Contribution ID: **173** Type: **Poster**

P1.50: Experimental analysis of small pixel effect in SI GaAs detectors via alpha particles

Monday, 26 June 2023 15:40 (1 minute)

Semi-insulating (SI) GaAs detectors represent a perspective alternative of commercially available silicon detectors, exhibiting high radiation hardness and better efficiency for gamma and X-ray registration due to higher density. The SI GaAs detectors found already application also as sensors for Timepix based detectors [1]. Here the miniaturization of Schottky contact to dimensions fitting the Timepix ASIC readout with 55 um pitch was utilized. However, the area of detector contact affects its detection parameters, e.g. the charge collection efficiency (CCE). In [2], the Monte Carlo simulations have revealed so called small pixel effect in highly pixelated X-ray imaging detectors fabricated from SI GaAs. The 300 um thick detector with 40 and 150 um pitch pixelated Schottky contacts on one side and a large area ohmic contact on the opposite surface of substrate were compared to larger detectors. The simulations show that the CCE changes with the depth of GaAs substrate depending on the Schottky contact size. The small pixel detector CCE increases steeply from Schottky pixel electrode and then mildly decreases to ohmic one. On the other hand, the larger area detector shows mild increase of CCE from Schottky pixel electrode up to the ohmic one. Finally, the CCE of small pixel detectors near Schottky electrode is higher than of large ones and on the opposite, near the ohmic electrode the larger detectors exhibit higher CCE.
We have prepared the SI GaAs detectors from 350 um double-side polished Vertical Gradient Freeze (VGF) substrate produced by Wafer Technology Ltd. The Schottky contacts of a circular shape with various diameters from 100 up to 1000 um from Ti/Pt/Au (15/35/50 nm) multilayer and a whole area Ni/AuGe/Au (30/50/60 nm) ohmic electrodes were evaporated at Institute of Electrical Engineering of Slovak Academy of Sciences in Bratislava. At first, we measured current-voltage characteristics of prepared Schottky barrier detector structures. We revealed the dependence between the break down voltage and the Schottky area contact. With decreasing the contact area, the breakdown voltage increases.
Following, the small pixel effect was studied experimentally by alpha spectrometry, where 241Am source with 84.8% yield of 5486 keV alpha particles was used. These alpha particles have the longitudinal projected range in GaAs of 20 um after penetrating the used metallization of electrodes, according to SRIM [3] simulation. Measuring the alpha spectra irradiating detector from two different sides reveals the CCE in region near Schottky vs. ohmic electrode. Measured alpha spectra when irradiating the Schottky electrode show increasing CCE with decreasing the Schottky contact area. On the other hand, the alpha spectra measured during ohmic electrode side irradiation proved the improvement of the CCE with increasing Schottky electrode area. This is in accordance with simulated small pixel effect theory of CCE variation with SI GaAs detector depth [2]. The utilization of SI GaAs based sensor in Timepix type detector with 55 um pixel pitch and its irradiation from common ohmic electrode will have positive effect on detector CCE when comparing with single large area SI GaAs detector typically tested by exposition from Schottky contact side.

[1] B. Zatko, et al., JINST 13 (2018), C01034
[2] P.J. Sellin, NIM-A 434 (1999), 75-81
[3] J. F. Ziegler et al., NIM-B 268 (2010), 1818-1823

The authors acknowledge funding from the Slovak Research and Development Agency (Research Projects APVV-18-0273 and APVV-18-0243).

Primary author: KURUCOVÁ, Nikola (Institute of Nuclear and Physical Engineering, Faculty of Electrical

Engineering and Information Technology, Slovak University of Technology in Bratislava)

Co-authors: SAGATOVA, Andrea (Institute of Nuclear and Physical Engineering, Faculty of Electrical Engineering and Information Technology, Slovak University of Technology in Bratislava); Dr ZATKO, Bohumir (Institute of Electrical Engineering, Slovak Academy of Sciences); KOVACOVA, Eva (Institute of Electrical Engineering, Slovak Academy of Sciences); SKRINIAROVA, Jaroslava (Institute of Informatics, Slovak Academy of Sciences); PAVLOVIC, Marius (Institute of Nuclear and Physical Engineering, Faculty of Electrical Engineering and Information Technology, Slovak University of Technology in Bratislava); PREDANOCY, Martin (Institute of Informatics, Slovak Academy of Sciences); BOHACEK, Pavol (Institute of Electrical Engineering, Slovak Academy of Sciences)

Presenter: KURUCOVÁ, Nikola (Institute of Nuclear and Physical Engineering, Faculty of Electrical Engineering and Information Technology, Slovak University of Technology in Bratislava)

Session Classification: Poster (incl. coffee)