EFFECT OF COOLING RATE ON PHASE TRANSFORMATION IN 6-8 WT % YSZ APS TBCs

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In properly produced as-sprayed thermal barrier coatings of yttria partially stabilized zirconia (7YSZ) the only phase that can be found is the metastable tetragonal prime structure t'. Even though t' is sometimes called "not transformable", because it behaves as practically stable up to rather high temperature, long term exposure much above 1200 °C produces its equilibrium transformation in tetragonal and cubic phases. During cooling down to room temperature the tetragonal phase will transform in monoclinic one. Although it is considered a martensitic transformation, fast cooling after prolonged high temperature exposure (over 1300°C) can avoid or limit the evolution from tetragonal to monoclinic structure. The effect of the cooling rate on this transformation has been investigated in free standing TBCs both with porous microstructure and dense vertically cracked one, exposed at 1400°C for 100 hours. The samples have been analysed by XRD and subsequent Rietveld refinement analysis to quantify the phase content: the results highlight that different cooling rates give different monoclinic contents, confirming the cooling rate effect on the transformation. If the phase equilibrium was not achieved due to fast cooling, it could be restored at low temperature for short duration independent of cooling rate. It was demonstrated that after exposure at 1400°C followed by fast cooling, the equilibrium phase composition could be achieved by a low temperature heat treatment of 12h at 200°C. For validation, the quantitative phase analysis has been performed before and after that low temperature heat treatment. Moreover the unit cell volume per each phase has been measured, for both samples at equilibrium and samples after fast cooling. Therefore the strain induced by the volume increase due to monoclinic phase formation has been calculated and compared with TBC maximum allowable strain.