Charge Carrier Lifetime Determination in GaAs:Cr under Near-Surface Illumination

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Chromium compensated gallium arsenide (GaAs:Cr) proposed by Tomsk State University has shown itself as a material of high quality and strong demand in producing radiation sensors. Modern technology allows to have 3 and 4 inch material with resistivity value up to 109 Ω*cm and thickness of 500 – 1000 μm. HR GaAs:Cr sensors have already found employment in ATLAS project, in different experiments at Rutherford Appleton Laboratory and PSI, and will find its place in new applied researches as building of recording and measuring equipment for X-ray Free Electron Laser (XFEL). As detector quality material always should have big values of charge carrier lifetimes, the problem of its determination always stands. In this paper a method of electron and holes lifetime calculation under near-surface illumination is presented.

Investigated structures were made of GaAs:Cr and had Ni contacts. The structure of contacts resembles mesh (Figure 1). This was done in order to avoid light absorption in nontransparent metal layer. Samples were 500 μm thick and active area size of 0.12 mm2.

Prior to amplitude spectrum measurements, IV-characteristics of samples were investigated in the range of applied bias from 0.01 V to 500 V. It was shown that proposed "mesh" structure of contact has no effect on IV-characteristics comparing to pad sensors'. The amplitude spectra of investigated structures were obtained when illuminating with LED. The wavelength of used LED was 396 nm. The measurements were carried out in the voltage range 10 – 150V. Using obtained data charge collection efficiency dependencies on electric field distribution were built. The analysis of these dependencies was carried out using Hecht equation. It is shown that calculated electron lifetime is of the same order as the one obtained from gamma spectra of investigated structures.

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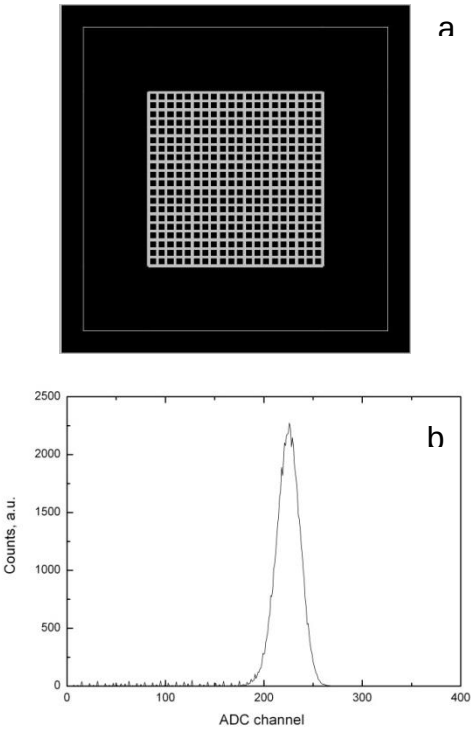

Fig. 1 The structure of "mesh" contact of investigated samples (a); amplitude spectrum of sample under illumination at 150 V (b).