L3 spectrometer demonstration

Stress, Stress Mapping and more

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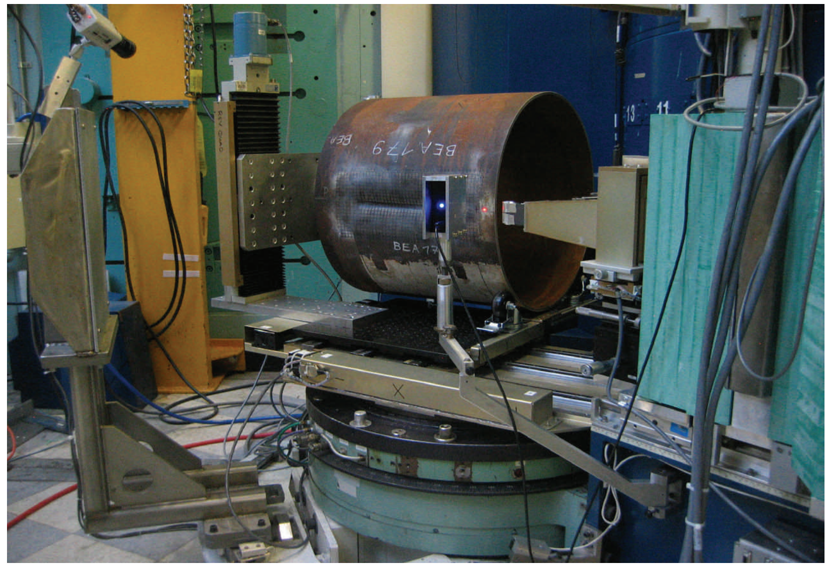

Stress is force normalized to the area over which it is acting. Everyday objects are subject to stresses that can be either externally imposed, for example the weight of a truck driving across a bridge, or can be internal stresses that reside within the material as a result of its history, for example residual stresses due to the manufacturing processes (fabrication history) used to make the turbine blade of a jet engine.

Strain and stress mapping has become an important technique at all major neutron scattering laboratories.

The data that can be obtained are used to answer such questions as:

Materials Scietists & Engineers:

- What is the mechanical behaviour of this new material?
- What are the limitations of this novel fabrication technique?
- How do the particles and matrix interact?
- Does stress impact bonding?
- How do stresses evolve?
- How can stress affect other measurements?

Industrial Clients:

- Why did it fail?
- When will it fail?
- Can I or should I make this change in the fabrication route?
- Can we maintain quality with this alternative supplier?
- Can we prove that our method is superior?
- How can we obtain regulatory approval?

Description of Technique:

The basic principles of the technique are straightforward and easily demonstrated. Simply put, tensile stresses will pull the planes of atoms further apart while compressive stress will push them closer together compared to spacing when there is no stress. Diffraction is used to measure that spacing of the planes of atoms. This is readily understood from Bragg Law, *viz*,

$$n\lambda = 2d \sin\theta,$$

where λ is the neutron wavelength, 2θ is the measured diffraction angle, and d is the perpendicular spacing between the planes of atoms. The integer n in the equation indicates that the condition is satisfied for all orders.

Due to the high penetration of neutrons in most industrial alloys and ceramics, neutron diffraction has emerged as the only technique capable of *non-destructively* mapping strains and stresses *at depth,* often in *full-scale industrial components.* Consequently the technique is of interest to academics and industrial researchers alike.

An actual industrial component will be used to demonstrate the technique. The effort in stress mapping is setting up the sample to measure the strains (the material's response to stress) at location of interest in the sample for various orientations of the sample.