Announcing the Final Examination of Sanna Siddiqui for the degree of Master of Science

Time & Location: June 30, 2014 at 9:00 AM in Engr 1 288
Title: Synchrotron X-Ray Diffraction and Piezospectroscopy Used for the Investigation of Individual Mechanical Effects from Environmental Contaminants and Oxide Layer Undulation in Thermal Barrier Coatings

The durability of Thermal barrier coatings (TBCs) used on the turbine blades of aircraft and power generation engines has been known to be affected by sand particle ingestion comprised of Calcium-Magnesium-Alumina-Silicate (CMAS). Previous studies have shown that these effects present themselves through variations in the thermomechanical and thermochemical properties of the coating. This study investigated the impact of CMAS ingestion on the YSZ Topcoat and Thermally Grown Oxide (TGO) strain in sprayed Thermal Barrier Coating (TBC) samples of varying porosity with and without CMAS ingestion. In-Situ Synchrotron X-ray Diffraction measurements were taken on the sample under thermal loading conditions from which the YSZ and TGO peaks were identified and biaxial strain calculations were determined at high temperature. Quantitative strain results are presented for the YSZ and TGO during a thermal cycle. In-plane strain results for YSZ near the TGO interface for a complete thermal cycle are presented, for a 6% porous superdense sample with CMAS infiltration. The outcomes from this study can be used to understand the role of CMAS on the strain tolerance of the TBC coating.

It is well known that under engine operational conditions the development of the TGO layer, with large critical stresses, has been linked to failure of the coating. The growth of the TGO manifests as undulations in a series of peaks and troughs. Understanding the mechanics of the oxide layer at these locations provides significant information with respect to the failure mechanisms of the TBC coating. This study investigated the stress at the peak and trough of a TGO undulation for a cycled Dense Vertically Cracked (DVC) plasma sprayed TBC sample through photo-luminescence (PL) spectroscopy. High resolution nanoscale stress maps were taken nondestructively in the undulation of the TGO. Preliminary results from first line mapping of TGO peak and trough scan, at a resolution of 200 nm, have shown a non-uniform TGO stress variation. The results obtained from this study can be used to understand the stress variation in the peak and trough of a DVC sample's TGO undulation and how it contributes to the life of the TBC coating.

Major: Mechanical Engineering

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Bachelor’s of Aerospace Engineering, BS, 2012, University of Central Florida

Committee in Charge:
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Approved for distribution by Dr. Seetha Raghavan, Committee Chair, on June 13, 2014.

The public is welcome to attend.