GENERATION OF THE ELECTRON-HOLE PAIRS IN THE INTRINSIC SEMICONDUCTOR IN EXTERNAL ELECTRIC FIELD

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S u m m a r y

We calculated an increase of the number of electron-hole pairs in the intrinsic semiconductor placed in an external electric field. This effect was experimentally observed by A.Ioffe and is caused by a decrease of atomic ionization potential in the presence of an external electric field (Zenner effect). From the viewpoint of band theory, this effect can be explained by the band distortion and by the specific tunnel effect of electrons from the valence band to the conduction band. We get a solution of the Poisson equation for the electrostatic potential in a semiconductor plate, whose thickness is much less than its width and length, therefore it is possible to consider that the potential distribution is one-dimensional. This presents a possibility to find the distributions of electron and hole concentrations considered to be nongenerated. Analytic equations are obtained in two limiting cases: for large thicknesses ($L >> l_D$) and for small thicknesses ($L << l_D$), where L – the plate thickness and l_D – the Debye screening length. At $L >> l_D$, the electron and hole redistribution almost fully screens the external electric field that is mainly concentrated near the plate edges. At $L << l_D$, the number of electrons and holes in the semiconductor is unsufficient for the complete screening of the electric field which is practically constant (the potential changes linearly) over the whole plate thickness. It is possible to calculate only numerically the number of generated electron-hole pairs in the semiconductor placed in the electric field. For small potential differences ΔV on the semiconductor edges, the number of generated electron-hole pairs ΔN is proportional to ΔV^2 in both limiting cases. At large ΔV (but those that doesn't cause an electric breakdown of semiconductor), ΔN increases exponentially with ΔV and it may be by many orders larger than the number of equilibrium electron-hole pairs that exist in the semiconductor in the absence of an external electric field.