COMPARISON BETWEEN MEASURED AND SIMULATED DEVICE CHARACTERISTICS
OF HIGH ELECTRON MOBILITY TRANSISTORS

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Abstract

Measurements of the C-V characteristics of pseudomorphic high electron mobility
transistors (HEMT) and the comparison with simulations are presented. It is well known
that the shape of the gate capacitance Cg versus gate voltage Vg relationship is strongly
influenced by the properties of the quasi two-dimensional electron gas (Q2DEG) which
forms the active region of the device, as well as by the onset of a so-called parasitic
channel in the wide bandgap material. In order to study the influence of important
technological parameters on the capacitance, the Schrödinger and Poisson equations
were solved self-consistently in the structure, using the thickness of the doped layer dA
and the doping density ND as the main fit parameters. The simulation results are
compared with measurements performed on wafer on sub-μm gate-length transistors as
well as on so-called fat FETs (Lg = 100 μm). In addition we present comparisons
between measurements and the quasi-2D simulation program HELENA [1].

Summary

The self-consistent Schrödinger-Poisson-Solver (SPS) computes the charge-control law
and the layer capacitances for arbitrary heterojunction MODFET structures as described
in [2] and [3]. Only physical parameters like the effective electron masses, the
dielectricity constants of the different materials and the conduction band-edge
discontinuities (with ΔEc = 0.66 ΔEg) forming the heterojunction were used as input
parameters in addition to the structural layout concerning the thickness of the different
layers and the doping densities. SPS considers up to three conduction band valleys (\(\Gamma, X, L\)), the local exchange-correlation potential and deep donor levels according to the model of Schubert and Ploog [4].

Measurements were performed on wafer by using a HP 4275 A impedance analyzer. The simulated and measured C-V characteristics were found to be in good agreement with each other. The evaluated fit parameters deviate substantially from nominal process targets. Nevertheless, the correctness of the simulation results was corroborated by results extracted from measurements of other HEMT electrical properties. The consistency of the evaluated parameters could also be demonstrated by comparisons with the quasi-2D simulation program HELENA. Furthermore, simulation results obtained by HELENA led to very good correspondence when compared to DC-, AC- and noise measurements.

References


