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Soft X-ray transmission of an optical blocking filter for a X-ray CCD camera

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Introduction

A Charge Coupled Device can be used as an X-ray Detector and has many wonderful advantages. As well as good imaging capability with less than 10µm, if it is used as a photon detector, it has almost ideal energy resolution of Si detector. Thus CCDs are now widely used as soft X-ray detectors.

We are planning to install CCD cameras on the Japanese 5th X-ray astronomical satellite, Astro-E2, which is now scheduled to launch in early 2005, Since a CCD has high detection efficiency for optical light and ultra violet light, we will use an optical blocking filter in front of the CCD chips. The experimental calibration of the soft X-ray transmission of them is very important. Especially the X-ray transmission properties around the absorption edges are comples[1] and must be determined by a measurement. We measured the soft X-ray transmission of an engineering model of the optical blocking filter.

The design parameter of the optical blocking filter is summarized in table 1. It is a polyimide sandwiched by aluminium (Al). The polyimide is mainly composed of carbon (C), and oxygen (O). Thus we focused on the measurement of the transmission around the K-absorption edges of Al, O, and C.

Measurement and Results

The BL-11A line provides us good quality monochromatic soft X-rays between 90eV and 1900eV. This energy range covers the C-K, O-K and Al-K edges. When we measured the transmission around C-K and O-K edges, we used the second order rejection mirrors.

The beam was restricted by a slit. The sample optical blocking filter was installed on a rotational axle and it could be put in or be put off the beam. A window less photo diode (AXW-100 TS) was used as a detector and its current was measured. The windowless Si(Li) detector cooled by LN_2 was also used in order to check the energy spectrum of the beam.

The transmission of the optical blocking filter was calculated as a ratio of current with the filter and that without it. Derived transmission is shown in figure 1. The absorption fine structures around the absorption edges were clearly measured. The best-fit model transmission is also plotted in the same figures, where the absorption coefficients by Henke [2] are used and the materials are assumed to be composed of Al and polyimide. Although the discrepancy of the depth of O-K edge is prominent, the resultant thickness is listed in table 1.

Discussion

We measured the soft X-ray transmission of the optical blocking filter. The absorption fine structure was clearly obtained. The flight filters will be fabricated soon and we are now ready to calibrate the flight filters.

The discrepancy of the depth of the O-K edge means the existence of extra oxygen. One possibility is the oxidization of the aluminium. This possibility has been pointed out[3]. The oxidization of the aluminum might affect the optical transmission and actually unexpected transmission of the optical light is sometimes found. Thus the evaluation of the oxidization is very important.

We assumed the existence of a layer of Al_2O_3, adding to the original Al and polyimide layers and derived the best-fit thicknesses of them. The results are summarized in table 1. The next interest is the long-term change of the degree of the oxidization. This is our next subject.

Table 1: Thickness of the Materials

	Al	Polyimide	Al_2O_3
Design	1298Å	970Å	...
Simple Model	1151Å	1305Å	...
Oxidization Model	1006Å	1262Å	138Å

References

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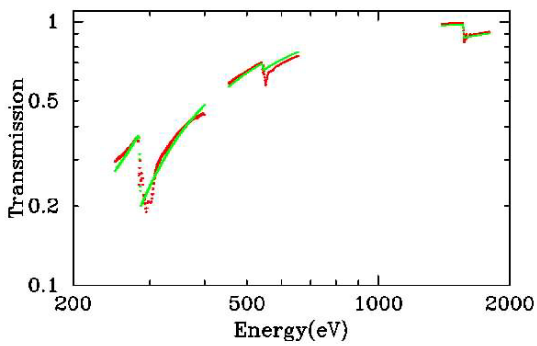

Fig.1 Measured transmission of the Optical Blocking Filter. The solid line is a model curve calculated using absorption coefficients by Henke et al. (1993).