Fracture behavior and thermal durability of lanthanum zirconate based thermal barrier coatings with buffer layer in thermally graded mechanical fatigue environments

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The effects of buffer layer on the fracture behavior and lifetime performance of lanthanum zirconate ($La_2Zr_2O_7$; LZO)-based thermal barrier coatings (TBCs) were investigated through thermally graded mechanical fatigue (TGMF) tests, which is designed to simulate the operating conditions of rotation parts in gas turbines. To improve the thermal durability of LZO-based TBCs, composite top coats, consisting of two feedstock powders of LZO and 8 wt% yttria-doped stabilized zirconia (8YSZ), were prepared by mixing in different volume ratios (50:50 and 25:75, respectively). In addition, buffer layers were introduced in layered LZO-based TBCs deposited using an air-plasma spray method. The TGMF tests with a tensile load of 60 MPa were performed until 2000 cycles at a surface temperature of 1100℃ for a dwell time of 10 min, and then the samples were cooled at room temperature for 10 min in each cycle. For the single layer TBCs, the thermal durability was enhanced by controlling the LZO:8YSZ ratio as 25:75 vol.%. The TBC with the double buffer layer showed the best thermal cycle performance among all samples, suggesting the buffer layer was efficient in improving lifetime performance. It is noted that failure modes were different in TBC samples. Delamination and/or cracks were created at the interface between the bond and top coats or above the interface in the single-layer TBCs, but the TBCs with the buffer layer was delaminated and/or cracked at the interface between the buffer layer and the top coat, independent of buffer layer species. This study allows us to further understand the LZO-based TBC's failure mechanisms in operating conditions, especially in the thermal and mechanical environments, in order to design reliable TBC systems.