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Development of TlBr hybrid pixel detector combined with Tl electrode sensor and photon counting ASIC

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The hybrid pixel detectors are powerful technologies for the radiation imaging. Sensors and ASICs can be improved for performance in the individual processes. In particular, photon counting ASICs are revolutionizing various applications. We developed a cadmium telluride (CdTe) pixel detector (WERPAD: Wide Energy Range Pixel Array Detector). Dual energy and energy dispersive X-ray diffractions could be achieved at the synchrotron radiation facility of SPring-8. In this scientific work, we have been studying thallium bromide (TlBr) pixel detectors combined with the WERPAD ASIC for further performance improvement.
TlBr is a promising compound semiconductor material for high energy X-ray and gamma ray detections. It has higher photon stopping power than CdTe because of the atomic numbers (Tl: 81 and Br: 35) and the high density (7.56 g/cm3). Owing to its wide band-gap energy of 2.68 eV, TlBr crystals exhibit a high resistivity of 10ˆ10 –10ˆ11 Ω cm. We have investigated Tl/TlBr/Tl configuration. The Tl electrodes realized an excellent energy resolution (< 2% @ 662 keV) and stable operation at room temperature (25 degrees Celsius) in overcoming the polarization problem.
The WERPAD ASIC has a preamplifier, a shaper, 3-level window-type comparators, a 24-bits counter in the pixel size of 200 μm and 95 × 100 pixels in the full size chip. We have investigated a prototype sensor by using a high resistivity TlBr single crystal of 5 × 5 mm2 in the electrode sides and 2 mm in thickness. The sensor was bump-bonded with the test purpose WERPAD ASIC (20 × 100 pixels). 137Cs gamma-ray images have been stably measured at room temperature, successfully. In this workshop we will describe the detail performances of this prototype detector and future prospects for synchrotron radiation and medical applications.

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