

The development of hard x-ray optics for MIRRORCLE-6X microscope beam line

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A laboratory-scale hard x-ray microscope based on the portable synchrotron named MIRRORCLE-6X is developed at SLLS. MIRRORCLE-6X is a novel x-ray source suitable for hard x-ray microscopy because of its x-ray source size having the order of micron, and its high brilliance. We have developed Wolter type-I mirrors using grazing incident optics. For focusing X-rays into sub-mm size we use a set of two identical Wolter mirrors. Each is shaped in an axially symmetric hyperboloid and paraboloid surface. One mirror reflects incident x-rays at large angles and transforms them into parallel beam. The second Wolter type mirror placed along the optical axis focuses these parallel x-rays to the point. Diverging X-rays are focused after 4 times-reflections with two mirrors.

We manufactured Wolter type mirror by replication method. Nickel electroforming was applied to the master mandrel made from oxygen-free copper. The smooth surfaces were manufactured by super precision machining. The surface roughness of master mandrel is made within 1nm r.m.s. We could perform the successful replication between Nickel and oxygen-free copper without losing surface roughness. Figure.1 shows the fabricated set of Wolter type grazing incidence mirrors. We have observed 90% reflectivity for 2-8keV x-rays with one aspheric surface of this mirror. We have observed the focused spot of X-rays from MIRRORCLE-6X. We will demonstrate microscopy images at the conference, although our final goal is a deposition of multilayer to these Wolter type mirror.

