THE INFLUENCE OF HEATING AND COOLING RATES ON TBC FAILURE IN HIGH HEAT FLUX TESTS

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High heat flux testing is a commonly used procedure to investigate TBC failure modes. Samples of TBC on superalloy are thermally cycled, with the TBC being heated and the superalloy subjected to forced cooling in order to induce a temperature gradient. Typically conditions are deliberately chosen to be more aggressive than in the engine in order to induce TBC delamination or complete spallation within a few days. We have developed a test bench with a CO2 laser as the heat source which, unlike the more commonly used burner rigs, allows exquisite control of the heating and cooling rates. An optical system detects the hot spots which are caused by TBC delamination. We experimentally validate a two-phase model for TBC failure. In Phase I a vertical crack is driven from the TBC surface down towards the bond coat, which requires a sufficiently high cooling rate. This acts as a starting defect for Phase II, in which a horizontal crack propagates and causes delamination / spallation, which requires a sufficiently high heating rate. In general, we find that heating and cooling rates are a more useful tool to probe TBC robustness than surface temperature or number of thermal cycles.