SIMULTANEOUS RESIDUAL STRESS MAPPING OF TOPCOAT AND TGO IN APS TBC USING COMBINED MICRO-RAMAN-PL SPECTROSCOPY

Srikanth Batna, Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology, India
srekant.b@gmail.com
G. Siva Kumar, International Advanced Research Centre for Powder Metallurgy and New Materials, India
Ashutosh S. Gandhi, Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology, India

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Non-destructive evaluation of thermal barrier coatings (TBCs) using Raman and photoluminescence (PL) spectroscopic techniques have drawn considerable attention for structural health monitoring of gas turbines. The inherent advantages of high spatial resolution and penetration depth offer ease of measuring stress induced in TBCs subjected to prolonged thermal exposure. In the present work, we endeavoured to explore the efficacy and capabilities of the Raman spectroscopy as a tool to evaluate stress in APS based 7 wt% yttria stabilized zirconia TBCs. Raman spectra using 633 nm laser were obtained from the specimens subjected to isothermal heat treatment at 1000°C for various ageing up to 1000 hours. Simultaneous Raman and PL mapping was carried out from same location (2 x 2 mm^2) in topcoat, and TGO by probing through the topcoat. Stress maps were plotted to understand the local stress variation and track the evolution of stress in the topcoat and thermally grown oxide (TGO) with ageing. Histogram plots for the TGO stress maps indicated the spread in stress data due to heterogeneity. Average values of stress maps were calculated with ageing. Tensile stress was present in all topcoats varying from 80 ± 14 MPa for 100 h ageing, to 120 ± 13 MPa for 1000 h, with a steady increase in stress. Average stress in TGO was found to be varying in the range of -1.6 GPa to 1 GPa. The Raman mapping also revealed the variation in monoclinic phase distribution with ageing. These results suggests that using simultaneous Raman-PL mapping, stress evolution in TBC and TGO, and also phase evolution can be investigated at the same time.

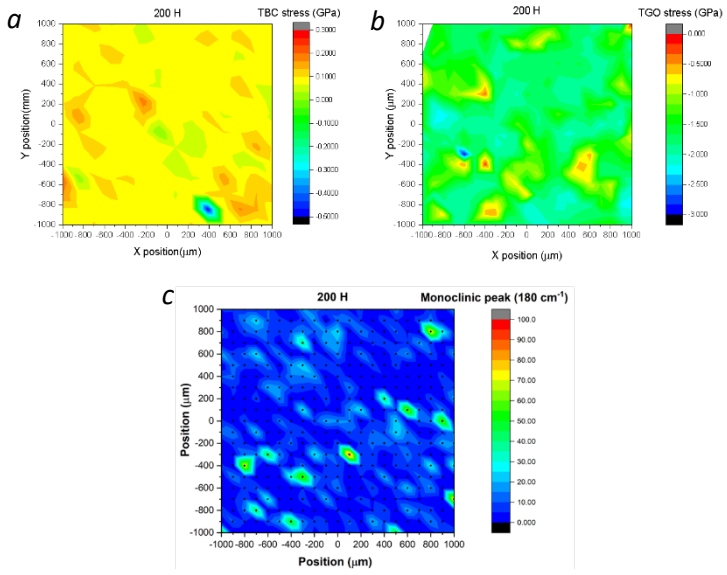

Figure 1 2D maps showing stress variation in a TBC and b TGO c monoclinic phase precipitation in 200 hours annealed sample