EXPERIMENTAL CHARACTERIZATION OF ELASTIC STIFFNESS AND DELAMINATION TOUGHNESS IN COMMERCIAL THERMAL BARRIER COATING SYSTEMS

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Layered thermal barrier coating (TBC) systems used in jet engines consist of a nickel-based superalloy substrate, intermetallic bond coat, thermally grown oxide (TGO) and a electron beam physical vapor deposition (EBPVD) 7% yttria-stabilized zirconia (7YSZ) top coat. Thermal protection is only provided when the TBC remains attached to the substrate, and mechanism-based lifetime assessment models rely on accurate knowledge of the experimentally measured interfacial fracture toughness and the topcoat modulus. We are employing 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. Of special interest are the CED specimens, which provide a direct measure of mode-II delamination toughness of the coating. In a parallel study, novel micro-bend techniques are being employed to measure the elastic modulus of both attached and freestanding EBPVD 7YSZ topcoats. Results for commercial TBC systems provided by industrial collaborators will be presented and used to characterize the effect of mode mix and various manifestations of thermal cycling on these material properties.