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ELECTRICAL PROPERTIES OF AN ACCEPTOR-LIKE STATE OF METASTABLE EL2 IN n-TYPE GaAs UNDER UNIAXIAL STRESS*

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The electrical resistivity and deep level transient spectroscopy measurements of n-type GaAs under uniaxial stress for [100] and [111] directions at low temperatures are presented. After the transformation of EL2 to its metastable state the stress induced strong anisotropy in the increase in resistivity was observed. The observed splitting of the acceptor-like state of metastable EL2 implies the trigonal symmetry of that defect.

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It is known that the acceptor level of the EL2 defect in its metastable configuration ($\mathrm{EL2}^{*(0/-)}$) under atmospheric pressure is degenerated with the conduction band of GaAs [1]. This acceptor level enters the gap at hydrostatic pressure of $0.2 \div 0.3$ GPa, which causes the decrease in free-electron concentration and can be detected by means of deep level transient spectroscopy (DLTS) [1].

We performed the electrical conductivity and DLTS measurements under uniaxial stress in order to investigate the symmetry properties of this level.

The investigated material was n-type liquid encapsulated Czochralski grown GaAs ($n = 3.2 \times 10^{16}$ cm^{-3}). Samples were X-ray oriented and an uniaxial stress could be applied along the [111] and [100] directions. The sample resistivity was measured using four-probe method. The DLTS measurements were performed using Schottky barriers in frequency scan mode [2]. Uniaxial stresses up to 0.7 GPa were obtained with a press apparatus attached to the Oxford Instruments cryostat.

For both directions of stress the same experimental procedure was applied. A "dark" resistivity was measured just after cooling down the sample to 4.2 K in a dark under atmospheric pressure (see Fig. 1). Under the highest stress the DLTS signal was recorded. Then at low stress the sample was illuminated with 1.05 μm light for approximately 10 min. The sample resistivity decreased during the illumination and it increased after the light was off. Electrical measurements were performed after sufficiently long time ($30 \div 40$ min), when the sample resis-

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tivity was established. The electrical conductivity at 4.2 K is presented in Fig. 1. Then the resistivity was measured at temperatures 20 K, 30 K, 40 K and 50 K (see Fig. 2). The persistent changes of resistivity after illumination of the sample under the stress of 610 MPa along [111] axis were also measured (see Fig. 1).

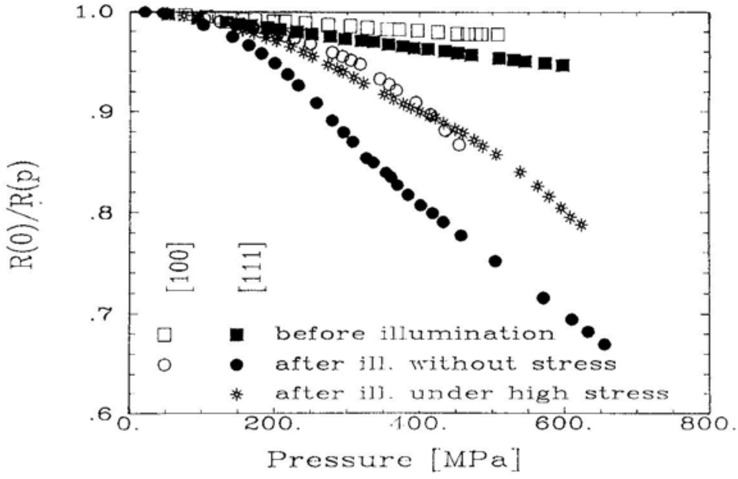

Fig. 1. Relative changes of the sample conductance at 4.2 K under the stress along [111] axis (closed symbols) and along [100] axis (open symbols). The conductance measured just after cooling down the sample in a dark and after subsequent illumination with 1.05 μm light is marked with circles and squares respectively. The conductance measured after illumination with 1.05 μm light under the stress of 610 MPa along [111] direction is marked with asterisks.

The stress induced persistent changes of the sample resistivity were caused by the illumination (1.05 μm) transferring the EL2 to its metastable configuration and vanished at the temperature of thermal recovery of the EL2 from the metastable to the normal state (40 K÷50 K). These facts confirm that observed stress induced persistent resistivity is due to the stress shift and splitting of the $\mathrm{EL2}^{*(0/-)}$ level. The DLTS signal was correlated to the stress induced persistent resistivity and corresponded to the ionization of the $\mathrm{EL2}^{*(0/-)}$ level. Our results can be explained assuming the model $\mathrm{As_{Ga}} \leftrightarrow \mathrm{As_i V_{Ga}}$ of EL2 metastability [3]. According to that model the metastable configuration of EL2 has a trigonal symmetry. Therefore the 4-fold orientationally degenerated $\mathrm{EL2}^{*(0/-)}$ level splits into two (triplet and singlet) components under [111] stress and does not split under [100] stress [4]. Our results are in good agreement with this model. The effect of persistent resistivity is stronger for [111] stress than for [100] stress. For [100] direction the stress induced persistent resistivity is caused only by a shift of $\mathrm{EL2}^{*(0/-)}$ with a hydrostatic component coefficient. For [111] stress this effect is due to the splitting of $\mathrm{EL2}^{*(0/-)}$ level.

As was found from optical measurements very recently [5], only one of two possible orientations of metastable EL2 could be created by illumination under high stress along [111] axis. One can see in Fig. 1 that the persistent stress in-

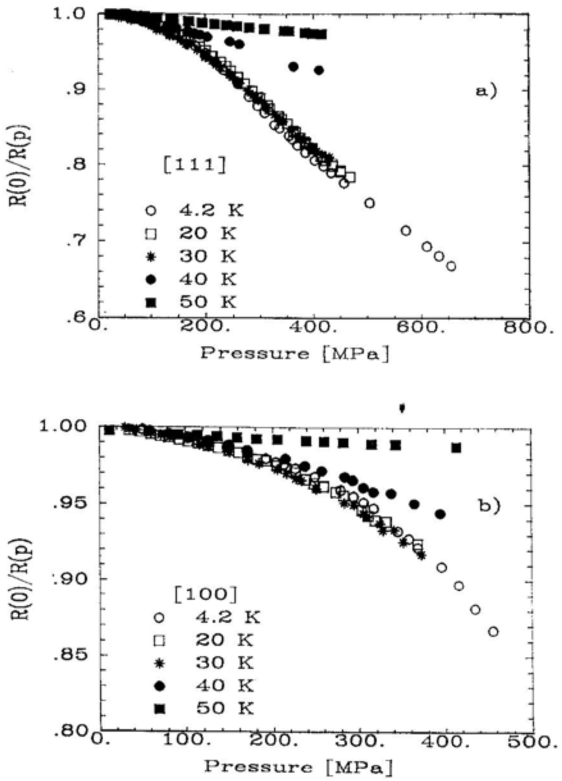

Fig. 2. Relative changes of the sample conductance under the stress along [111] axis (a) and along [100] axis (b) at several temperatures after illumination with 1.05 μm light without stress.

duced resistivity under [111] stress depends on the conditions of illumination. The dependence of the stress induced resistivity after illumination under the high stress along [111] axis has the same character as the stress induced resistivity under [100] stress. The detailed analysis of the obtained data will be published elsewhere.

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