Practical use of quasi-kinoform zone plate : Towards high-efficiency microbeam for hard /high-energy x-rays

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The sputtered-sliced zone plates (ss-FZPs) with various aspect ratios (thickness) are possible to use in wide x-ray energy ranges (8 ~ over100 keV). For more practical use of ss-FZP, the higher focusing efficiency is indispensable as well as the high spatial resolution. We have planned to develop a kinoform type zone plate (K-ZP). The ideal focusing efficiency of the K-ZP is 100% assuming that there is no absorption. As a first step we have tried to fabricate a quasi-kinoform zone plate (QK-ZP) using the sputtered-sliced method to obtain high-efficiency. The QK-ZP was fabricated by depositing four kind layers of different Al/Cu compositions in one cycle, a transparent layer (Al), two half transparent layers (Al:66% and Cu:33%; Al:33% and Cu:66%) and an opaque layer (Cu), thus, 60 layers in whole zone area on a rotating fine gold wire core having a diameter of 50 micron. The zone plate thickness and the film thickness of the outermost zone were ~55 micron and 0.145 micron respectively.

The focusing experiment was performed at the end station of the 250m-long beamline (BL-20XU) of SPring-8. At first, the experiment was made at 30 keV without OSA (order sorting aperture) to observe the whole diffraction order lights from the QK-ZP in the CCD detector located downstream of the focusing point. We, then, compared the intensities of the 1st and the -1st order diffraction light. It was found that the intensity of the 1st order light was apparently increased while that of the -1st order was almost disappeared. The ZP was, then, proven to be worked as a kinoform-like ZP. The focusing efficiencies of the 1st order focus were ~50% and ~10% at 50keV and 23keV respectively, while that of the 2nd order was determined to be the maximum value of 21% at 23keV. We, then, made a scanning x-ray microscopy experiment using the 2nd order beam without using OSA at 23keV. The transmission image of Ta test pattern (thickness: 0.5 micron) was obtained. The fine pattern up to 0.5 micron was resolved.