

**X-RAY DIFFRACTION AT CONSTANT PENETRATION DEPTH:  
A VIABLE APPROACH FOR CHARACTERIZING  
STEEP RESIDUAL STRESS GRADIENTS**

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The experimental analysis of near-surface residual stresses by X-ray diffraction methods is based on measuring the spacings of lattice planes while the inclination  $\psi$  with respect to the surface plane is changed stepwise. A characteristic feature of conventional techniques is that the penetration depth of the X-rays is altered as inclination is varied. By simultaneously varying three different goniometer angles in a particular fashion, both the penetration depth and the measuring direction can be held constant while  $\psi$  is varied. Thus the normal and shear stresses can be derived from the  $\sin^2\psi$  plots by means of standard evaluation procedures developed for gradient-free stress states. The depth profile of residual stress is then obtained via Laplace transformation of the results from several stress measurements carried out at different penetration depths.

The feasibility of this experimental approach for characterizing the strongly graded, non-equiaxed stress state existing at a machined surface is demonstrated. The results from constant-penetration-depth measurements on the ground surface of an engineering ceramic are compared with those from conventional  $\sin^2\psi$  measurements.