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N95- 26134

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MECHANICAL PROPERTIES TESTING AND RESULTS FOR THERMAL BARRIER COATINGS

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Thermal Barrier Coatings (TBC's) provide a significant challenge in the evaluation of their mechanical properties in ways that provide data that is not specimen dependent. The paper reviews various developments of the principal author over the past several years for both plasma sprayed and physical vapor deposited (PVD) materials, as well as new data on the fatigue behavior of one material system. The test methods that have been employed address tensile and compressive modulus and ultimate strength, tensile and compressive fatigue strength, and interfacial strength, which testing is now underway.

Property testing is especially difficult for TBC's owing to the limitation on fabrication thickness of the coating. Bending tests are not used as these tests do not provide sufficiently uniform states of strain for property evaluations. Test specimens with uniform states of axial stress have been devised for each material system. The results show that the material property results between various experimentors and experimental methods are not yet consistent. However, the results provide critical design data at a suitable level of accuracy for life prediction.

The paper will review both tensile and compressive mechanical testing of uniaxial specimens showing property dependencies on material density and temperatures for both material systems. Successful test results for both tensile and compressive fatigue loadings will be given. The test data shows that the fatigue strength of the TBC's is highly stress dependent in both loading conditions and is likely to depend on stress range and not mean stress. The fatigue strength of the plasma sprayed TBC's appears to increase with elevated temperatures in a range of temperatures below the creep activation temperature for the materials. The plasma sprayed TBC materials have been confirmed to have cyclic hysteresis at all temperature levels down to room temperature. Limited failure analysis data for various specimens suggest that the failure modes are driven by normal geometric discontinuities in the TBC's.

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