APPROACHES TO THE PROBLEM OF THE INVERSE LAPLACE TRANSFORM IN RESIDUAL STRESS ANALYSIS BY COMPARISON OF EXPERIMENTAL RESULTS OF $\sigma(\tau)$ AND $\sigma(z)$

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Surface treated 100Cr6 steel samples were analysed concerning their residual stresses. The aim of the project is the development of measurement and evaluation strategies for determining stress gradients by energy and angle dispersive X-ray diffraction. The main problem of conventional Laplace methods is that they only determine real stress values $\sigma(z)$ if no gradient of the residual stresses within the X-ray penetration depth τ occurs. Otherwise the measured Laplace profiles $\sigma(\tau)$ have to be recalculated by inverse Laplace transform (ILT) to obtain the residual stresses in real space being those from practical relevance for engineering applications.

Strain distributions of deep ground and shot peened 100Cr6 samples were measured by energy dispersive Laplace methods up to X-ray energies of approximately 80 keV. The used setup allows the analysis of several lattice planes in one measurement and realises penetration depths of more than 100 µm. The surface near regions were additionally analysed by monochromatic synchrotron radiation, equivalent to Cukα and Mokα wavelengths, at the {110} and the {431/510} lattice plane respectively to affirm the energy dispersive values since this method may lead to scattering results here. The in depth stress distributions were calculated via Universalplot method and afterwards transformed by ILT applying different exponentially damped fit functions. Comparisons of these distributions with stress profiles obtained by successive layer removal, using minimal increments of 1 µm, show a good agreement for the ground as well as for the shot peened samples, provided the fit function in Laplace space is able to represent the $\sigma(\tau)$ data satisfactorily.

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