TBC systems on gamma titanium aluminides

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Titanium aluminides based on γ-TiAl are considered as promising candidates for high temperature applications in automotive and aero engines. However, their oxidation resistance is insufficient at temperatures above 800°C. To increase the service temperature the use of protective coatings is a suitable method to improve the oxidation resistance of γ-TiAl components. Thermal barrier coatings (TBCs), widely applied in aero-engines and land-based gas turbines, enable to reduce the surface temperature of components with internal cooling and can be used to enhance the durability of the component or to increase the gas temperature. Typical TBC systems consist of an yttria stabilized zirconia layer, a bond coat, the high temperature material, and a thin thermally grown oxide between bond coat and ceramic topcoat. The present lecture reports on the performance of TBC systems on γ-TiAl alloys using different oxidation resistant coatings as bond coats.

The oxidation protective coatings were produced by magnetron sputtering techniques, pack cementation or the halogen effect, including CrAlYN/CrN nanoscale multilayer coatings, CrAlYN thin films, intermetallic Ti-Al-Cr based layers, a two-phase aluminide coating and a fluorine treated surface zone. On the coated γ-TiAl samples, thermal barrier coatings of 7wt% yttria stabilized zirconia were deposited using electron-beam physical vapour deposition. Lifetimes of the different TBC systems were determined in the temperature range between 900 and 1000°C performing cyclic oxidation tests in laboratory air. Mass change data were measured during exposure up to failure or the maximum exposure length of 1000 1-h cycles. Post-oxidation analysis of the coating systems was carried out using scanning electron microscopy and energy-dispersive X-ray spectroscopy. Based on mass gain data and microstructural analyses the oxidation protection capability of the bond coats was evaluated and failure mechanisms of the TBC systems were discussed.