Design and Fabrication of a Si PIN-type Radiation Detector for Indoor Radon Measurement

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Introduction

^{222}Rn, which emits 5.5 MeV alpha particle, is a cancer-causing natural radioactive gas. It is recommended that the radon level in public space may be fixed below 4 pCi/L. It is reported that more 88% of ^{218}Po atoms, which is one of the progeny nuclei of ^{222}Rn, tended to become positively charged. The principle of radon detection, which is used in this detector is an electrostatic collection of the progeny nuclei of ^{222}Rn and an energy measurement of its alpha decay with the fabricated Si PIN-type radiation detector. A double guard electrode and a diffused edge protection structure were incorporated to achieve a low noise and fully depleted radiation detector. In this study, characteristics of the fabricated silicon PIN-type radiation detector were addressed.

Materials and Methods

A schematic structure of a designed PIN-type radiation detector is shown in figure 1. The active area was about 10 x 10 mm^2. An edge protection structure, which is for the prevention of a breakdown at relatively lower voltages, was incorporated [1]. Two n-type silicon, which have different resistivity, were used in detector fabrication. The fabricated Si PIN-type radiation detector for indoor radon measurement.

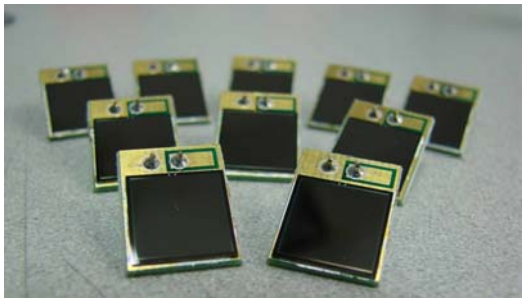

Fig. 1. The fabricated Si PIN-type radiation detector.

Results and Discussion

A Keithley 6517A high precision electrometer and a shielding case, which was for prevention from an external electromagnetic wave and light, were used in measurement [2]. The meausred leakage currents are shown in figure 2. In case of 7 kΩ·cm PIN-type detector, leakage currents were slightly lower than the case of 4.5 kΩ·cm PIN-type detector due to the difference of resistivity. And a breakdown was not also observed up to 200 V in both cases.

The energy spectrum for 5.5 MeV alpha particles from ^{241}Am were measured with a pulser

in vacuum by using an ORTEC Soloist as shown in figure 3. Energy resolution was 6 channel FWHM. A ^{222}Rn was measured by using uranium concentrated soil sample. Radioactivity of ^{226}Ra in soil sample was 5.6 Bq/g and an emanation rate was 25%.

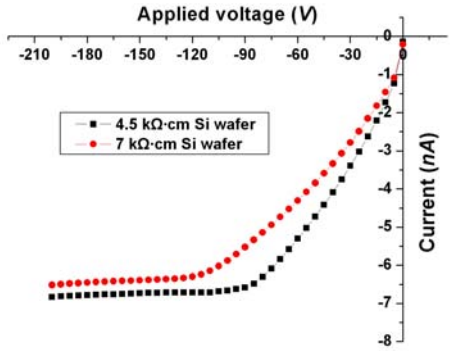

Fig. 2 The measured leakage currents.

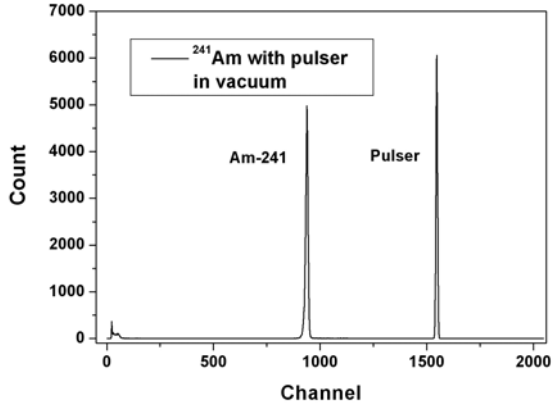

Fig. 3. The measured alpha spectrum.

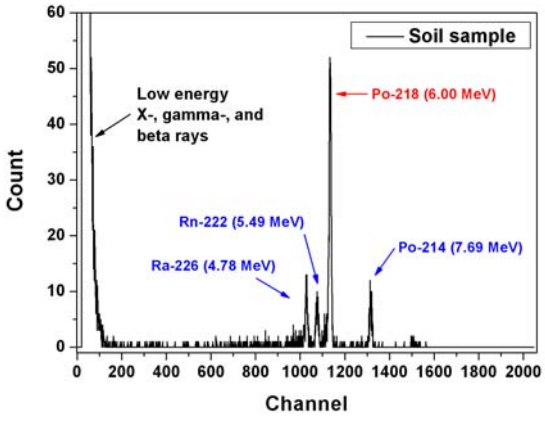

Fig. 4 The measured alpha spectrum from soil sample.

Conclusion

A silicon PIN-type radiation detector was designed and fabricated for indoor radon measurement. Low leakage currents and high biasing voltage were achieved. In radon measurement with a soil sample, the sensitivity of the fabricated PIN-type radiation detector was calculated as 0.31 cpm/(pCi/L).

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Reference

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2. Keithley Model 6517A, 6517A electrometer user's manual, http://www.keithley.com