Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 10-11, 2007

CsI/PIN Diode Detector Manufacture and Gamma-ray Response Measurement

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1. Introduction

In the nuclear industry changes fast to expand from conventional industry to newly emerging market industry. Such industries are environment and security field. Conventional devices to field-orientation application are too heavy not enough to be hand held.[1]

Especially emerging environment and security markets need a device which should be handheld and available long term battery operation. Photomultiplier based detection system could not satisfied these requirements.

One of the promising system is the scintilator/PIN diode device.[2] Present investigation is motivated for the purpose of developing a gamma-ray monitoring system with nuclei identification and small and light enough to be transportable by worker.

2. Methods and Results

2.1. Fabrication and Experimental Procedures.

Detector structure has been fabricated by CsI bulk crystal by combining with PIN diode. CsI crystals were 3 types with cubic structure, 10x10x10mm, 10x10x20mm, and 20x20x20mm. PIN diode were 10x10mm active area, which were purchased from Hamamatsu Photonics.

Figure1. Photos of the fabricated CsI/PIN structure detector.

The CsI crystal was prepared by using the standard processes; sawing polishing, coupling to PIN diode and packaging. Figure 1 is the fabricated and packaged detection sensors.

The gamma-ray response was measure by 10uCi Cs-137 source by adjusting distance to determine detection limit. Dose was measured by using calibrated dosimeter.

Pulse height spectrum was obtained by standard electronics which consisted of a preamplifier, a shaping amplifier, and a multi-channel analyzer(MCA).

2.2. Discussion and Result.

CsI/PIN structure detector responses are almost linear as a function of detection crystal volume. In the 10x10x10mm crystal detector showed large response variation comparing to large volume detector. It is consider as coupling mismatch to CsI crystal to PIN diode. Figure 2 is the gamma-ray responses with respect to different diction volumes.

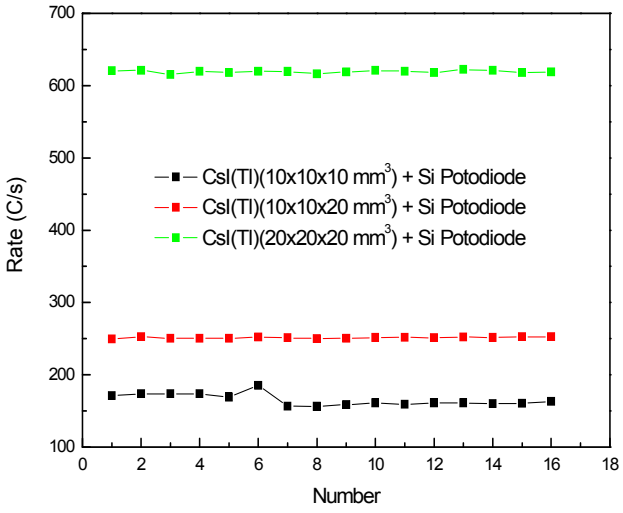

Figure2. Gamma-ray response with respect to detection volume

Detection sensitivity is depended on crystal geometry and electronics signal processing speed. Electrical processing speed is serious factor gamma-ray absorption rate to several ten thousand counts. To determine detection response accurately, data acquisition speed was controlled by source strength not to electrical factor ignorable. Electrical nosed originated from the connector and ground loop, and partially from the gamma-ray and light leakage.

Figure 3 is the measured detector sensitivity as a function of distance between source and detector.

The geometrical effect is simply detection solid angle, which is proportional inversely to square of distance as shown in figure 3.

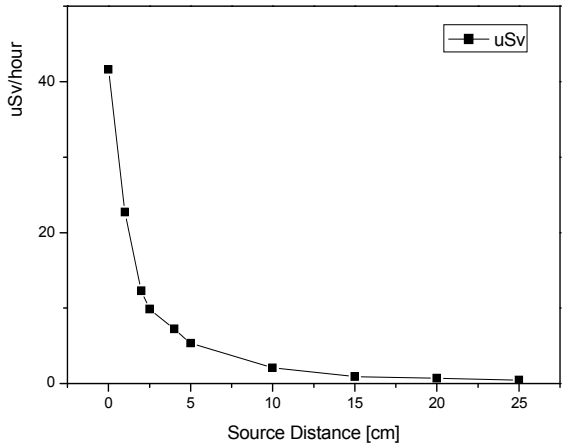

Figure 3 is the measured detector sensitivity as a function of distance between source and detector.

3. Conclusion

We investigated different size of CsI/PIN diode detector. It gives good response of gamma-rays. CsI/PIN diode detector system is expected as a hand-held portabe dosimeter.

Acknowledgements

This work has been carried out under the Nuclear R&D program of the Ministry of Science and Technology (MOST) of Korea. We are also supported by the Science Research Center / Engineering Research Center program of MOST / Korea Science and Engineering Foundation.

Reference

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[2] G. F. Knoll, "Radiation Detection and Measurement", 3rd Ed. ch. 11, John Wiley & Sons Inc. New York, (2000),