

**Experiment title:**Investigation of Residual Stresses and Texture Gradients
in Cold Forward Extruded Steel Samples**Experiment****number:**

HS - 240

Beamline:

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9

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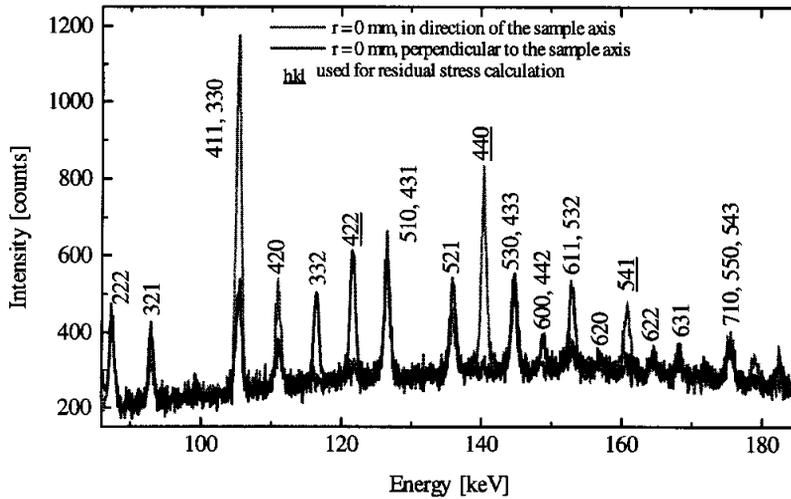
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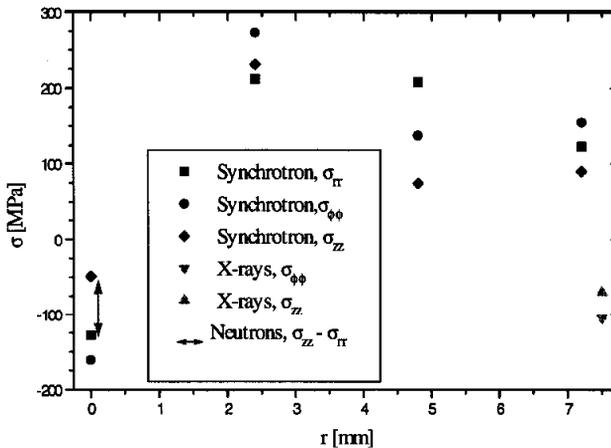
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Report:

In full forward extruded samples residual stress and texture gradients arise due to strong plastic deformations, which are inhomogeneously distributed across the sample diameter. Here, the residual stress and the texture gradients were studied in a cylindrical sample, \varnothing 15mm, German steel grade C15, that was full forward extruded with a degree of natural strain of $\varphi = 1.2$. Due to the high intensity and high parallelity of the synchrotron beam the gauge volume was a parallelepiped with the dimensions 1.65 mm perpendicular to the scattering vector and 0.15 mm parallel to it. Thus the gauge volume was small enough, so that several volume elements could be investigated across the sample diameter. The energy spectra obtained in the direction parallel and perpendicular to the axis of the sample reveal a $\langle 110 \rangle$ fiber texture that is typical for cold extruded and cold drawn bcc materials. A comparison of the intensity of the 110 type reflections for different volume elements across the sample diameter further on clearly indicates that the maximum of the texture is in the center of the sample and that the texture is distinctly less pronounced near the sample boundary.



From the energy values obtained for the 442, 440 and 541 reflection in radial, hoop and axial direction of the sample the residual stresses were calculated at the different positions of the gauge volume. The d_0 value necessary for the determination of the three-dimensional residual stress state was calculated as an average of the d values obtained for the different reflections and volume elements ('random - walk - method').



Neutron diffraction and synchrotron diffraction in very good agreement reveal, that in the inner part of the specimen the residual stresses in radial σ_{rr} , hoop $\sigma_{\phi\phi}$, and axial direction σ_{zz} , are compressive. These compressive residual stresses are balanced by tensile residual stresses in the outer part of the sample //1/. The quantitative stress values also fulfill within an experimental error margin of ± 80 MPa the mechanical equilibrium condition. The residual stress distribution can be linked to the deformation process during the cold forward extrusion.

//1/W. Reimers, M. Broda, G. Bruschi, D. Dantz, K.-D. Liss, A. Pyzalla, T. Schmackers, T. Tschentscher: Evaluation of Residual Stresses in the Bulk of Materials by High Energy Synchrotron Diffraction, submitted to Journal of Non-destructive Evaluation