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Fabrication and Characterization of Advanced Thermal Barrier Coatings for Hydrogen-fueled Gas Turbine Application: A Sintering Resistance in Water-vapor Environment

Ni-based superalloys are widely used in the hot sections of gas turbines due to their high melting points and mechanical strength. To protect these components from extreme temperatures, refractory ceramic thermal barrier coatings (TBCs) are applied. Recently, efforts to replace liquefied natural gas (LNG) with hydrogen fuel have been pursued to reduce greenhouse gas emissions. However, hydrogen combustion raises the turbine inlet temperature (TIT) to about 1500–1600 ℃ and creates a water-vapor-rich environment. Conventional TBCs such as 8 wt.% yttria-stabilized zirconia (8YSZ) exhibit limitations under these conditions due to phase transformations, sintering, and increased thermal conductivity from high-temperature degradation and water vapor exposure. Therefore, thermally and chemically stable materials are required for hydrogen-fueled turbines.

This study investigates advanced TBC materials that can replace 8YSZ or be used as multilayer coatings. Multi-component rare-earth-stabilized zirconia materials were fabricated and characterized for their thermal, thermophysical, microstructural, and phase behavior. The coatings were tested in dry and steam atmospheres for various durations to examine sintering behavior, and sintering resistance was evaluated through microstructural analysis.

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Doctoral or Master Student

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Yes

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