Carrier dynamics and resolution of co-planar grid radiation detectors

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Co-planar grid detectors utilizing single carrier sensing techniques, offer a practical solution for developing compound semiconductor gamma-ray detectors with high resolving power [1]. We present a fully analytical model for describing the response of co-planar grid geometries. We discuss the results of an analysis of the spatial dependence of carrier collection. and show that the topology of electron drift trajectories is governed by the parameter $\alpha=(\delta V/V)(L/c)$, where $\delta V/V$ is the relative variation of grid potential and L/c is an aspect ratio, with L being the detector thickness and c the cell width (i.e., the sum of the widths of the individual strips of both grids). This parameter describes the ratio of the characteristic electrostatic field in the near-field region of the individual strip and the mean field in the bulk. For $\alpha>2$, all electrons are collected by the high potential grid, whereas for $\alpha<2$ the electrons which were created beneath the central area of a lower potential strips are collected by the lower potential grid. Because of this, the co-planar grid detection techniques is shown to possess an intrinsic lateral inhomogeneity in its response, which is inherent to the design. Decreasing the dependence of the collected electron charge on the photon absorption depth (by cancelling the difference weighting potential outside the near field region), simultaneously brings about the dependence of the collected charge on the lateral coordinate. Thus, the inhomogenous component is due to both a lateral and bulk contributions. As a result, the resolution of a co-planar grid detector is dominated largely by the inhomogeneous broadening of the signal and not by Fano or electronic noise. We evaluate the inhomogeneous broadening due to depth dependence of the signal, which is as expected, of the same order of magnitude as for a small pixel detector. Lateral contributions are evaluated for full-area illumination, where they become important.

References

[1] Alan Owens, A.G.Kozorezov "Single carrier sensing techniques in compound semiconductor detectors".