Evaluation of Characteristics of Fabricated SiC Semiconductor Radiation Detector and Energy Spectrum Measurement

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1. Introduction

Recently, a semiconductor detector is drawing attention because of its discriminative advantages in measurement of neutrons compared with other detectors. Especially, as silicon carbide (SiC) has the capability to process neutron pulsing fast and high radiation-resistant, it has been considered as stable sensor to detect radiation in the intense radiation environment. In addition, it is expected to be the detector used in neutron monitor in harsh environment such as a reactor because of its characteristics of high resistance to high temperature and its good hardness. In case of thermal neutron detection it can be considered in the form of covering with ^{6}LiF or ^{10}B on SiC wafer.

2. Methods and Results

In this section, details of the semiconductor radiation sensor, SiC, used in detector fabrication are described. And response of some of the fabricated detectors before and after neutron irradiation is shown.

2.1 Fabrication

Structure of the SiC wafer used in this study is shown in Fig. 1.

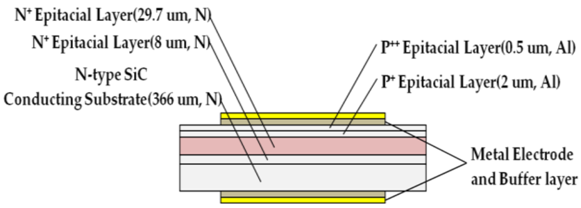

Fig. 1. Schematic drawing of inner-layer structure of SiC wafer. The red-colored area means an active area.

Several kinds of metal electrodes deposited on the wafer are considered to compare the capability of processing current signals generated from the radiation. In case of detector of the thermal neutron, ^{6}LiF was evaporated in one side of the electrode metal as a material of neutron converter and its thickness of 2 um was determined on basis of the result evaluated by using MNCPX simulation code and experience of pre-experiment. The description of fabricated detectors is shown Table. I.

Table I: Details of metal used in fabricated detector

	Buffer layer - Electrode	Thickness / Radius
Fast neutron detector	Cr-Au	0.03um - 0.2um / 3mm - 4mm
	Ni-Au	
	Ti-Cr	
	Ti-Au	
Thermal neutron detector	Ni-Au	0.03um - 0.2um / 3mm - 4mm, ^{6}LiF 2um
	Ni-Cr	

2.2 I/V Measurement

I/V measurements were performed for the basic electronic properties of semiconductor detector. Fig. 3 shows its electrical characterization.

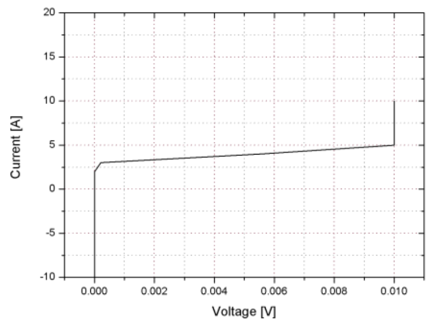

Fig. 2. Current response of SiC detector against a change of voltage.

2.3 Energy Spectrum Measurement for Alpha source

With respect to each fabricated detector alpha spectrum was measured to evaluate the detector performance. The source used in experiment was ^{238}Pu with distance of 5 mm and all of the measurements were performed for 10 minutes. The SiC sensors irradiated at HANARO ENF facility also were measured after fabrication of the detector. The neutron flux was 3×10^{13} n/cm$^{2}\cdot$s and irradiation time was 5 hours. The result of count rate measured is shown in Fig. 3 – Fig. 5.

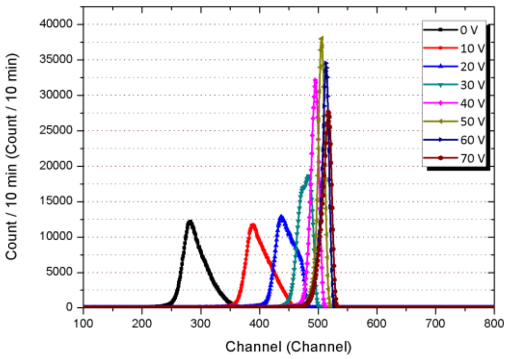

Fig. 3. Count rate of fast neutron SiC detector covered with Ni-Au against a change of bias voltage to -70 V.

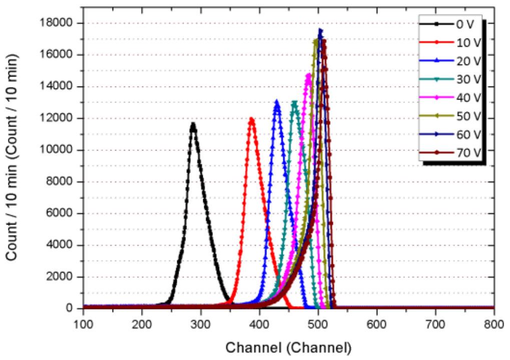

Fig. 4. Count rate of thermal neutron SiC detector covered with Ni-Au(2um ^{6}LiF) against a change of bias voltage.

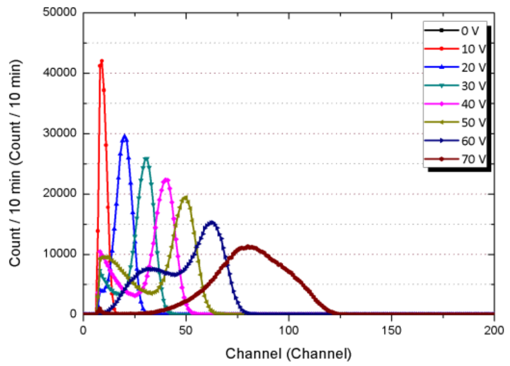

Fig. 5. Count rate of fast neutron SiC detector covered with Ni-Au against the change of bias voltage after neutron irradiation.

3. Conclusions

As bias approved in detector increase peak had a tendency to move to higher channel and clearness. After neutron irradiation of detector, the peak appeared at lower channel overall than it was not irradiated. However it still shows the peak obviously and is expected as detector to measure a radiation. In near future the neutron irradiation experiment will be performed at Korea Atomic Energy Research Institute (KAERI), Korea Institute of Geoscience And Material resources (KIGAM) and Korea Research Institute of Standards and Science (KRISS) to evaluate the linearity of fabricated SiC semiconductor radiation detector by changing neutron energy and flux.

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