IN SITU HEATING STUDIES ON THE INTERNAL STRESSES OF MULTILAYER ENVIRONMENTAL BARRIER COATINGS

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Silicon-based ceramics such as SiC and Si_3N_4 are promising materials for use in gas turbine engines due to high melting temperatures and excellent thermomechanical stability. Unfortunately the SiO_2 layer on surface of these materials reacts with water to form $SiO(OH)_2$ that volatizes in the high pressure and gas flow of combustion environments. Environmental barrier coatings (EBCs) were developed to protect the underlying component from recession. However, mismatch of the coefficient of thermal expansion (CTE) in these coating systems results in stresses that can cause cracking or spallation, which exposes the substrate to the combustion atmosphere and drastically reduces component lifetime. State-of-the-art coatings for SiC/SiC composites consist of a $Ba_{1-x}Sr_xAl_2Si_2O_8$ (BSAS) topcoat, a mullite or mullite + $SrAl_2Si_2O_8$ (SAS) interlayer, and a silicon bond coat. When heated above 1200°C, the as-deposited BSAS undergoes a crystallographic transformation accompanied by a change in volume and CTE reduction. Internal stresses in these candidate systems were investigated using microfocused high-energy X-rays in a transmission diffraction geometry. Strains were measured *in situ* during cooling from 900°C in samples with a metastable hexacelsian or a stable celsian BSAS topcoat, and converted to stresses using X-ray elastic constants, where available. Changes in the CTE of the BSAS layer influenced the sign and the magnitude of the stresses in the other coating layers. In addition to stress measurements, the CTE of the EBC materials were measured. The coating CTE values and elastic properties were used to model the evolution of coating stresses versus temperature, which were compared to the measured X-ray internal stresses.

Information Page:

This abstract is being submitted for the Denver X-ray Conference.

I hereby give permission to post this abstract on the DXC web site and all affiliated web sites.

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I would prefer an oral presentation in the "High Temperature In-Situ Analysis" session.

I am intending to enter the Jerome B. Cohen Student Award contest, which I believe means that this paper will be submitted to the DXC proceedings.