MULTILAYER X-RAY OPTICS FOR FUTURE MISSIONS

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1. Introduction

Multilayers have a great potentiality to improve the image quality, spectral resolution and energy coverage of x-ray optical systems. The angular resolution of a normal incidence telescope aims at approaching the diffraction limit in the soft x-ray region. Multilayer supermirror makes it possible to fabricate a grazing incidence telescope with high sensitivity in hard x-ray region. Multilayer coated gratings are also useful dispersive elements with high efficiency and spectral resolution in the 2-10keV region. The application of multilayers is expected to open up a new field in astronomical imaging and spectroscopic observations which are not accessible by present telescopes.

2. Normal incidence telescope

Mo/Si multilayered spherical mirror with 20cm in diameter and 30cm in focal length was fabricated, which was on board a sounding rocket for the observation of a hot white dwarf(HZ43) and hot interstellar medium in the direction of north galactic pole within the field of view of 4 deg.[1]. The wavelength bands were tuned at 130-140A and 170-180A. The peak reflectivity was obtained to be 60%. For future missions we have to develop a multilayered normal incidence telescope with reflectivity of more than 30% in 50-80A band.

3. Grazing incidence telescope

In order to extend the energy region to hard x-rays, Pt/C supermirrors(depth-graded multilayer) were successfully deposited on float glass and replica foil mirrors used for Astro-E[2]. The reflectivity was obtained to be 30% in 24-37keV band at the incidence angle of 0.3 deg., as shown in figure 1. The

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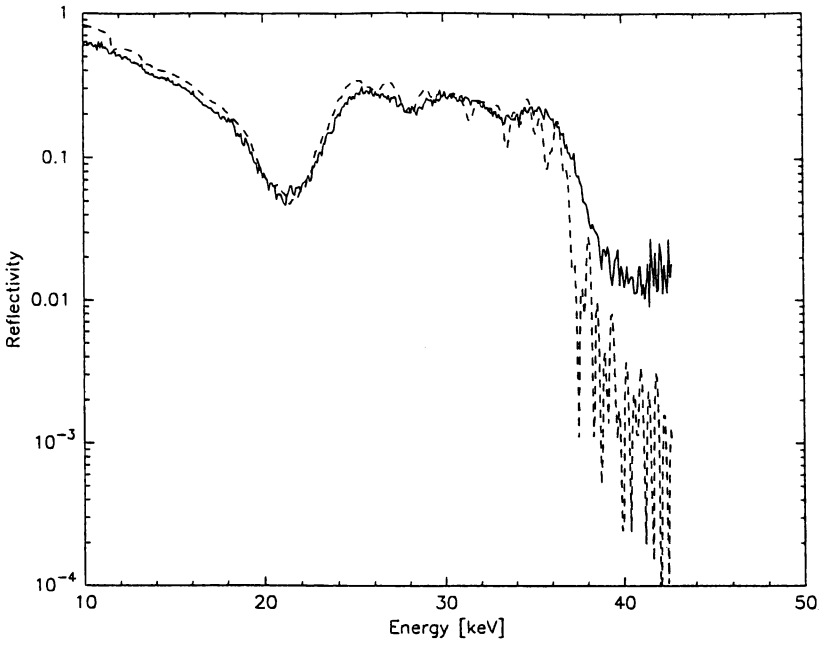

Figure 1. X-ray reflectivity of Pt/C supermirror at the incidence angle of 0.3deg.

supermirror consists of five different multilayers with combinations of periodic length and number of layer pairs of (106, 1), (51-49, 4), (43, 8), (38, 13), (35, 18) and (33, 25) from outermost layer to substrate. This fact promises that supermirror is a real break-through to construct a hard x-ray telescope.

4. Spectrometer

Pt/C(2d=100A, N=10) multilayer coated laminar gratings(500 grooves/mm, groove depth 400A) were fabricated and characterized with Cu-K_α (8.04keV) and monochromatized synchrotron radiation in 1-3keV[3]. The first order peak reflectivity and resolution were obtained to be 20% and more than 100 for Cu-K_α, respectively. We are aiming at making a spectrometer with $E/\Delta E$=1000 in 2-10keV region and even with imaging capability.

References

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[2]Tamura, K. et al., (1997), *Proc. SPIE*, **3113**, 285
[3]Ishiguro, E., et al., (1995), *Rev. Sci. Instrum.*, **66**. 2112