University of Texas at San Antonio

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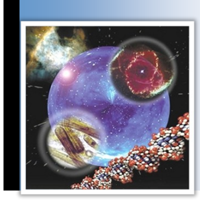
Thermal Barrier Coatings as Enablers of Energy Efficiency: Design Concepts and Fundamental Challenges

Thermal barrier coatings (TBC) are now enabling materials in the design of advanced gas turbines with improved efficiency for propulsion and power generation. Zirconia with 7±1wt%Y_2O_3 (7YSZ) has been the standard TBC material since their commercial insertion. The demands for increased engine performance and fuel flexibility translate into higher temperatures, ≥1300°C, and more aggressive operating environments for TBCs, motivating the search for alternate insulating oxides. Candidate materials are mostly based on ZrO_2 with rare earth and/or or transition metal additions. Two groups emerge, one based on the non-transformable tetragonal (t') form of ZrO_2, and the other on rare earth zirconates. Unfortunately no candidate in either group meets all the requirements for the more advanced applications. Tetragonal materials are endowed with toughening mechanisms that underpin their durability. However, as the engine temperature increases they are compromised by sintering, destabilization of the t' phase, and by penetration of molten silicate deposits. In contrast, the zirconate materials are phase stable and offer improved resistance to sintering and silicate penetration, but are limited by the absence of intrinsic toughening mechanisms, thermochemical interactions with the thermally grown oxide that protects the underlying alloy, and often by processability. This presentation will discuss the scientific foundation of the design strategies for these materials and the challenges ahead.



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