Instrumentation and Technique

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X-ray Polarimeter with Transmission Multi-layers

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Introduction

The polarization of the X-ray from astronomical objects includes important information of the X-ray emission mechanism and sometimes of the geometrical situation of the X-ray sources. However, since the measurement of the X-ray polarization is relatively difficult, the significant observation has not been performed so far, except for some bright sources. One reason is that the complex mechanism for the polarization measurement is not suitable for the detector which must be installed onboard the satellite.

The reflectivity and the transmission of the Multi Layers depend on the polarization, especially for the 45 deg incident angle. The transmission type polarimeter has been developed by Yamamoto(1993). The transmission type polarimeter might be very suitable for the detector onboard the satellite, because the transmission polarimeter can be used as a filter, which can be install in front of the other conventional detectors. If the detector is an imaging detector, such as a CCD, the images as a function of the position angle of the polarization can be observed. This would give us unprecedented information of the astronomical objects.

We started the investigation of the transmission type polarimater with multi layers.

Multi Layers

The transmission of the multi layers are calculated according to Underwood and Barbee (1981). Considering the technical feasibility, we now chose a Mo/Si multi-layers for 13.5nm wave length. This is not well suitable for the astronomical usage, but is suitable for the test development. A Si3N4 thin film is used as a substrate. The thickness is 100nm and its size is 1mm square. The simulated transmission is shown in figure 1. The nine layer pare is optimum with high transmission and big difference between S- and P- polarization. The multi layers were fabricated by a DC magnetron spattering at JAXA/ISAS.

Performance Evaluation

The photons around 13.5nm were exposed onto the Mo/Si multi-layers on the Si3N4 substrate with the incident angle of 45 deg using the BL11A beam line. The transmitted photons were detected by a photo-diode. The multilayer can be rotated around the axis on the beam line. The photon energy was scanned from 12.5nm to 14.5nm, The measurements have been performed at the seven position angles from -90 deg to 90 deg with 30deg step. The measured transmissions are compiled in the figure 2. The clear performance for the polarimater has been confirmed.

References

[1] M. Yamamoto, OYO Butsuri, 62, 676-682 (1993)
[2] J.H. Underwood and T.W. Barbee, Jr. Applied Optics 20, 3027-3034 (1981).

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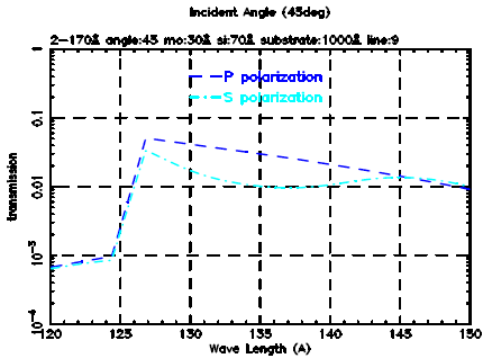

Figure 1. The transmission of Mo/Si multi-layers on a 100nm Si3N4 substrate for S and P polarization, respectively. The incident angle is fixed at 45 deg.

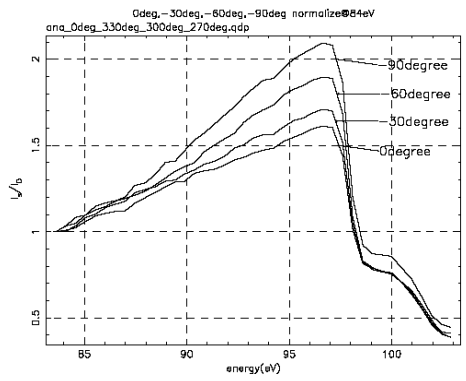

Figure 2. The measured transmission of the multi-layers around 13.5nm region, for four position angles, -90, -60, -30 and 0 deg. The transmissions at 84eV are normalized to be 1.