

APPLICATION OF X-RAY DIFFRACTION STRESS ANALYSIS AT CONSTANT PENETRATION DEPTH FOR THE DETERMINATION OF BOTH REAL-SPACE RESIDUAL-STRESS AND LATTICE-PARAMETER GRADIENTS

M. Wohlschlägel, U. Welzel* and E.J. Mittemeijer

Max Planck Institute for Metals Research, Heisenbergstr. 3, D-70569 Stuttgart, Germany

* contact author; u.welzel@mf.mpg.de

A γ' -Fe₄N_{1-x} layer on a α -Fe substrate (thickness 6 μm) has been produced by gas nitriding in a quartz-tube furnace. As a consequence of the specimen-preparation process a nitrogen concentration-depth profile is built up in the layer, thus causing a combined lattice parameter- and residual stress-depth gradient. The analysis of such combined gradients by X-ray diffraction is complicated by the fact that the asymmetry of the measured diffraction line is a function of the orientation of the diffraction vector with respect to the specimen surface normal. In the current study the unraveling of the residual stress and the strain-free lattice-parameter depth profiles has been realized by X-ray diffraction stress analysis at constant penetration depths employing the combined ω/χ mode. In order to cover a large range of penetration depth different photon energies have been employed using a laboratory diffractometer and a synchrotron beamline. The $\sin^2\psi$ method was adopted to calculate the residual stress gradient and the strain-free lattice parameter gradient was determined by measurement along the strain-free direction. Real-space profiles for residual stress and strain-free lattice parameter were obtained by fitting calculated to measured Laplace-space (penetration-depth) profiles. The systematic change of diffraction line asymmetry with measurement direction has been accounted for using the centroid of the measured diffraction line as diffraction-line position. The results for the concentration-depth profile (as follows from the strain-free lattice parameter depth profile) and the stress-depth profile are discussed with reference to literature data.