Silicon Micro-pore X-ray Optics

Yuichiro Ezoe[1], Masaki Koshiishi[1], Kazuhisa Mitsuda[1], Makoto Mita[1], Yoshitaka Ishisaki[2], Akio Hoshino[2], Takayuki Takano[3], and Ryutaro Maeda[3]

[1] Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA),
[2] Tokyo Metropolitan University,
[3] National Institute of Advanced Industrial Science and Technology (AIST),

Grazing-incidence X-ray optics is a general tool to concentrate X-rays into a focus and used in wide fields such as nuclear physics, biomedicine and space science. In this talk, we review our development of an extremely light-weight and low-cost micro-pore optics based on the semiconductor MEMS (Micro Electro Mechanical Systems) technology for future astronomical missions. Using anisotropic chemical wet etching of silicon wafers, we can build an array of fine ($\sim$several μm) slit-like pores through a several hundreds μm-thick wafer. Because of totally different etching rate between different crystal planes, a side wall of each pore is correctly aligned to a certain crystal plane and hence extremely smooth. For example, silicon (111) planes vertical to the silicon (110) wafer face have been known to be very smooth with rms roughness down to several nanometers. We have fabricated a sample mirror device and successfully shown that these sidewalls really reflect X-rays (Ezoe et al. SPIE 2005, 5900, 329). Combined with a optics mount, which is also fabricated with the MEMS techniques, the silicon wafers can be arranged in horizontal and vertical directions to approximate a Wolter-type I optic. Moderate angular resolution (arcminites) and extreme light weight will be achieved at the same time. This optics will satisfy limited resources (size, weight and cost) of small satellite missions such as the Japanese DIOS (Diffuse Intergalactic Oxygen Surveyor) mission. We will show basic properties of these MEMS X-ray mirrors, and also fabrication process and performance of our sample optic.