidation resistance under the presence of rapidly flowing water vapor as it is present in combustion atmospheres. They suffer from both volatilization of silicon hydroxide, which leads to severe surface recession, and steam enhanced oxidation. Therefore, environmental barrier coatings (EBCs) are mandatory that protect the underlying CMC. In this presentation, multilayer EBCs manufactured by PVD methods are introduced. Both SiC-based CMCs and model SiC-alloys were coated by magnetron sputtering processes with a first layer of an oxide-modified silicon as the bond coat, an intermediate layer of a rare-earth di-silicate, and a mono-silicate layer for protection against water vapor recession. The coating architecture was designed to minimize chemical interactions between different layers and to have a strain tolerant microstructure. Samples were tested up to 1250°C in air in a furnace cycle test and under flowing water vapour at isothermal conditions. The EBC system showed no spallation after up to 1000hrs of cyclic testing and retains stable interfaces between the layers. Special emphasis is put on the phase formation during a mandatory heat treatment of the initially amorphous layers. While the uncoated substrate suffered from severe degradation under flowing water vapor and showed rapid loss of the matrix material after only 1h of testing, the EBC considerably lowered the mass loss and provides a good protection of the CMC in this test. The evolution of the microstructure of the coating layers during testing, interfacial reactions, and phase formation will be presented based on XRD and TEM investigations. Finally, the perfect coverage and good adhesion of PVD-based EBCs on sharp edges such as a trailing edge of a vane is addressed.