TWO-DIMENSIONAL HYDRODYNAMIC SIMULATION OF HETEROSTRUCTURE DEVICES

R. Deutschmann, C. Fischer†, T. Simlinger†, C. Köpf†, S. Selberherr†

Siemens AG, Corporate Research and Development, Dept. ZFE STKM 51,
Otto-Hahn-Ring 6, D-81730 Munich, Germany
Phone: +49-89-636-44909, Fax: +49-89-636-40822, E-Mail: rde@altair.zfe.siemens.de

† Institute for Microelectronics, TU Vienna, Gusshausstr. 27-29, A-1020 Vienna, Austria

A new two-dimensional hydrodynamic simulation module has now been developed, capable of simulating heterojunction devices like conventional AlGaAs/GaAs and pseudomorphic AlGaAs/InGaAs/GaAs HEMTs. It has been implemented in the VISTA (Viennese Integrated System for Technology CAD Applications) framework. This provides an efficient exchange of data between the device simulator and other VISTA tools, e.g. a process simulator or visualizing tools. This module is to our knowledge the first simulator which is able to calculate abrupt changes of any material properties, variables, and functions in two dimensions as required for heterojunction devices. In a drift-diffusion approximation the Poisson's and current continuity equations are solved first, and the results are used as initial guess for a hydrodynamic energy transport simulation scheme including energy balance equations. They describe the physical, electrical, and thermal properties of the device, concerning the effects in the electron, hole and lattice subsystems. In addition to the hydrodynamic model an extended Shockley-Read-Hall (SRH) generation and recombination model for deep impurities, and a model for impact ionization consistent with hydrodynamic transport have been implemented.

As a particular example the physical and electrical behaviour of pseudomorphic HEMTs have been studied. Several simulation results will be shown to elucidate the various simulation results which can be received. The simulated transfer characteristic for a pseudomorphic low noise HEMT is in good agreement with the measurement. At positive gate voltages drain current saturation can be observed due to the well known parallel FET effect. In addition, a large fraction of the conduction electrons becomes trapped by DX centers resulting in a reduction of the ionized deep impurities. Taking this effect into account the drain current saturation at positive gate voltages could be correctly simulated.