XRD residual stress characterization of air plasma sprayed RE-zirconates type of ceramic coatings

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Abstract

Residual stress, especially the thermal stress, is a dominant factor causing reliability problems of high-temperature coatings and may influence some key performances of coatings, such as the resistance to spalling, delamination, surface crack, etc. The failure expected in a coating system can be predicted based on the knowledge on residual stresses, their redistribution, and the external loads, as well as the interface response. Generally, the magnitudes and distributions of the residual stresses within a high-temperature coating are dependent not only on the thermal history during coating deposition process and the deposition characteristics.

The study has been done on AMS 5599 type alloy with 4 different type of ceramic coatings. In all the specimens Ni23Co17Cr12,5Al0,45Y VPS-sprayed powder was employed as the interlayer. Rare earth zirconates powders was used for the outer layer air plasma spraying of $Gd_2Zr_2O_7$, $La_2Zr_2O_7$, $Sm_2Zr_2O_7$, $Nd_2Zr_2O_7$ type, and for comparison conventional 8YSZ (yttria stabilized zirconia) powder. In addition to that, microstructural analysis has been done.

The stress measurement was made with accordance to "A National Measurement Good Practice Guide. No 52. Determination of residual stress by X-ray diffraction – Issue 2". X-ray measurements in the mode Θ–2Θ angles in the range of 20–80° using Cu Kα (40 kV, 20 mA) radiation in steps of 0.02 were performed in order to access the structural characterization of the coatings. Residual stresses were determined by X-ray diffraction using the $\sin^2\psi$ technique (omega method). Measurements of lattice plane of each type of ceramic coatings were performed to obtain the coatings surface strains. The diffraction angle for those planes occurred for example at about 2Θ =144.58 for 8YSZ and 2Θ =146,45 for $Sm_2Zr_2O_7$ coating and. The ψ angle was scanned from -25° to 25° by steps of 5° in order to get the interplanar distance d_ψ. The biaxial stresses in the plane parallel to the interface were calculated considering an isotropic biaxial stress distribution with s_{33}=0. The XRD spectra were acquired for the as-sprayed coatings at initial conditions.

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