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FACT SHEET

RESIDUAL STRESS MEASUREMENT

With X-ray Diffraction (XRD)

Residual stress measurements are particularly useful for quality control purposes.

Determining the distribution of residual stress is important because unknown residual stress level can lead to premature catastrophic failure of a component.

Residual Stress

Residual stresses (RS) are internal stresses present in the material after external loading forces have been removed. Manufacturing processes such as machining, casting, alloying, quenching, cutting and tooling can all contribute to a change in residual stress. Regardless of industry understanding residual stress can help to make high-integrity products safer and more reliable and provide vital information about the performance and lifecycle management of your product.

Residual stress measurements are UKAS accredited and performed in compliance with the NPL Good Practice Guidelines.

X-ray Diffraction (XRD)

To help our customers combat these issues, the XRD unit at Intertek can:

- Help to analyse failures caused by fatigue or stress corrosion cracking (SCC)
- Estimate fatigue life and stress concentration
- Assess the effect of heat treatment and surface treatments
- Provide evidence peening operations are having the desired result
- Validate manufacturing processes
- Gain an understanding of wire electrode discharge machining (EDM)
- Study surface distortion
- Process modelling and optimisation
- Design improvements
- Identify RS at the surface and subsurface

Our Technique

Using the $\sin^2\psi$ technique, we measure the spacing between atomic planes and use this as an atomic strain gauge.

Material elastic constants are then used to calculate the residual stress without the need for a stress-free standard.

Components such as gear teeth with very high compressive stress levels in a high stress, cyclic application, at levels around -1000 mPa can be measured to determine fatigue life / component life.

X-ray diffraction is based on Bragg's law and with our range of X-ray tubes can accommodate a range of metals and alloys such as:

- Titanium alloys e.g. for aerospace, medical applications
- Nickel alloys
- Aluminium alloys
- Steel

Data Processing

Data processing software using the Moore-Evans correction for removed layers model allows residual stress to be quantified at different depth, revealing a depth profile with varying stress field.

XRD is great tool for both industrial and scientific research.

Benefits

The benefits of choosing to measure residual stress via XRD include:

- Material removal by electro-polishing does not induce or change the stress state
- Hydro-fluoric acid immersion etching facility for titanium material removal
- Non-destructive surface measurements can be evaluated without the need to section samples from large components, leaving the original object intact
- Lower cost compared with Neutron and Synchrotron methods
- Quantify internal structures and how they evolve over time
- Complementary tests such as optical microscopy, scanning electron microscopy (SEM), surface measurement (Infinite Focus Microscopy) and hardness testing can be used in conjunction with XRD to provide a complete picture

FOR MORE INFORMATION

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