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Dark-field X-ray microscopy is a new full-field imaging technique for nondestructively mapping the structure of deeply embedded crystalline elements in three dimensions. Placing an objective in the diffracted beam generates a magnified projection image of a local volume. By placing a detector in the back focal plane, high-resolution reciprocal space maps are generated for the local volume. Geometrical optics is used to provide analytical expressions for the resolution and range of the reciprocal space maps and the associated field of view in the sample plane. To understand the effects of coherence a comparison is made with wavefront simulations using the fractional Fourier transform. Reciprocal space mapping is demonstrated experimentally at an X-ray energy of 15.6 keV. The resolution function exhibits suppressed streaks and an FWHM resolution in all directions of ΔQ/Q = 4 × 10⁻⁵ or better. It is demonstrated by simulations that scanning a square aperture in the back focal plane enables strain mapping with no loss in resolution to be combined with a spatial resolution of 100 nm.

General information
Publication status: Published
Organisations: Department of Physics, Neutrons and X-rays for Materials Physics, Department of Energy Conversion and Storage, European Synchrotron Radiation Facility
Corresponding author: Poulsen, H.
Number of pages: 9
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Journal of Applied Crystallography
Volume: 51
Issue number: 5
ISSN (Print): 0021-8898
Ratings:
BFI (2018): BFI-level 2
Scopus rating (2018): CiteScore 3.35 SJR 1.86 SNIP 1.611
Web of Science (2018): Impact factor 3.161
Web of Science (2018): Indexed yes
Original language: English
Keywords: X-ray diffraction microscopy, Diffraction contrast tomography, Structural characterization, Synchrotron radiation, Tomography, Diffraction imaging
Electronic versions:
nb5230.pdf
DOIs:
10.1107/S1600576718011378
Source: FindIt
Source ID: 2439258499
Research output: Contribution to journal › Journal article – Annual report year: 2018 › Research › peer-review