A 100-μm-Thick Full Multilayer Laue Lens Structure*

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Multilayer Laue Lenses (MLLs) were developed to efficiently focus hard x-rays. Using a partial MLL, a line focus of 16 nm of 19.5-keV hard x-rays has been achieved with an efficiency of 31% [1]. The partial MLL linear zone-plate structure consists of 1588 alternating WSi_2 and Si layers with thicknesses varying from 5 nm to ~25 nm according to the Fresnel zone-plate formula. This partial structure comprised the outer 13.25 μm of the 16.53 μm radius that corresponds to one half of a full linear zone plate. The partial MLL thus has a correspondingly smaller numerical aperture and reduced photo intensity as compared to a full structure.

In this study we investigate fabricating a full linear MLL structure with a large diameter of 100-μm, which is comparable in size with traditional zone plates. Each 50-μm half-structure has 1788 WSi_2 and Si layers with 12-nm to ~32-nm thicknesses and ~32-μm total thickness, followed by a thick WSi_2 layer of ~17 μm, and an AuSn layer of ~1 μm. The 1788 coated zones comprised the outer portion of the 50-μm-radius linear zone plate. The thick WSi_2 and the AuSn layer acts as a center stop. The number of zones to grow was based on the consideration for the ease of deposition without jeopardizing too much of the MLL performance. DC magnetron sputtering was used to grow the half structure. Attention has been paid to overcome the enormous film stress involved in these unprecedentedly thick multilayers [2]. The coating system was thoroughly cleaned after coating the ~32-μm-thick multilayer before coating the thick WSi_2 and the AuSn layer. A pair of new WSi_2 and Si targets, 3 inch diameter and 0.25 inch thick, was needed for coating the half MLL structure. A predetermined growth-rate correction was used in the deposition program based on feedback from scanning electron microscope (SEM) measurements of previous MLL depositions. A full MLL wafer was fabricated by bonding two half-structure wafers in a vacuum oven at ~300° C [3]. The SEM images of sliced and polished samples demonstrated good linearity in 1/d vs. position plots. These thick full MLL wafers have the potential of producing practical MLL devices with high photon fluxes, as well as fine focuses for hard x-ray applications.

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