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Trial electrode topology of a radiation detector: Design, modeling, semi-insulating GaAs technology and performance testing

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The paper is devoted to design, numerical modeling, fabrication and evaluation of a detector with the new electrodes topology: standard sandwich-like two electrode detector is complemented by an additional electrode surrounding the small circular anode Schottky contact. It is shown that the detection efficiency of such detector with connected bottom and surface electrode increases 2-4 times for 5 keV photons while the dc leakage current changes negligible and it is very low. Hence the detector could operate at room temperature with good spectrometric performance. If all electrodes use Schottky barrier metallization, the detector could operate also in opposite polarity: negatively biased bottom contact connected with the surface additional electrode. In such case the detection efficiency for 5 keV photons increased even more, 3-6 times comparing to the standard two electrode configuration. In the former case, however, the leakage current is higher due to larger area of the bottom, cathode contact. Hence such detector operation needs lowered temperature using Peltier cooler. Moreover, the technology is more complicated by both-sided photolithography if the bottom full area contact is replaced by a contact with the defined area.

The idea is applied and verified the semi-insulating GaAs material. I-V characteristics and pulse height spectra of the ^{241}Am are demonstrated at room as well as at lowered temperature down to -50 degrees Celsius. The detection efficiency of the ^{55}Fe is evaluated for different electrode connections.

Preliminary results shows reverse current $1\text{E}-10$ A at 295 K and -200 V (single cathode) or at -100 V (cathode connected with the additional surface electrode). The breakdown voltage exceeds -700 V. The energy resolution and the detectable threshold is limited by the noise of the used preamplifier (about 1.5 keV FWHM for GaAs). Hence usage of ultra low noise preamplifier for detection evaluation in soft X-ray region will be necessary.

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