

EXPERIMENTAL MEASUREMENTS OF THERMAL BARRIER COATING INTERFACIAL FRACTURE TOUGHNESS AS A FUNCTION OF MODE-MIX

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Mechanism-based lifetime assessment models of thermal barrier coating (TBC) systems rely on accurate knowledge of the experimentally measured interfacial fracture toughness over a range of mode mix and especially at mode II. Previously, no reliable test method had been employed to evaluate these properties under pure mode II conditions, which are most representative of critical TBC spall delamination upon turbine engine cool down. We have used conventional 4-point bend experiments and a newly developed compression edge-delamination (CED) methodology to make direct measurements of coating interfacial toughness as a function of mode mix. The material system examined was provided by collaborators at GE and consists of an Electron-Beam Physical Vapor Deposited (EBPVD) 7% Ytria-Stabilized Zirconia (YSZ) top coat, which is deposited on a Pt-modified diffusion aluminide β -(Ni,Pt)Al bond coat on a single crystal René N5 substrate. CED tests showed that thermal cycling caused a 50% reduction in mode II interfacial toughness. Results for as-deposited samples tested using a modified 4-point bend technique match previously reported data, and a toughness function for the as-deposited interfacial toughness vs. mode mix has been developed using results from this study and from previously reported values. Crack face friction has also shown to play a profound role in calculation of the interfacial toughness, and details regarding the characterization and implementation into the finite element model used to extract the interfacial toughness will be examined. Finally, microstructural observations, including morphological and chemical changes, linked to the degradation of the coating interfaces due to thermal cycling will be analyzed.

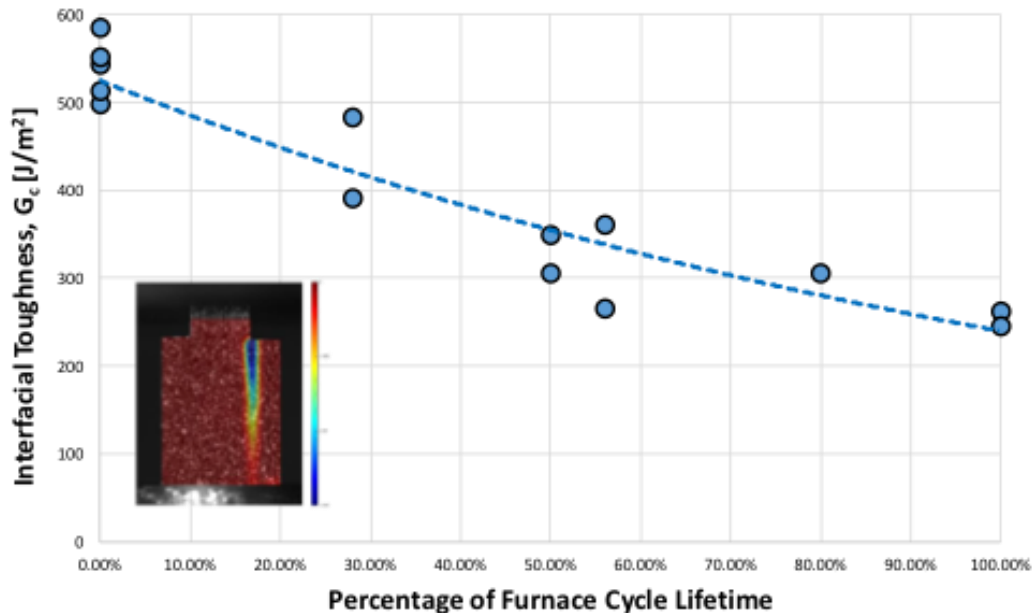


Figure 1 – Mode-II interfacial fracture toughness of an EBPVD 7%YSZ topcoat on a Pt-modified diffusion aluminide bond coat on a single crystalline René N5 substrate measured as function of furnace cycle lifetime.