Ge/GaAs heterostructure matrix detector

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Germanium is a widely used material for radiation detectors due to its many advantageous physical properties. As a relatively low-bandgap material it offers a low electron-hole pair creation energy, which gives potential for good energy resolution. Furthermore, it is available in wafers with very high crystalline quality and extremely low impurity concentration. However, the conventional processing methods do not enable matrix detectors [1].

We present a new technique to realize a Ge pixel detector. In our approach, the pixel matrix is patterned on a thin epitaxial GaAs layer. This allows precise patterning of the detector structure.

The germanium substrate in the detector matrices described here is of ultra high purity, with p-type impurity concentration of 10^{10} cm^{-3}. The n-doped GaAs-layer is grown by MOCVD method on top of the germanium wafer and patterned into a pixel matrix by mesa etching. The (100) substrate is misoriented 6° to <111> in order to reduce the formation of anti-phase boundaries [2].

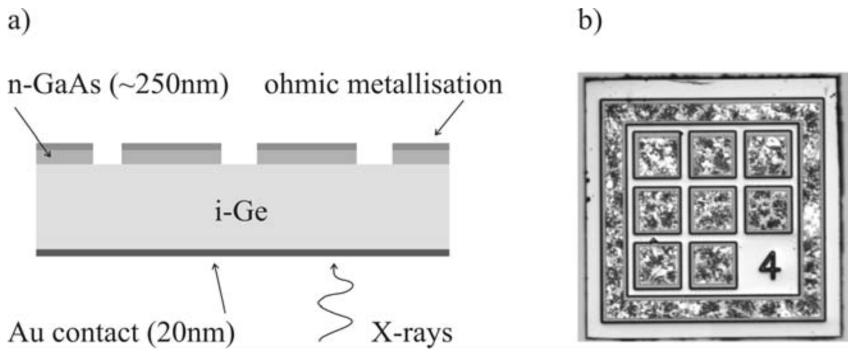

Figure 1: a) Schematic cross section of manufactured test detector matrices b) Photomicrograph of fabricated detector test matrix (width of the matrix is 2.5 mm).

Dark currents of typically 50 pA/pixel with reverse bias of 10 V were measured at 77 K. With a pixel area of 0.3 mm^2, this corresponds to leakage current density of 17 nA/cm^2. Dependence of mesa etching depth on IV characteristics and interpixel resistance were studied.

References

[1] –L. S. Darken, C. E. Cox, in: T.E. Schlesinger, R.B. James (Eds.), Semiconductors for Room Temperature Nuclear Detector Applications, Semiconductors and Semimetals, vol. 43, Academic Press, San Diego, CA, USA, 1995.

[2] – Yuan Li, et al., Journal of Crystal Growth **163** (1996) 195-202.