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TBC lifetime under thermal gradient cyclic testing with simultaneous CMAS attack: Towards prediction of advanced TBC performance

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Degradation of thermal barrier coatings (TBCs) in gas-turbine engines due to calcium–magnesium–aluminosilicate (CMAS) glassy deposits from various sources has been a persistent issue since many years. Understanding of the mechanism of CMAS induced degradation of TBC as well as approaches for mitigating CMAS attack by means of advanced TBC compositions have grown remarkably. However, most of the reported results have been obtained from isothermal lab testing or evaluation of ex-service components either. In this study a burner rig facility has been used for the evaluation of TBC performance, where a thermal gradient is applied across the TBC, with simultaneous injection of CMAS to simulate the conditions closer to actual service in an engine while preserving full control on important degradation limiting parameters. Tests have been performed on the state of the art material YSZ as well as on advanced TBC systems comprising top coats from pyrochlores, garnets or hexaaluminates. In addition, load parameters including composition and deposition rate of CMAS, surface temperature and high temperature dwell times have been varied systematically. Tests have been evaluated by means of SEM, EDX and XRD to check for chemical interaction and degradation mechanism. Major impacts on thermal gradient cycling lifetime as well as similarities and discrepancies related to prior reported chemical degradation and mitigation mechanism are reviewed. Implications towards the implementation in life time prediction models are also drawn.

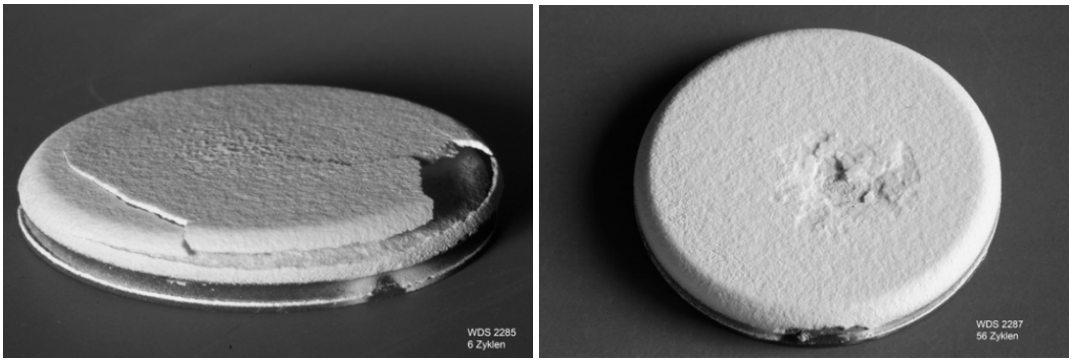

Figure 1 – CMAS induced failure of TBC ceramic topcoats differing in modes of delamination and cycling lifetime correlated to specific load conditions.