Temperature dependencies of current-voltage characteristics of GaAs:Cr sensors with different types of contacts

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The compensation of GaAs with Cr impurity leads to an increase in the resistivity and lifetime of the charge carriers. This fact allows for the use of GaAs as a material for the fabrication of X-ray imaging detectors [1]. GaAs:Cr detectors are known for their good energy resolution and a greater charge collection efficiency. The characteristics of the detectors depend on the semiconductor material and the properties of the metal contacts. In particular, depending on the type of semiconductor-metal contact, one can observe a change in the dark current, which leads to a change in the signal-noise ratio. In this paper, we present studies of the *I-V* characteristics of GaAs:Cr sensors with three types of metal contacts: Ni-Ni Schottky contacts, ohmic AuGe-AuGe contacts, and AuGe-Ni contacts.

The *I-V* characteristics were obtained using a sourcemeter Keithley 2410 and a thermostat. The experiment was carried out in the voltage range of 0.01–500V and the following temperatures: 15, 25, 40, and 60℃. We used 500μm thick sensors with an active area of 0.09 cm^2.

The obtained *I-V* characteristics for the three types of metal contacts are shown in Figure 1. The current-voltage characteristics of the investigated detectors with Schottky contacts have three distinct regions: the first region, where the current density is linearly dependent on the voltage (from 0.01 to 0.5 V), the second region with the sublinear dependence (from 0.5 to 10V), and the third region also with linear dependence (U>10V). The sublinear dependence on the second region is due to a barrier on the metal-semiconductor interface. We assume that the third region is due to the Poole–Frenkel or Schottky effect, which should be investigated in more detail. The barrier height was calculated from the second region on the basis of thermionic emission. We obtained a barrier height of the order of 0.5 eV.

The current-voltage characteristics of the detectors with ohmic contacts have two distinct regions: the first region with a linear dependence of current density on voltage and the second region with a quadratic dependence. The quadratic dependence is due to unipolar electron injection from the metal contact. From the linear fit of the first region we obtained a resistivity of the semiconductor material of the order of $10^8 - 10^9 \Omega \cdot cm$.

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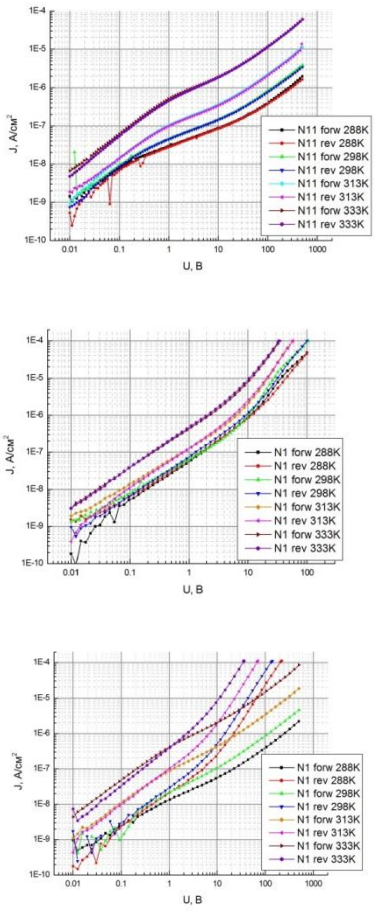

Fig. 1 *I-V* curves of GaAs:Cr samples with different metal contacts: (a) Ni-Ni Schottky contacts, (b) ohmic AuGe-AuGe contacts, (c) AuGe-Ni contacts

[1] G. Ayzenshtat et al., Nucl. Instrum. Meth., V. 487, № 1-2, p.96-101, 2002