Thermal Barrier Coatings have been extensively used to protect and insulate the metallic components in turbine engines from extreme environments to achieve higher turbine inlet temperatures, resulting in an increase in combined engine cycle efficiency, lowering NOx emissions and fuel consumption. Additionally, as the major failure mechanisms determining lifetime are thermally activated during engine operation, uncertainty in temperature measurements affects lifetime prediction. Early detection of Thermal Barrier Coatings spallation symptoms, associated with local delamination induced temperature changes, can reduce forced engine outages. Further improvements are envisioned with the development of more reliable measurement techniques. For this purpose, Phosphor Thermometry has been considered a promising method for precision monitoring of turbine blade coatings that contain embedded phosphor dopants. In this work, a modified four-flux Kubelka-Munk model for luminescent rare-earth doped Thermal Barrier Coating configurations supported the design and the fabrication of viable sensing coatings for potential industrial implementation. Phosphor Thermometry instrumentation was developed with the objective of expanding capabilities of the technique, using a synchronized acquisition method on sensing coatings. Experiments on an innovative Erbium-Europium co-doped Yttria-Stabilized Zirconia coating have demonstrated the effectiveness of this advanced Phosphor Thermometry instrument with enhanced sensitivity and extended temperature range. Delamination progression monitoring was achieved for the first time using a Thermal Barrier Coating configuration subjected to indentation that includes a thin luminescent layer deposited on surface and associating the multi-layer configuration with a predictive model that evaluates the advancement of the degradation of the coatings. To further ensure the integrity of the phosphor doped coatings, synchrotron X-ray diffraction was performed to characterize the specific residual strains and thermal expansion of the materials, determining mechanical robustness and compatibility with state-of-the-art Thermal Barrier Coatings. The outcomes of this work pave the way for in-situ temperature measurements on phosphor-doped turbine blade coatings with increased performance and accuracy.

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The public is welcome to attend.