Fabrication and Performance of a Lithium Compound Refractive X-Ray Lenses

Kristina Young[ab], Ali Khounsary[ab], Andrew N. Jansen[c], Eric M. Dufresne[a], and Philip Nash[b]

[a]Advanced Photon Source, Argonne National Laboratory, Argonne, IL 60439
[b]Department of Mechanical, Materials, and Aerospace Engineering, Illinois Institute of Technology, Chicago, IL 60616
[c]Chemical Engineering Division, Argonne National Laboratory, Argonne, IL 60439

Compound refractive lenses (CRLs) are arrays of single- or double-sided concave lenses used to focus x-rays. Their simple design and ease of implementation and alignment make them attractive as x-ray focusing devices.

Several factors affect the design of CRLs. This includes incident beam energy, size, and power, as well and the desired focal length. These in turn affect the choice of lens material, lens configuration, and the fabrication methodology. Lithium is a desirable lens material especially for low to moderate photon energies (<30 keV), because of its low x-ray absorption in this energy range. However, it is a difficult material to handle and use because it is rather malleable and more importantly, it reacts rapidly with moisture in the air, and to a lesser extent oxygen and nitrogen. It also tends to adhere to tools such as mold and dies that could be used in fabrication.

This presentation reports on the fabrication and performance of parabolic lithium lenses with a 100-μm tip radius. Lenses are fabricated one by one in a high-precision press fitted with precision-machined stainless steel parabolic indenters. A prototype CRL consisting of 32 lenses stacked aligned in a sealed tube is constructed and tested with 10 keV photons. A theoretical focal length of 1.70 m was expected. Test results indicate a vertical focal spot of 24 μm at 1.71 m from the lens assembly with a gain of about 20. Further developments and future prospects are discussed.