Full Multilayer Laue Lens for Focusing Hard X-rays*

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Using partial multilayer Laue lens (MLL) linear zone-plate structures with thousands of alternating WSi₂ and Si layers with thicknesses varying according to the Fresnel zone-plate formula, we have been able to focus hard x-rays to sizes as small as 16 nm [1, 2]. These partial MLLs consist of less than half of the zones in a complete linear zone-plate structure and have correspondingly smaller numerical aperture. In this study we investigate fabricating a complete linear MLL structure. The increased numerical aperture of a full MLL is expected to improve focusing. A full linear MLL can be fabricated by bonding two partial-structure-multilayer wafers using a precisely-thickness-controlled AuSn layer and heating in a vacuum oven at 280-300°C [3]. It can also be achieved by growing the whole structure using magnetron sputtering without bonding. A full structure with a total of 5166 layers of WSi₂ and Si, with layer thicknesses gradually varying from 4 nm to ~400 nm and then from ~400 nm back to 4 nm, has been successfully fabricated. Two coatings were used to grow the full structure of ~40 microns, with each coating covering one half of the full structure. Each coating took over 56 h from start to finish. The sample was sliced and polished without cracking and SEM images demonstrate good contrast between WSi₂ and Si layers down to 4 nm. Two center images are shown below. These results demonstrate the feasibility of a full linear MLL for focusing hard x-rays.

2. H. C. Kang et al., unpublished.

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