Development of High Resolution Wide-band X-ray Detector: Scintillator-deposited Charge-coupled Device

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We report here a newly developed wide-band photon-counting detector for 0.1−100 keV X-rays possessing high spatial resolution, to be employed as the focal plane detector of the supermirror: the scintillator-deposited CCD (SD-CCD). We employ CCDs as a soft X-ray detector. The scintillator is directly coupled to the back surface of the CCD. The majority of X-rays having energy of above 10 keV cannot be absorbed by the CCD and pass through it. However, they can be absorbed by the scintillator and emit hundreds or thousands of visible light photons. The visible light photons can be absorbed by the same CCD. In order to maximize the number of visible light photons detected by CCDs, the surface of the scintillator is coated by a reflector, such as aluminum, which leads to a better energy resolution.

We measured the X-ray spectral response of the scintillator-deposited CCD (SD-CCD) with SPring-8 BL20B2. We irradiated monochromatic X-ray beam having energy of 20−80 keV and measured the energy dependences of the mean pulse height as well as the energy resolution of the SD-CCD. A good linear relationship between the X-ray energy and the mean pulse height channel can be obtained with our device, suggesting the SD-CCD can surely function as a hard X-ray spectrometer. In order to investigate the imaging capability of the SD-CCD, we measure the contrast transfer function with a test chart having a spatial frequency up to 10 LP/mm whereas the spatial resolution of the SD-CCD far exceeds the limitation by the test charge employed. We thus performed the demonstrative experiment with a sharp-edge structure and obtained (10 ± 3) micron at 17.4 keV with an X-ray photon-counting mode.