REACTIONS OF RARE EARTH HAFNATES AND ZIRCONATES WITH SILICATE MELTS OF DIFFERENT BASICITY

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The drive to replace superalloys with SiC ceramic matrix composites in the hottest sections of gas turbine engines requires new protective coatings with higher temperature capabilities. Molten silicate deposits represent a fundamental barrier to progress in engine technology since the deposits degrade all coating materials of interest. One promising mitigation strategy for segmented coating microstructures is that of reactive crystallization, wherein the coating vigorously reacts and forms kinetically stable products that fill in the flow channels and arrest melt infiltration. Rare earth-stabilized zirconates have demonstrated desirable performance up to ~1300°C, but there is a paucity of data on their hafnate counterparts, which typically have slightly lower coefficients of thermal expansion and slightly higher temperature stability. Moreover, there is inadequate understanding of the relative response of hafnates and zirconates to melts of different chemical compositions. This research compares the behavior of both rare-earth zirconates and hafnates and their reactions with quinary (Ca, Mg, Fe, Al, Si) silicate melts at temperatures in excess of 1400°C. The implications for applications in gas-turbine coatings are discussed.

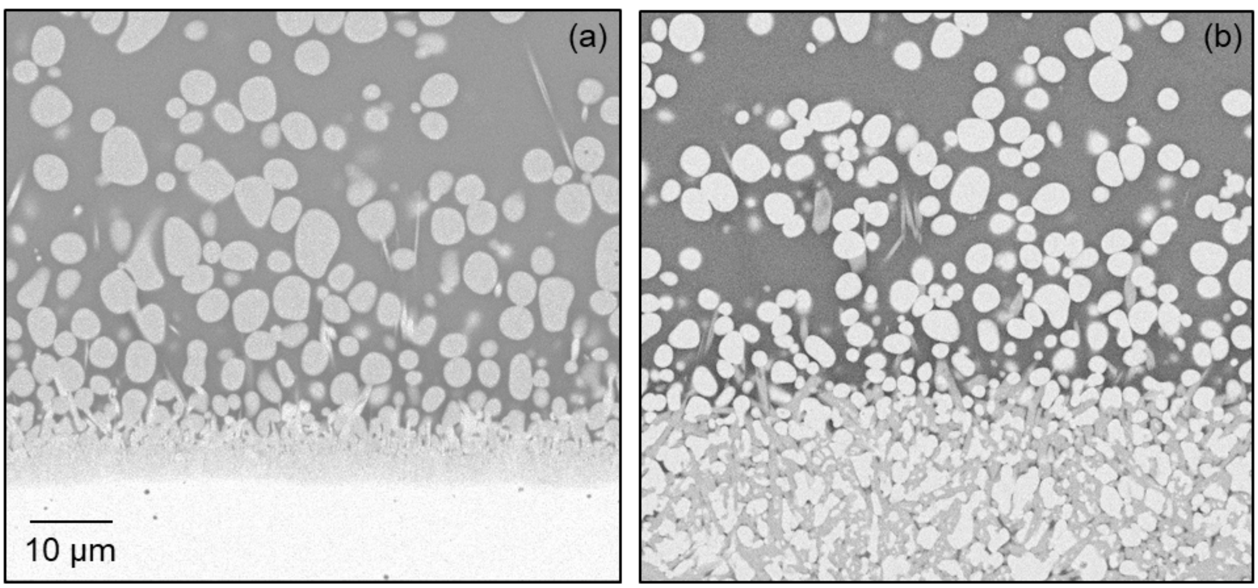

Figure 1 – BSE images showing (a) a dense microstructure on the surface of a $Gd_2Zr_2O_7$ compact following a 1-h exposure at 1400°C to a CMFAS deposit with Ca:Si=0.21 and (b) a reaction front containing intergranular glass on the surface of a $Gd_2Hf_2O_7$ compact following the same exposure.