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Soft X-ray Transmission of Optical Blocking Filters for the X-ray CCD Cameras onboard Astro-E 2

Shunji KITAMOTO[1*], Takayoshi KOHMURA[1], Norimasa YAMAMOTO[1], Haruko TAKANO[1], Harue SAITO[1], Kazuharu SAGA[1], Kiyoshi HAYASHIDA[2], Haruyoshi KATAYAMA[2]
[1]Departmento of Physics, Rikkyo University,
3-34-1, Nishi-Ikebukuro, Toshima-ku, Tokyo, 171-8501, Japan
[2]Department of Earth and Space Science, Graduate School of Science, Osaka University
1-1, Machikaneyama, Toyonaka, Osaka, 560-0042, Japan

Introduction

We are planning to install CCD cameras on the Japanese 5th X-ray astronomical satellite, Astro-E 2, which is now scheduled for launch in early 2005. Since a CCD has high detection efficiency for optical and ultra violet light, we will use an Optical Blocking Filter (OBF) in front of a CCD chip. 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 complex [1,2], which is known as X-ray Absorption Fine Structure (XAFS).

OBFs for Astro-E 2

The Astro-E 2 satellite is a recovery satellite of Astro-E, which was launched on 10 Feb. 2000 but could not enter a satellite orbit. Thus, the Astro-E 2 satellite was proposed and is scheduled for launch in early 2005. Because of this short time scheduling, the design of Astro-E 2 is almost the same as that of Astro-E. The design of the CCD cameras is also similar. The properties of the CCD camera for Astro-E can be seen in various reports[3,4,5], and some reports on the OBFs have also been published[6,7]. The OBFs, which were made by Luxel Co. LTD, are composed of a thin polyimide ($C_{22}H_{10}O_4N_2$) film sandwiched by Al. Four cameras will be installed on the Astro-E 2 satellite and we have six OBFs including spares.

Results

The measurement was performed at Beam line 11A. Derived X-ray transmission is shown in figure 1, where the transmissions of six filters are compiled. The measurement covers the energy range from 180eV to 1800 eV. The X-ray Absorption Fine Structures (XAFSs) around the K-edges of Al, O, N and C were clearly measured. The X-ray transmissions of the six filters are almost same within ~1%. The average transmission of six films are calculated and fitted by a two material model composed of polyimide and Al using the available absorption coefficients. The derived thickness of polyimide is a little thicker than design value. We derived the amount of the components of polyimide from the depth of the absorption edge. Then we found the presence of extra oxigen.

Conclusion

The average data provided a good model transmission including XAFS. Small gaps of the measurement could be interpolated and the energy region above 1800 eV could be extrapolated using the best fit model. We found the existence of the extra O by the comparison of the depth of the absorption edges, comparing the two materials model composed of polyimide and Al. This discrepancy can be reconciled by introducing the Al_2O_3.

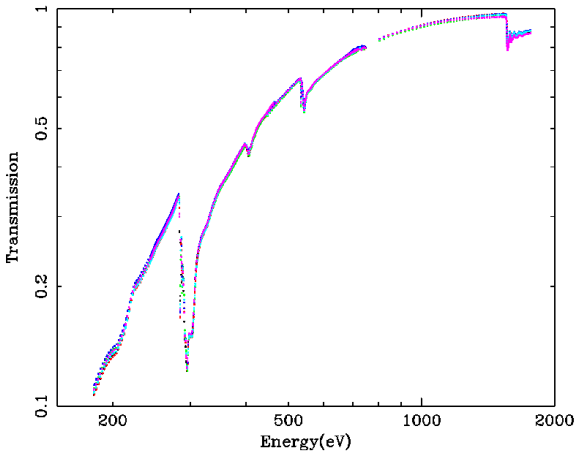

Figure 1. Soft X-ray transmission of six OBFs. The transmissions are the same within ~1%.

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* kitamoto@rikkyo.ne.jp