Precision and Accuracy of Stress Measurement with a Portable X-ray Machine

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The use of portable X-ray stress analyzers, which utilize an area detector along with a newly adopted 'cosα' or full-ring fitting method, has recently gained interest. In laboratory conditions, these measurements are fast, convenient, and precise because they employ a single exposure technique that does not require sample rotation. In addition, the effects of grain size and orientation can be evaluated from the Debye ring recorded on the area detector prior to data analysis. Accuracy of the measured stress, however, has been questioned because in most cases just a single reflection is analyzed and sample-to-detector distances are relatively short. We present our recent article, a comprehensive analysis of the uncertainty associated with a state-of-art commercial portable X-ray device [1]. Annealed ferrite reference powders were used to quantify instrument precision, while accuracy of the stress measurement was tested by in-situ tensile loading on 1018 carbon steel and 6061 aluminium alloy bar samples. Results show that precision and accuracy are sensitive to the instrument (or sample) tilt angle (ψ_0) as well as to the selected hkl reflection of the sample. The instrument, sample, and data analysis methods all affect the overall uncertainty and each contribution is described for this specific portable X-ray system. Finally, based on our conclusions, desirable measurement/analysis protocols for accurate stress assessments are also presented.

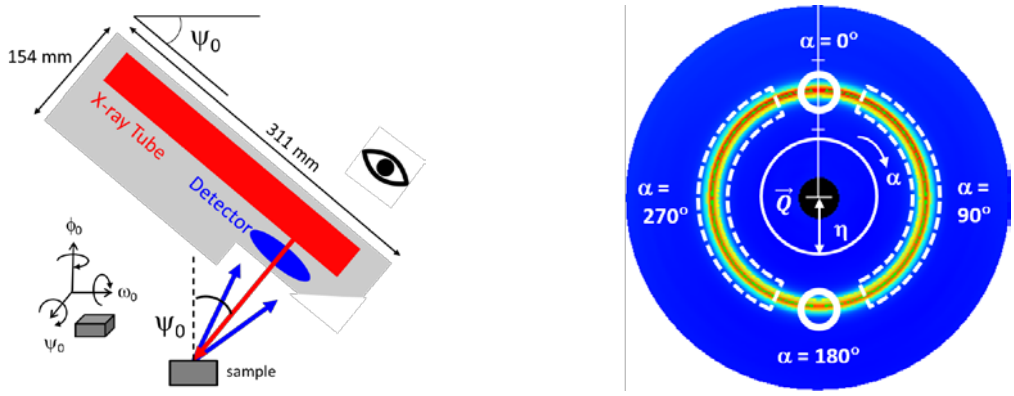

Figure 1. A schematic diagram of the portable X-ray machine used in this study (left) and a typical diffraction pattern of steel (211) peak measured by this device (right).

References

1. Lee S.-Y. *et. al.* Precision and accuracy of stress measurement with a portable X-ray machine using an area detector. *Journal of Applied Crystallography*. **50**, 131-144 (2017).

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