A COMPARATIVE STUDY OF PHASE EVOLUTION IN YSZ POWDERS, PELLETS AND FREE-STANDING AIR PLASMA SPRAYED THERMAL BARRIER COATINGS

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Low thermal conductivity, high thermal expansion coefficient, and excellent fracture toughness of *t'* yttria stabilised zirconia (YSZ) make it the material of choice for TBCs in gas turbines. However, with thermal exposure, the metastable *t'* experiences phase transformations. The mechanism of this transformation is still a subject of debate. Various phase assemblies have been reported in the literature, consisting of one or more of the following: tetragonal zirconia phases (*t*, *t'* and *t"*), cubic fluorite, and monoclinic zirconia (*c* and *m*). To address this concern, the present study reports the phase evolution behaviour observed in YSZ powders, pellets and air plasma sprayed coatings. For investigating phase transformations at temperatures above and below the $T_{0(c/t)}$ curve in the yttria-zirconia phase diagram, 1300°C and 1700°C temperatures were chosen for aging powders synthesized using solution combustion route, and pellets. Phase stability of air plasma sprayed commercial purity (CPYSZ) and high purity (HPYSZ) free-standing coatings exposed to heat treatment at 1200°C, 1250°C and 1300°C for periods ranging from 0.5 h to 512 h was also examined. Room temperature X-ray diffraction (XRD) and Raman spectroscopy have been used for phase identification and quantification. XRD profile analyses revealed that the initial *t'* phase gradually transformed into yttria lean tetragonal (*t*) and yttria rich cubic (*c*) phases on aging of powders and pellets at 1300°C. In contrast, after heating at 1700°C, *t* and *t"* were the phases observed. In the APS coatings, aging at 1300°C led to the emergence of *t* and *c* as well as the retention of *t'*. The *t'* disappeared after 256 h at 1300°C. It is also worth noting that the cubic phase as well as the monoclinic phase emerged earlier (at lower thermal exposure) in CPYSZ coatings as compared to HPYSZ. The quantitative changes in Raman spectra with respect to aging temperature and time also provide useful insights in tracking the phase transformations. To summarize, the evolution of various discernible phases (*t'*, *t*, *t"*, *c* and *m*) was thoroughly explored and compared on the basis of the starting material (powders, pellets and APS coatings, purity) and the thermal exposure conditions.

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