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Determination of the Electrical Parameters of the GaS Thin Film

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In this work, the electrical conductivity, volt-ampere characteristics of GaS thin film obtained by thermal evaporation on clean glass were studied before and after gamma irradiation, thermal annealing temperature, and their electrical parameters were determined. The changes in the values of the electrical parameters were compared.

Keywords: thin film, electrical conductivity, radiation, charge carrier, volt-ampere characteristic

In semiconductors with a wide band gap, one of the research methods used to clarify the energy spectrum of their band gap, the characteristics of electronic processes, the interaction of free charge carriers and local levels, as well as the characteristics of the effects related to this interaction, the mechanism of occurrence, is the study of the volt-ampere characteristic [1–4]. The main feature of this study is that by directly measuring the injection current, it is possible to obtain information about the energy state of the traps located in the forbidden zone, the concentration and the capture cross section of charge carriers at local levels.

The electrical conductivity of the GaS thin film obtained by thermal evaporation on a glass substrate was studied. In order to measure the electrical conductivity of the obtained layer, contacts with silver paste were applied to the sample. As a result of X-ray analysis of the sample, it was determined that the thin layer has an amorphous structure. The physical properties of GaS single crystal have been widely studied and are successfully applied in various fields of electronics. The purpose of the work is to determine the dependence of the volt-ampere characteristic, electrical conductivity of GaS amorphous thin film on temperature, gamma radiation, and thermal annealing temperature. The electrical properties of the prepared samples were measured in the temperature range of 110–300 K, and during the measurement, the electric voltage of the sample was measured using a B7-27A voltmeter. The current generated in the crystal was recorded using a B7-30 voltmeter-electrometer amplifier.

Fig. 1 (curve-1) shows the VAX of a GaS thin film obtained on glass. Depending on the value of the voltage applied to the crystal, the current varies according to the law of n= 1 in the range of 0.1–1 V, and according to the law of n= 1.3 in the range of 1–100 V. The concentration of charge carriers, level activation energy and capture factor were calculated from the graph as $1.1\cdot10^{10}$ cm^{-3}, 0.552 eV, 7.228, respectively. Fig. 1 (curve-2) shows the VAX of the thin layer after 1 hour of thermal annealing at 100^{o}C. The curve changes according to the law of n= 1, 1.5 and n= 1. The concentration of charge carriers P= $4.83 \cdot 10^9$ cm^{-3}, the activation energy of the level *E*= 0.573 eV and the retention factor were calculated from the graph.

