Development of Compact Sensor with CdS Photoresistor for High Gamma-ray Field Monitoring

*Huy Le Viet, Hiroyuki Miyamaru and Takao Kojima

Division of Quantum and Radiation Engineering, Graduate School of Engineering, Osaka Prefecture University.

Abstract

A gamma-ray sensor composed of a cadmium sulfide (CdS) photoresistor and a CsI(Tl) scintillator is developed for intense gamma-ray monitoring. The sensor exhibited radiation-resistant ability and linear output over a wide exposure range. Several experiments were performed with the developed sensor for confirmation of feasibility. The CdS photoresistor shows capability for gamma-ray dosimetry as an inexpensive, robust, compact, and high-sensitivity device.

Keywords: CdS photoresistor; CsI(Tl) scintillator; Gamma-ray sensor; Radiation exposure.

1. Introduction

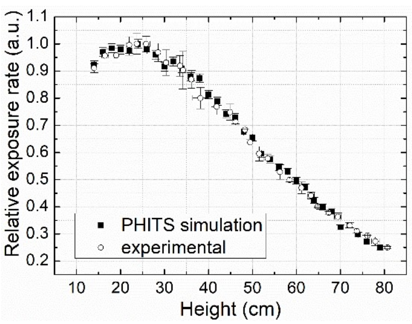
A new gamma-ray sensor using a cadmium sulfide (CdS) photoresistor has been developed for the purpose of intense radiation source monitoring, radiation exposure evaluation in small regions, and multiple radiation monitoring. In this study, the characteristic of the developed sensor and some applications are discussed.

2. Materials and method

The compact sensor was fabricated with a CdS photoresistor placed in close contact with a small-sized CsI(Tl) scintillator. At the dark condition, the electrical resistance of the photoresistor is about 770 kΩ, but it reduces drastically when receiving light emission from the scintillator exposed to gamma rays. This change is used to evaluate the exposure rate. The resistance change was converted into the voltage change with a voltage divider circuit, and output voltage was derived with a PC accompanied with LabVIEW programming through an NI-USB data logging device. Gamma-ray exposure experiment was performed using a 591 TBq Co-60 source. The exposure rate was simultaneously measured with a small-sized ion chamber (PTW, type 31013) and was compared to the resistance of the sensor for calibration.

3. Experimental results

The output of the sensor exhibited a linearity response as increasing exposure rate. The resistance changed 2.5 orders from 0 to 14 mC/kg/s, and remained consistency in one-hour exposure.



The developed sensor was subjected to measure vertical radiation exposure outside of the Co-60 source. Spatial exposure was calculated with PHITS and it agreed well with the experimental results as shown in left figure. In addition, the sensor was superior to the ion chamber in one-dimensional spatial resolution performed with a narrow slit. The high spatial resolution of the sensor is afforded by small area of the CdS photoresistor, and flexible size of the scintillator.

4. Conclusion

The developed sensor exhibits various advantages, including compactness, robustness, inexpensiveness, high-sensitivity, and high-spatial-resolution. The sensor is capable for intense radiation source monitoring and exposure examining for complex setups.