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# Energy Spectrum Measurement of a Fabricated Semiconductor Radiation Detector at HANARO ENF facility

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## 1. Introduction

In recent years there have been studied compound semiconductor radiation detectors based on CZT, CdTe, and $HgI_2$, etc. To achieve neutron detection with these compound semiconductors, preliminary test with a silicon based wafer was performed. A Silicon Carbide radiation detector can be one of candidates for this purpose. Because Silicon Carbide material have unique properties such as wide bandgap energy(3.25 eV), relatively high radiation resistance and possibility of high temperature operation (~600℃). If neutron converting materials such as $^{6}$LiF or $^{10}$B are deposited on a Silicon Carbide wafer, energy spectrum of thermal neutron can be measured and can be operated as neutron detector. In this study neutron converting characteristics were investigated.

## 2. Methods and Results

### *2.1 Prediction of neutron reaction in Silicon Carbide radiation detector*

By using MCNPX code, neutron reaction probability of a $^{6}$LiF converter was simulated with respect to neutron energies. The simulation parameters are as below:

- Silicon Carbide substrate dimension : 5×5 $mm^2$.
- $^{6}$LiF converter thickness and diameter : 9um and 2mm. respectively
- A range of neutron energy : 0.01 eV ~ 10 MeV
- Type of neutron source : point source.
- Running time : 10 hours @ each simulation

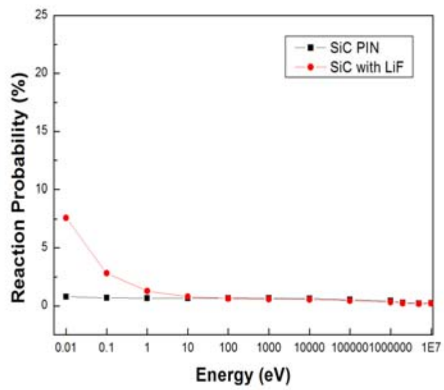


Figure.1 Reaction probability about neutron energy change

As a result of neutron reaction prediction, thermal/fast neutrons react with a Silicon Carbide wafer and also a $^{6}$LiF converter. Thus, reaction probability of Silicon Carbide radiation detector in energy range of 0.01 eV ~ 1 eV are increased.

| Energy(eV) | Probability(%) |
|---|---|
| 0.01 | 5.354 |
| 0.1 | 2.012 |
| 1 | 0.842 |

Table 1. Reaction probability of thermal neutron

### *2.2 Fabrication of Silicon Carbide radiation detector*

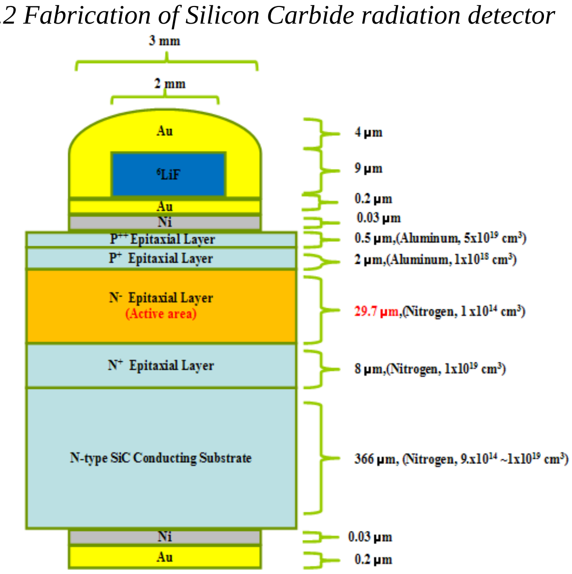


Figure.2 Basic structure of neutron detector

To deposit a $^{6}$LiF converter on Silicon Carbide radiation detector, a thermal evaporator was used. Before deposit electrode Au, Ni was evaporated as a buffer layer to enhance adhesion. Au thickness was 2000Å and Ni thickness is 300Å. And then, $^{6}$LiF converter was evaporated at 9um thickness. This converter produces alpha particle and tritium by reaction with neutron. Au was evaporated with 4um to prevent oxidization of $^{6}$LiF.

### *2.3 Thermal neutron energy spectrum*

Thermal neutron on fabricated Silicon Carbide radiation detector was irradiated at HANARO ENF facility in Korea Atomic Energy Research Institute (KAERI). The thermal neutron flux was $1.9\times10^{7}$

n/cm$^2$·s, which was measured with Au wire by using NAA (Neutron Activation Analysis). Irradiated time and neutron energy of Silicon Carbide radiation detector were 5 min and < 0.625 eV.

Pulse height spectrum was obtained by a fabricated preamplifier, an amplifier at KAERI, and a Ortec multi-channel analyzer.

As a result of this experiment, measured count rate was 1667 count/s. Irradiated neutron counts per second were 597233. The measured reaction probability by the Silicon Carbide detector was 3.3%. Because neutron energy at HANARO ENF facility is not mono-energy, experiment result corresponds with probability 0.8 ~ 5% of simulation result. And from an energy spectrum, Silicon Carbide radiation detector has a reliance about thermal neutron measurement.

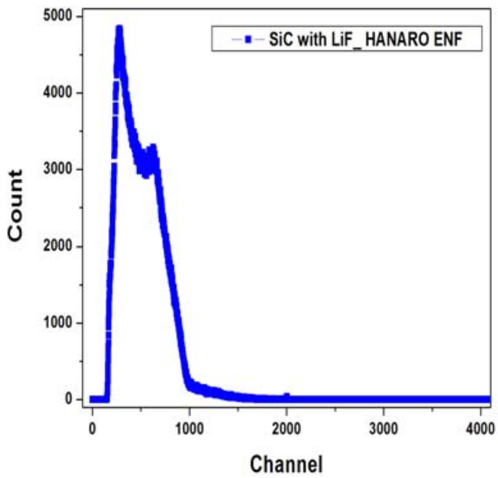


Figure.3 Energy spectrum of Silicon Carbide radiation detector

## 3. Conclusions

Semiconductor detectors equipped with a converter like $^6$LiF or $^{10}$B can currently be considered very interesting alternative to conventional neutron detectors, because of their compactness and reliability. As preliminary test, Silicon Carbide radiation detector with $^6$LiF converter by MCNPX code was simulated for predication of neutron detection efficiency. In future work, Silicon Carbide radiation detector will be irradiated by changing a neutron dose rate and then, evaluated linear response.

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