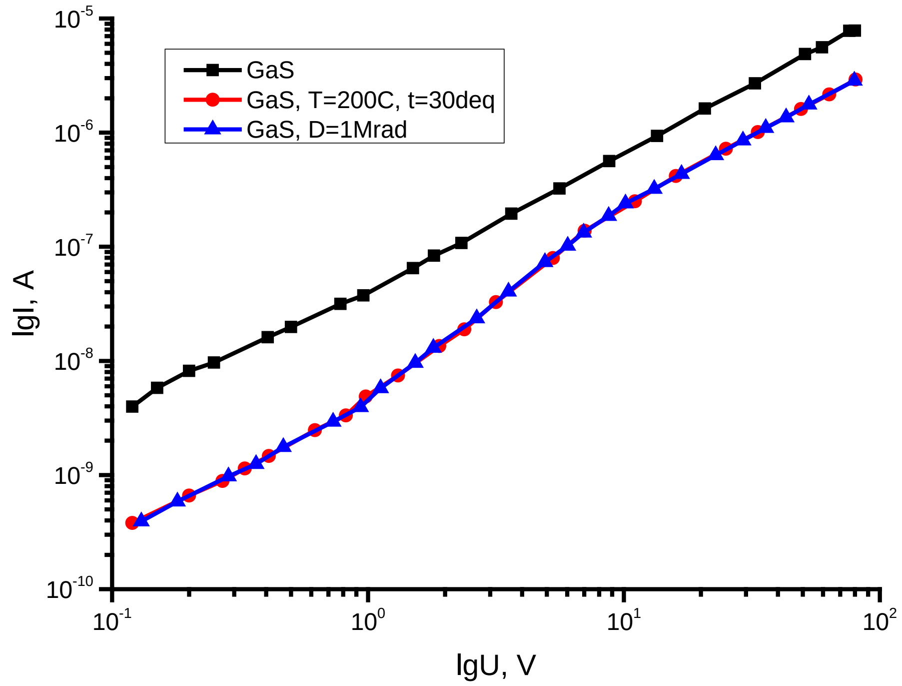

Figure 1. VAX of a thin GaS layer obtained on a glass substrate: squares – GaS thin film obtained on glass, circles – VAX of the thin layer after 1 hour of thermal annealing at 100^{o}C, triangles – irradiated at a dose of D= 1Mrad.

After irradiating the sample with a dose of D= 1Mrad, VAX was established and the nature of the curve did not change, and its values were the same as those obtained after thermal annealing. Fig. 2 (curve-1) shows the temperature dependence of the electrical conductivity of a pure GaS thin film. The activation energy of charge carriers in the temperature range of 110–145 K is 0.153 eV, in the range of 145–250 K it is 0.207 eV, and in the range of 250–300 K it is 0.414 eV.

Fig. 2 shows the temperature dependence of the electrical conductivity of the GaS thin film after 30 minutes of thermal annealing at 200^{0}C. The activation energy of charge carriers in the temperature range of 110–250K was calculated as 0.099 eV, and in the temperature range of 250–300 K as 0.178 eV. When the sample was irradiated with gamma rays with a dose of D= 1 Mrad, there was no change in the temperature dependence of the sample's electrical conductivity. Thus, the values of the parameters obtained after irradiation are the same as the values of the parameters obtained after thermal annealing.

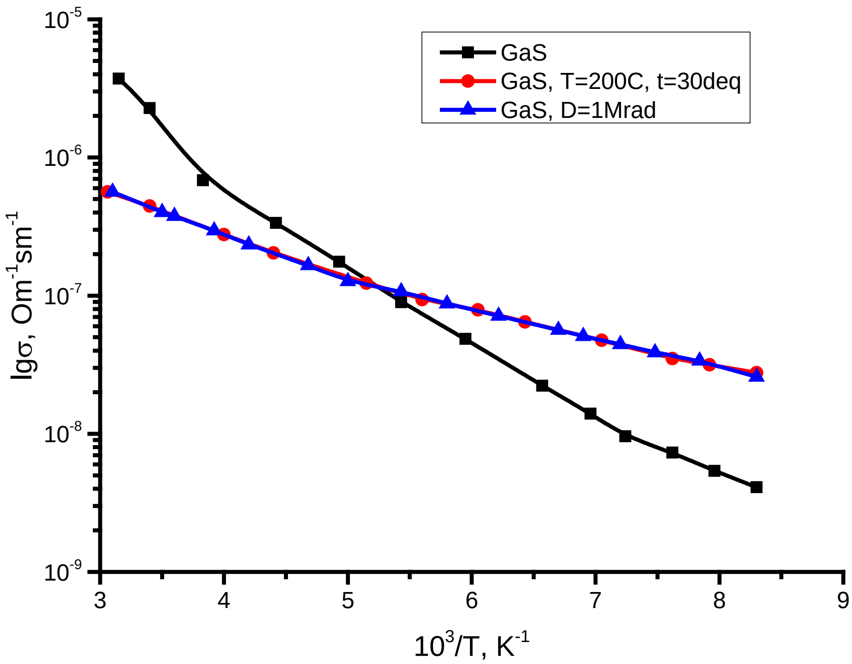

Figure 2. Temperature dependence of the electrical conductivity of a thin GaS layer obtained on a glass substrate: squares – GaS, circles – GaS thin film after 30 minutes of thermal annealing at 200^0C, triangles – irradiated at a dose of D= 1Mrad.

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