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Multilayer Laue Lenses – A Path Towards Nanofocusing of X-rays.[1]

JÖRG MASER, Argonne National Laboratory

The possibility of imaging at near-atomic resolution using short-wavelength x-rays has been a dream ever since the nature of x-rays was first understood nearly 100 years ago. Although hard x-rays can in principle be focused to spot sizes on the order of their wavelength (0.1 nm), this limit has never been approached because of the difficulty in fabricating the optics – indeed, it has not even been clear what type of optics will work. We have developed a new approach towards manufacture of hard x-ray optics, the "Multilayer Laue Lens" (MLL) [1]. MLL's are fabricated by coating a flat substrate with alternating layers of nanometer thickness, with d-spacing varying to form the zones of a linear zone plate. Thin cross sections of the multilayer are then made. These allow focusing of x-rays when illuminated in transmission (Laue) diffraction geometry. Crossing two such linear zone plate sections will allow 2-dimensional focusing. We have shown that a resolution of 5 nm should be achievable using the non-optimized geometry we are currently fabricating, and that a resolution of 1 nm is feasible using an optimized geometry. We have experimentally demonstrated a line focus with a width of below 20 nm at photon energies of 20 keV and 30 keV, with diffraction efficiencies of 30% and above 15%, respectively.

[1] H.C. Kang, J. Maser, G.B. Stephenson, C. Liu, R. Conley, A.T. Macrander, S. Vogt, Phys. Rev. Lett. **96**, March, 127401-1-127401-4 (2006).

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