Contribution ID: **199**

Type: **Poster presentation + pitch**

The radiation hardness comparision of Si, SiC, GaAs and CdTe detectors under high-energy electron irradiation

Bohumír Zaťko1,*, Andrea Šagátová2, Katarína Sedlačková2, Ladislav Hrubčín1,3, Pavol Boháček1

1.Institute of Electrical Engineering, Slovak Academy of Sciences, Dúbravská cesta 9, 841 04 Bratislava, Slovakia
2.Slovak University of Technology in Bratislava, Faculty of Electrical Engineering and Information Technology, Institute of Nuclear and Physical Engineering, Ilkovičova 3, 812 19 Bratislava, Slovakia
3.Joint Institute for Nuclear Research, Joliot-Curie 6, RUS-141980 Dubna, Moscow Region, Russian Federation

- Corresponding author, bohumir.zatko@savba.sk

We have fabricated and studied semiconductor detectors of ionizing radiation for more than two decades. In preference, we have investigated detector structures based on bulk semi-insulating GaAs and 4H-SiC high-quality epitaxial layer. The electrical and detection performance of fabricated detector structures were researched [1, 2]. Also, the radiation hardness or lifetime in radiation harsh environment is very important parameter of detectors. We have comprehensively studied the radiation hardness of semi-insulating GaAs detectors [3, 4].

In this paper, the radiation hardness of various detector types was investigated. In our study, we used four types of typical radiation detectors based on Si (silicon), 4H-SiC, semi-insulating GaAs and CdTe. Detectors based on Si have the thickness of 300 um and active area of 6×6 mm2. The high-quality epitaxial layer with doping concentration about 7×10E13 cm-3 and 70 um thickness was used for 4H-SiC detectors fabrication. The diameter of Ni Schottky contact was 2 mm. In case of semi-insulating GaAs detectors, we utilized 220 um thick base material with 1 mm circular Pt Schottky contact. The CdTe Schottky detectors have 4×4 mm2 size and 1 mm thickness. Studied detectors were irradiated with 5 MeV electrons by using several steps. After each irradiation step the spectrometric performance of all detector samples was investigated and then the total dose was increased. The detection and spectrometric parameters of detectors were measured with the same read-out chain based on Amptek charge sensitive preamplifier and digital pulse processor. As a source of testing radiation, we used 241-Am radioisotope which generates X-rays and gamma-rays peak up to about 60 keV. Fig. 1 shows selected measured spectra of Si and 4H-SiC detectors. Left chart shows the spectrometric performance of Si detector after 0.5 kGy and 1.0 kGy dose of high-energy electron irradiation. Due to better visibility of 60 keV peak we inset also magnified spectra. It can be seen that after only 1 kGy of radiation dose the Si detector completely loses its ability to resolve X-rays peaks. On the contrary 4H-SiC detectors is still able to resolve X-ray peaks even after 30 kGy of irradiation dose. Our study indicates that Si detectors work only up to 4.1 kGy or irradiation dose which totally damage the samples, which means that detectors were not able to detect any radiation. On the contrary 4H-SiC detectors were irradiated up to 2.5 MGy and were still able to detect radiation with very limiting resolution. Regarding semi-insulating GaAs detectors, most of results we published in our previous works and detectors were able to operate up to 1 MGy of radiation dose. Detectors still can detect radiation but due to very small charge collection efficiency about 10% the detection of 60 keV peak of 241-Am radioisotope was not possible. The CdTe detectors show similar radiation hardness like Si samples. But the major limitation is polarization effect which tested samples demonstrated. The unirradiated CdTe samples were able to work about 90 minutes without peaks shifting to lower channels but after only a radiation dose of about 2 kGy the operational time was shortened to only 1 minute after that detectors loses their spectrometric performance and should be switched off.

[1] Zaťko, B., Hrubčín, L., Šagátová, et al., Applied Surface Sci 536 (2021) 147801.
[2[Dubecký, F., Zaťko, B., Kolesár, V. et al., Applied Surface Sci 467-468 (2019) 1219.
[3] Šagátová, A., Zaťko, B., Nečas, V., and Fülöp, M., J. Instrument. 15 (2020) C01024.
[4] Šagátová, A., Zaťko, B., Nečas, V. et al, J. Instrument. 13 (2018) C01006.

The authors acknowledge funding from the Slovak Research and Development Agency by grants Nos. APVV-18-0273 and APVV-18-0243 and the Scientific Grant Agency of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences through grant No. VEGA 2/0084/20.

Author: Dr ZATKO, Bohumir (Institute of Electrical Engineering, Slovak Academy of Sciences)

Co-authors: SAGATOVA, Andrea (Slovak University of Technology in Bratislava); SEDLAČKOVÁ, Katarína; HRUBCIN, Ladislav (JINR Dubna); Dr BOHACEK, Pavol (Institute of Electrical Engineering, Slovak Academy of Sciences)

Presenter: Dr ZATKO, Bohumir (Institute of Electrical Engineering, Slovak Academy of Sciences)

Session Classification: Poster session 2

Track Classification: Sensor Materials, Device Processing & Technologies