A simple, high-yield solution for fabrication of x-ray transmission mirror optics

David N. Agyeman-Budu and Arthur R. Woll
Cornell High Energy Synchrotron Source, 161 Synchrotron Dr., Ithaca, NY 14853

Although the concept of x-ray transmission mirrors (XTM) was initially described over 30 years ago [1], very few working devices have been achieved, and to our knowledge none are in routine use. XTM are the complement to reflecting x-ray optics: they function as high-pass x-ray filters with superior selectivity compared to common absorbers, e.g. a metal foil or slab. Potential applications for synchrotron radiation include the creation of tunable bandwidth incident beams [2] and improved heat-load reduction from high-brightness sources. The absence of practical devices is due to the unsolved challenge of XTM optic fabrication: namely, operating at grazing incident angles such that the frame that mechanically supports the thin, reflecting membrane does not itself block the transmitted beam. The most recent efforts employed microfabrication techniques to create Si₃N₄ membranes on a silicon wafer. While successful, that approach was challenging, and suffered poor yield. Here, we demonstrate a greatly simplified yet reliable fabrication approach, and describe the characterization of the resulting XTM. Specifically, the XTM optics presented comprise ~300 nm thick Si₃N₄ membranes in a 2 x 75 mm² frame. We present the measured intensities of the L-lines from a tungsten-anode tube source, which allows us to determine the energy-dependent selectivity of the optics. At an incident angle of 0.22°, corresponding to a critical energy of 10 keV, the effective vertical aperture of the device is 0.2 mm. At this angle, the transmission of W-Lγ emission (11.3 keV) is 65%, 161 times greater than that of W-Lα (8.4 keV). In contrast, for an aluminum filter with 65% transmission at 11.3 keV, the transmission of 8.4 keV radiation is 33%, a reduction factor of only 1.9.

Reference: