Methodology of Synchrotron EDXRD Strain Profiling

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We have implemented two powerful techniques, one for residual strain depth-profiling and the other for tomography-like scatter-intensity profiling of materials, on X17B1 at the Brookhaven National Synchrotron Light Source. The techniques utilize energy dispersive x-ray scattering, from a fixed micro-scattering-volume, with micro-scanning of the specimen being used for the profiling.

We have used theoretical modeling to estimate the influence of instrumental effects on the experimental results. Outstanding agreement between this modeling and experimental results emphasize that we have a precise understanding of the as-implemented experimental technique. The contributions of the size and geometry of the diffraction volume to variations of the diffraction angle and to lattice parameter variations near surfaces and interfaces are discussed. The contribution of the former is shown to be essentially negligible due to the tight diffraction geometry collimation. The contribution of the latter near interfaces and for thin samples has been modeled for various lattice parameter distributions and methods for recovering the true lattice parameter variation have been investigated.

In our strain analysis we simultaneously use many Bragg lines so that the energy calibration for our spectra is important. We describe the details of a calibration procedure utilizing many cubic standards with a precision 1-5 eV over the 1-150 KeV range (as opposed to the 40-80 eV for traditional radioactive source calibration). This calibration, along with our analysis software/methodology, allow Bragg line energy and lattice parameter precisions of 0.1-20 eV and $1\text{-}3\text{X}10^{-4}$Å or better. The interactivity of the software enables the treatment of the the $\sim 10^3$ EDXRD spectra generated by our measurements. Our experimental and analysis techniques have yielded very good agreement with theory for a cantilever spring stressed material.

1. The above abstract can be posted on the DXC web site and affiliated web sites.
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3. Oral presentation is preferred in "Synchrotron Applications" session.
4. We intend to publish the paper in Advances in X-ray Analysis, Volume 46.