

ALGORITHM AND STRATEGY OF STRESS ANALYSIS WITH 2D DETECTOR

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2D detectors, when used for residual stress measurement, have many advantages over conventional 0D and 1D detectors. First, the measurement time is significantly reduced due to the large portion of the diffraction ring being measured at each exposure. 2D data has a large angular coverage in both 2θ and γ directions. The γ -integration helps to smooth out rough diffraction profiles due to large grain size, texture, small sample area or weak diffraction. This presentation will cover the algorithm and data collection strategy for stress analysis with a 2D detector.

The 2D fundamental equation, governing the relationship between the stress tensor and the diffraction cone distortion, is derived from the unit vector expression in sample space. The 2D fundamental equation can be used for both reflection mode and transmission mode diffraction. For biaxial stress measurement, the approximation of d-spacing or 2θ input for the stress-free condition does not introduce error in the stress calculation. The conventional fundamental equation for stress analysis can be considered as a special case of the more general 2D fundamental equation. Therefore, the 2D method and the conventional method are consistent both in theory and applications.

X-ray diffraction measures stress by measuring the d-spacing change caused by the stress. The measured directions are not necessarily matching the desired stress components. The final stress measurement results can be considered as an extrapolation from the measured values. Suitable data collection strategy for a particular experiment should be determined by considering the stress components of interest, the goniometer type, sample size, detector size and resolution, measurement accuracy and data collection time.

Reference: Bob He, *Two-dimensional X-ray Diffraction*, John Wiley & Sons, 2009