Thermal barrier coatings based on zirconia stabilized with charge compensating cations

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Research into low thermal conductivity zirconia based ceramics has provided a large variety of candidates for next generation thermal barrier oxides. Many of these candidates, however, have unacceptable trade-offs in toughness or phase stability. One interesting group of materials offers lower thermal conductivity, phase stability at temperatures well above current use, and toughness on par with standard 7YSZ. These materials are based upon zirconia co-doped with equal amounts of trivalent and pentavalent stabilizers, i.e. charge compensation requiring no additional anion vacancies. The highest dopant concentrations can lead to full stability against partitioning at temperatures as high as 1500°C, and against the monoclinic transformation upon cooling. The prototype system is ZrO_2-$YO_{1.5}$-$TaO_{2.5}$, but other rare earth stabilizers are of interest to further reduce thermal conductivity and Nb is an alternative to Ta. The viability of different systems is discussed, emphasizing recent work on Yb+Ta, and Y+Ta co-doped zirconias with regards to phase equilibria and thermal conductivity.