A STUDY OF RESIDUAL STRESSES IN VACUUM PLASMA SPRAYED TUNGSTEN COATINGS

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Thick tungsten coatings are potential plasma facing materials in fusion reactors but the coefficient of thermal expansion (CTE) mismatch between W and Cu or steel substrates leads to large thermally induced stresses and premature failure. While inter-layers can be used to grade and distribute stresses away from a discrete planar tungsten-steel interface, in the present study an alternative approach was used based on patterning of the interface with repeating mm-scale 3D features or "sculptures". Up to 2mm thick W coatings were manufactured directly on water-cooled patterned substrates using vacuum plasma spraying (VPS), without any inter-layers. Synchrotron-based white beam, high energy X-ray diffraction measurements [1] of lattice parameters was used to obtain maps of residual strains and stresses in the VPS tungsten. Residual elastic lattice strains were deduced from energy-dispersive diffraction profiles collected by two detectors mounted in the horizontal and vertical diffraction planes, providing information about lattice strains in two nearly perpendicular directions lying in the plane of the coating. On the basis of these data, maps of residual stresses in the VPS coatings were constructed. The findings are discussed in the context of the geometry of the substrate-coating interface and any inelastic processes operating to relieve and manage successfully the thermal expansion mismatch induced stresses.

[1] A. M. Korsunsky, S. P. Collins, R. A. Owen, M. R. Daymond, S. Achtioui and K. E. James (2002) "Fast residual stress mapping using energy-dispersive synchrotron X-ray diffraction on station 16.3 at the SRS", J. Synchrotron Rad. **9**, 77-81.