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Non-Specialist Talk - Measurement of Residual Stress with Diffraction Techniques

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Abstract content
   (Max 300 words)

The total stress that a component experiences in practical use is the vector sum of the applied and residual stresses. The applied stresses result from the loading forces to which the component is subjected in use and can be calculated to high precision. Residual stresses on the other hand result from the processing and manufacturing treatments of the material and mostly only known quantitatively. Diffraction techniques enable accurate non-destructive measurement of the prevailing residual strain tensors from which the stress fields can be calculated in conjunction with the material elastic moduli.

The principles underlying X-ray and neutron diffraction techniques will be introduced to a non-specialist audience, elucidated on hand of a practical application relevant to the South African motor vehicle industry.

Processes involved with the manufacture, forming and treatment of coil springs in the motor vehicles have recently undergone major technological advances, amongst others from exploiting the benefits of deliberately introduced residual stress fields in improving their performance and fatigue lifetimes. Coil springs can be manufactured by following two different processes, i.e. hot or cold forming. The latter is a novice technique being implemented by the motor vehicle industry in South Africa. It offers a number of advantages over the more traditional hot forming process in that the coiling and conditioning is done at much lower temperatures which not only leads to reduced production costs, but furthermore captures a residual stress field in the spring rods, that in practical use, leads to exertion of progressive resistance against applied load.

To investigate the interplay between the various process production stages on the residual stress fields, it is essential to directly measure the interior stresses with the spring geometry intact to negate possible relaxation effects that may result from sectioning or application of destructive approaches. We report on non-destructive investigations of the residual stress fields in samples that were extracted from the various production steps involved in the forming and conditioning of cold formed helical coil springs. Neutron diffraction strain scanning enabled comprehensive profiling of the tri-axial stress fields along the rods diameter, as well as two-dimensional contour mapping over the rod cross section.

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