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FREE CARRIERS SCREENING MECHANISM OF SHALLOW IMPURITY ELECTRIC FIELD BREAK DOWN ESTABLISHED FROM ZEEMAN AND CYCLOTRON RESONANCE PHOTOELECTRIC SPECTROSCOPY IN n-GaAs

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From the low temperature shallow impurity electric field break down (LTSIEBD) investigations in *n-GaAs* samples with shallow impurity (SI) concentrations N_D = 10^{14} -10^{15} cm^{-3} and compensation degree $K = N_A - N_D^{-1} = 0{,}2 - 0{,}8$ in crossed and parallel electric and magnetic fields up to H - 6.5T a new mechanism of LTSIEBD has been established. To study the LTSIEBD mechanism Zeeman (transitions from the ground to excited states $1s \rightarrow 2p_{+1}$, $1s \rightarrow 3p_{+l}$ etc. of SI) and cyclotron resonance photoelectric spectroscopy methods were used at applied electric fields corresponding to the samples CVC different regions including BD one- E_{bd} . The results obtained, such as lack of correlation between E_{bd} and K or mobility of carriers μ contradicts to known impact ionization mechanism (IIM). In serious contradiction with IIM is the independency of E_{hd} *(H)* on magnetic field value when $E \parallel H$, despite of SI ionization energy twofold increase in *n- GaAs* at H = *6.5T,* Cyclotron resonance (CR) investigation shows that for the most of samples the line width does not depend on electric field for $E < E_{bd}$ indicating the lack of free carriers heating, which also contradicts to IIM. From investigations of intensities of $1s \longrightarrow 2p_{+l}$, and CR lines in electric fields $E \leq E_{bd}$ at different magnetic fields, and their mutual directions $(E \parallel H$ and $E \perp H)$ it was established considerable decrease of free carriers (FC) capture cross section (CCS) by ionized SI centers, and as a result of this increase of FC concentrations. In the case of $E \parallel H$ the slope of $1s \rightarrow 2p_{+1}$ line intensity on electric field does not depend on magnetic field value, as it does when $E \perp H$. Some effects which take place in PS when $E = E_{bd}$, such as drastic narrowing of the $Is \rightarrow 2p_{+l}$ and CR lines [l-2], shift of CR line to higher magnetic fields (at fixed quantum energies) and disappearing of lines from *1s* to higher excited states (up to $Is \rightarrow 3p_{+1}$) of SI, are connected with screening of SI Coulomb potential by free carriers. So it was predicted by experiments to involve FC screening in explaining avalanche region peculiarities of CVC. It is shown that the FC concentration increase in an electric field owing to CCS decrease (but not the change of FC distribution function) is the main reason of LTSIEBD. When FC concentration becomes sufficiently high the screening of Coulomb potential of SI, and as a result CCS avalanche decrease occurs, and CCS equals zero when $r_s = a_B^*$ [3]. The last is also the Mott transition condition $N_D a_B^*$ ~1 for which ($N_D \approx 2\ 10^{16} cm^{-3}$ for *n - GaAs*) BD and S-like region in CVC disappear. So the numbered experimental facts and CCS calculation for screened Coulomb potential [3] witness of the screening mechanism for LTSIEBD.

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[3]. Alekperov O.Z. J. Phys.: Condens.Matter 10 (1998) 8517.