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VEQTER

Residual Stress Experts

VEQTER is an engineering company providing excellence in the measurement, analysis and management of residual stresses. We are world leaders in our field and offer expertise on any aspect related to residual stresses in engineering components and structures.

X-ray Diffraction Technique

The X-ray Diffraction (XRD) technique is the most widely used non-destructive technique, specialising in the measurement of surface residual stresses.

Using laboratory-based or portable equipment, the XRD technique measures surface residual stresses to depths of up to 30µm by measuring the material's inter-atomic spacing.

Laboratory x-rays have wavelengths of the order of a few angstroms (Å), which is the same order of magnitude as the typical inter-atomic/inter-planar distances in polycrystalline solids. X-rays scattered from a polycrystalline solid can constructively interfere producing a diffracted beam. The angles at which the maximum diffracted intensities occur are measured. From these angles it is possible to obtain the inter-planar spacing, d, of the diffraction planes using Bragg's law. If residual stresses exist within the sample, then the d spacing will be different from that of an unstressed sample (i.e. d_0). The difference is proportional to the magnitude of residual stress present. In principle therefore, we use the grains as internal strain gauges for residual (or applied) stresses.

To find out how VEQTER can help you please contact us on +44 (0) 117 992 7970 or using experts@veqter.co.uk

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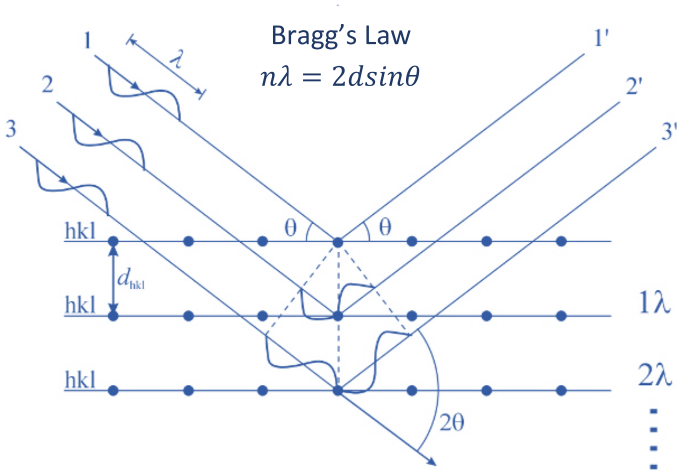
XRD Principle:

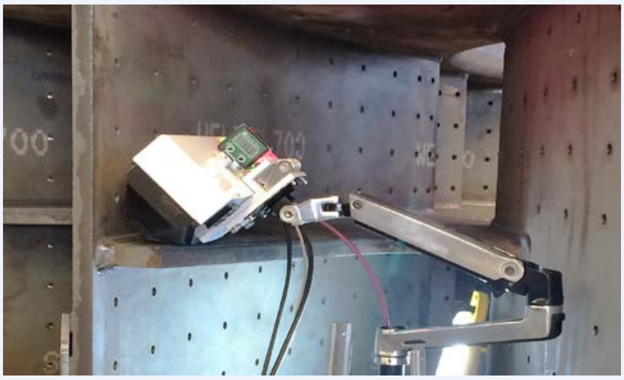
Due to the low penetration depths of the laboratory XRD technique, measurements are restricted to the surface of materials, but benefit from the use of differential analyses techniques so that a stress-free reference (i.e. d_0) sample is not required. For the most commonly used $\sin^2\psi$ technique, the diffraction angle, 2θ, and hence the lattice spacing, d, can be determined for multiple inclination angles, ψ, of the sample surface, providing the relevant stress measurements.

A new portable XRD machine has been developed that detects the complete debye ring of diffracted x-rays without the need for multiple inclinations of the sample surface. The complete debye ring provides lots of information about the texture in the sample and is analysed using the cos α technique to provide the lattice spacing, d, and hence the residual stresses.



Bi-axial residual stresses are measured using XRD and are nominally accurate to ±20MPa in steel. The accuracy of the technique is heavily dependent upon good surface preparation and grain size/texture. Although classified as a surface measurement technique, measurements can be made at depths up to 1mm when combined with layer removal.

Portable XRD Equipment:



Technique Specifications:

- Non-destructive technique;
- Laboratory or "on-site" measurements;
- Bi-axial (i.e. σ_{xx} and σ_{yy}) residual stress measurements;
- Small gauge volume and so great for measuring steep surface stress gradients when combined with layer removal.
- High magnitude residual stresses are measured accurately;
- Complex shapes can be measured providing rotation of the measuring head is not restricted;
- Nominal accuracy: 7MPa – Aluminium, 20MPa – Steel, 10MPa – Titanium;
- Very quick and easy to apply the process, and therefore cheap;
- Macro and micro stresses measured;
- Widely available.
- Measurement depths of only 10-20µm as standard, however when coupled with electro-polishing surface removal, depths of up to 1–1.5mm are achievable;
- Only applicable to polycrystalline materials;
- Accuracy seriously affected by grain size and texture;
- A good component surface finish is essential, so may need delicate preparation.

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