Southern University

Thermal Characterization of Novel Thermal Barrier Coatings (TBC)

This research involves the evaluation of thermal properties of yttria stabilized zirconia (YSZ) TBC coatings processed using air plasma spray (APS) methods for turbine and other industrial applications. The samples will be characterized using differential scanning calorimetry, thermo-gravimetric measurement techniques, and thermal conductivity measurement techniques. The investigation on conductivity measurements may involve the following characterization: i) conductivity as a function of porosity/crack density, ii) thickness, temperature and iii) thermal shock resistance of the coated substrate (with & without temperature gradients) will be characterized. Also effects of YSZ powder particulate size (variations of nano-particulates) on above attributes will be studied. The approach for the conductivity measurements will be to use steady state and transient state LASER heat flux method.

In order to accurately characterize the thermophysical properties of the specimens in this study testing is also needed to obtain other properties such as cp and density (ρ) of the TBCs so that the thermal conductivities can be obtained within limits of experimental uncertainty. In addition, the effect of interface thermal resistance of the bond coats has to be taken into account, in other words a three layer analyses is required. Therefore, the following testing sequence is proposed for characterizing the 100HE and APS with different bond coat materials:

1. Perform two-layer laser flash testing on a coated substrate with bond coat only to accurately obtain the thermophysical properties of the bond coat.
2. Perform three-layer laser flash testing on a coated substrate with bond coat and 8% YSZ TBC as in this study but accounting for the interfacial resistance of the bond coat to accurately obtain the thermophysical properties of the TBC layer.
3. Conduct a study on porosity effect of the TBC layer. Using a density porosimeter the pore sizes of the TBC layer will be measured. This will allow for characterizing the effect of pose size on the thermo-physical properties
4. Thermal cycling and microstructure degradation studies using our newly acquired thermal cycling furnace and SEM.

The results will be used to develop a database of properties that maybe used for recommending insulating properties of YSZ based TBCs and for use in thermo-mechanical in-service performance analyses of the coating and alloy substrates.