경 X-선 나노 집속을 위한 다층박막 Laue 광학계

Multilayer Laue Lens for Hard X-ray Nano-Focusing Optics

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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. The scientific impact would be deep and broad, opening up new frontiers in many fields of science, because x-ray microscopy provides capabilities (ability to penetrate, high accuracy chemical and structural information) that are complementary to other high-resolution microscopies. 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 made initial steps towards achieving this goalby investigating a new type of high-resolution x-ray optic, called a Multilayer Laue Lens (MLL).[1-4] The MLL is a linear zone plate structure that operates in the volume diffraction regime, similar to a crystal, to achieve high efficiency. We have shown theoretically that the MLL will efficiently focus hard x-rays to a spot of 1 nm or smaller.[2] We have also shown that simpleversions of the MLL can be fabricated by depositing thousands of nanometer-scale layers onto a substrate, and then dicing the multilayer into thin sections so that the layers can be illuminated edge-on to diffract x-rays into a small focus.[2,3] The calculated performance of these MLL structures has been confirmed by measurements of their focusing properties. A line focus of < 17 nm with an efficiency of 31% at a wavelength of 0.06 nm has been obtained for a partial MLL structure with 5 nm outermost zone width. These experiments show that hard x-ray focusing to below 10 nmwill be possible by assembling two of these partial MLLs in a face-to-face configuration.

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