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NON-OHMIC EFFECTS AND GALVANOMAGNETIC PHENOMENA IN QUANTUM CONFINED SEMICONDUCTOR STRUCTURES AT LOW AND SOME OTHER LATTICE TEMPERATURES

ABSTRACT

In the present thesis, the theory of the non-ohmic effects and of the galvanomagnetic phenomena in the quantum wells of some widely used heterostructures at low and some other lattice temperatures have been developed to understand and to explore the practicability of the characteristics, for the devices, which are made using these heterostructures.

The thesis deals with the electrical transport properties of degenerate carriers confined in quantum well of heterostructures under the condition when the applied electrical field is high at low temperatures.

Due to the complicated nature of the Boltzmann transport equation, it is usually not possible to solve the same analytically, without making some simplifying approximations. These approximations, very often compromise with the validity of the theoretical results over a quite considerable regime of the prevalent experimental conditions. Hence, an approximate analysis of the high-field transport properties have been made here by assuming a heated Fermi-Dirac distribution function at a field-dependent effective temperature of the carriers.

The electrical transport characteristics of an ensemble of two-dimensional electrons which is confined to an infinite triangular potential well of a heterostructure have been obtained, considering important low temperature features, which are often ignored in any calculation for mathematical simplicity. The features that has been considered here include the degeneracy of the carrier ensemble, the inelasticity of the electron-phonon interaction, the true phonon distribution in-place of the simple equipartition approximation, the effects of the transverse component of the phonon wave vector, etc. In the electrical quantum limit, the electronic interactions with the deformation potential acoustic phonons, the piezoelectric acoustic phonons, the remote ionized impurities, the background ionized impurities and the surface roughness have been considered in the present analysis.

The aspects of the electronic transport that have been dealt with include: (i) the effective electron temperature characteristics of the electron ensemble, (ii) the energy loss rate and the non-ohmic mobility characteristics of the electrons, (iii) the efficiency of the second harmonic generation of the microwave signals, due to the electrical nonlinearity of the electron ensemble, (iv) the ohmic and the non-ohmic Hall mobility characteristics.

The numerical results of the transport coefficients have been obtained for the two-dimensional ensembles of electrons in the quantum wells of InSb, GaAs and GaN. The results have been calculated for different levels of degeneracy and at different lattice temperatures. The results are also compared with the available experimental and the theoretical data. The applicability and inadequacy of the theory have been discussed in details. The scope for further refinements has been pointed out.

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