FLUCTUATIONAL METHOD FOR THE MODELING OF THz OSCILLATIONS IN TWO DIMENSIONAL ELECTRON GAS

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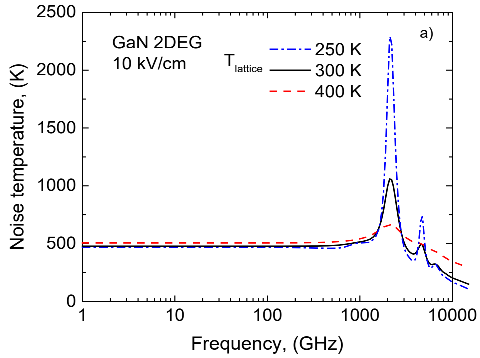
Hot-electron streaming motion regime is considered as one of the possible THz emission mechanisms in the semiconductor structures [1]. The high energy of the longitudinal polar optical phonon and strong electron-phonon interaction advertises gallium nitride as a promising material for the optical phonon assisted streaming motion regime where the electrons move in the momentum space in periodic manner under the constant applied electric field.

The conditions for the electron streaming motion regime are influenced by the density of two dimensional hot-electron gas (2DEG), lattice temperature and quality of the structures. Reliable techniques are required for the selection of structures and external conditions suitable for the electron streaming motion regime. Micro-wave fluctuations yield the information on kinetic processes taking place in the semiconductor structures. In GaN-based structures the peaks in the noise spectrum are expected in THz frequency range. To avoid technically compli-cated measurements at THz frequency, we propose hot-electron noise temperature in the X band as a marker for the electron kinetic processes taking place at THz frequency.

In the present manuscript kinetics of 2DEG is investigated by the means of deterministic numerical method [2]. The method is based on Fourier-like expansion of transport equation in two dimensional momenta space. Green's functions are calculated and Langevin approach is used for the evaluation of noise power spectral density. The same Green's functions are also used to obtain small signal mobility necessary for the calculation of equivalent noise temperature. Calculations are performed for the simplified model of the GaN 2DEG, where electrons are confined in the infinite 60 angstrom wide quantum well. The Pauli exclusion principle is not taken into account in the present calculations. The details of the model are given in [2].

The calculated electron noise temperature spectra contain peaks at the main frequency and the multiples defined by the electron streaming period (Fig. 1 a)). As the lower lattice temperature favors the electron streaming motion, the quality of the calculated terahertz peak increases with the decreasing lattice temperature (dash-doted, solid and dashed lines in Fig. 1 a)). Clear correlation exists between the quality of the THz peak and the plateau in the electron noise temperature dependence on the power supplied by the external electric field at 10 GHz frequency (Fig. 1 a) and b)): higher peak means more pronounced plateau.



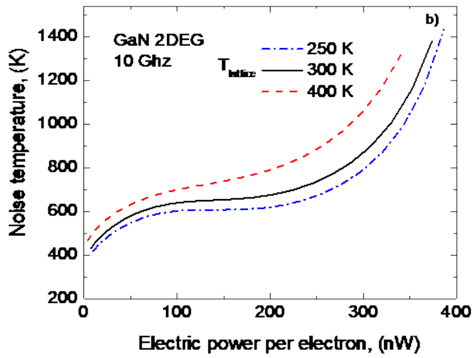


Fig. 1. Calculated spectra of the electron noise temperature in GaN 2DEG (a)) and the noise temperature dependence on the supplied power (b)) for 250K, 300K and 400K lattice temperature.

References

1. E. Starikov et all., JAP, **89**, (2001).
2. M. Ramonas et all., JAP, **128**, (2020).