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Pushing the Limits of Kyoto's SOI Pixel Sensor for X-ray Astronomy with the Pinned Depleted Diode

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We have been developing SOI pixel sensors for X-ray astronomy, called "XRPIX", which are fabricated using the silicon-on-insulator CMOS technology.XRPIX aims to detect X-rays in the energy band from 0.5 keV to 20 keV. The device consists of a fully depleted high-resistivity silicon sensor layer, a low-resistivity silicon layer for CMOS readout circuit, and a buried oxide layer in-between. The readout circuit has an event trigger output function, and reads out only pixels with an X-ray signal, thereby achieving a good time resolution and high throughput.Our latest device, XRPIX6E, is equipped with the Pinned Depleted Diode (PDD) structure (Kamehama et al. 2018), which greatly reduces stray capacitance at the charge sensing node, the dark current from the interface between the sensor layer and the buried oxide layer, and capacitive coupling between the sensing node and the readout circuit.The PDD structure also helps to improve the collection efficiency of the signal charge in the sensor layer. With XRPIX6E, we already achieved an energy resolution of 335 eV (FWHM) for 6.4 keV X-rays (Harada et al. submitted). Optimizing various bias voltages applied to the device and also integration time after a trigger output, we have succeeded in further improving the energy resolution and have achieved 200 eV (FWHM) at 6.4 keV in the readout mode using the event trigger output function.In order to characterize the device in more detail, we are conducting various experiments. One of them is a mesh experiment (Tsunemi et al. 1997) to study the sub-pixel response. Another is X-ray irradiation with a back-illumination configuration to evaluate the soft X-ray performance. In the presentation, we will report on the results of these experiments.

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