

TOWARD NANOMETER RESOLUTION FOR STRAIN MAPPING IN SINGLE CRYSTALS: NEW FOCUSING OPTICS AND DYNAMICAL DIFFRACTION ARTIFACTS

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Progress in the fabrication of x-ray optics has pushed the spatial resolution of x-ray microprobes well below 100 nm, which brings microdiffraction techniques into the nanoscale. In the first part we report x-ray dynamical diffraction simulations, and we update experimental results for a new type of focusing optics, called a Multilayer Laue Lens (MLL), which is well suited to achieve both a high spatial resolution and a high efficiency.¹ We have developed a new approach to describe the ultimate diffraction and imaging properties of MLL based on Takagi-Taupin descriptions of dynamical diffraction, and have investigated different non-optimized and optimized geometries for ultimate focusing; namely flat, wedged, and ideally curved MLL structures. We have, with the aid of Ewald sphere construction, derived an ideally curved structure which in principle is capable of achieving a resolution limit close to the wavelength. We also report experiments using partial MLL's with flat zones and an outmost zone width of 5 nm. These experiments conducted on sector 26 at the Advanced Photon Source at Argonne National Laboratory have yielded to date a line focus with a width of ~17 nm at x-ray energies of 19.5 keV and 29.25 keV. In the second part we report dynamical artifacts observed in microdiffraction experiments, and the aberration caused on the strain measurement. We discuss the origins of these artifacts and possible ways of removing them. With the new optics and the proper treatment of the dynamical artifacts, we show a path toward nanometer resolution for strain mapping in single crystals.

¹ H. C. Kang, J. Maser, G. B. Stephenson et al., "Nanometer Linear Focusing of Hard X Rays by a Multilayer Laue Lens," *Physical Review Letters* **96** (12), 127401-127404 (2006).

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