

## Neutron diffraction stress analysis of near surface stress gradients of surface treated steel samples

Jens Gibmeier<sup>1\*</sup>, Joana Kornmeier<sup>2</sup> and Michael Hofmann<sup>3</sup>

<sup>1</sup> Hahn-Meitner-Institute, c/o Bessy II, Albert-Einstein-Strasse 15, D-12489 Berlin

<sup>2</sup> Hahn-Meitner-Institute, Glienicke Strasse 100, D-14109 Berlin

<sup>3</sup> FRM-II, TU München, Lichtenbergstr. 1, D-85747 Garching

In order to tap the full optimisation potential for technical parts the residual stress distribution in the near surface region is of major interest for engineering work. The knowledge of the stress distribution is a necessary prerequisite for exactly tailored near surface layers of highly loaded technical components.

The most important and most frequently applied tools for residual stress analysis are the diffraction methods. Surface layers affected by mechanical surface treatments like e.g. shot peening typically ranges up to depths of some tenth of a millimetre. For non-destructive stress analysis of surface treated steel samples the application of laboratory X-rays or high energy synchrotron radiation in reflection mode covers the region from some micrometers up to a depth of about 150-200  $\mu\text{m}$ . To access the depth region  $> 200 \mu\text{m}$  an incremental layer removal technique in combination with reapplication of X-ray stress analysis for the new surfaces can be applied. However, this procedure is destructive, laborious and furthermore it has to be checked, whether corrections have to be applied. Using neutron radiation generally penetration depths up to several millimetres can be achieved. The most widely used set-up for neutron diffraction stress analysis is the  $90^\circ$  scattering technique. Stresses at the surface can be analysed using a strain scanning technique and a gauge volume, which is possibly partially immersed in the sample. Here corrections have to be applied using stress free reference samples. In addition the local resolution is generally poor.

In the present project an alternative approach has been pursued to overcome these shortcomings. The stress depth distribution of shot peened steel samples (SAE 4140) was determined by means of neutron diffraction according to the well known  $\sin^2\psi$ -method, being a standard technique in X-ray stress analysis. The experiments were carried out at the STRESS-SPEC-instrument at the research reactor FRM II, Munich. For data evaluation the universal-plot method was applied, which directly assign stress measures for each sample orientation to the mean penetration depth  $\tau$ . By that the stress depth gradient can be determined up to large distances from the sample surface non-destructively. The results determined that way are in good agreement with stress depth distributions determined in a round robin test for identical samples by means of X-ray diffraction in combination with incremental layer removal.

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Corresponding author:

Dr.-Ing. Jens Gibmeier  
Hahn-Meitner-Institute Berlin  
c/o Bessy II  
Albert-Einstein-Strasse 15  
D-12489 Berlin, Germany  
Tel.: +49-30-6392 5686  
Fax: +49-30-6392 5752  
Email: [jens.gibmeier@online.de](mailto:jens.gibmeier@online.de)

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