SERC GRANT GR/F65590 FINAL REPORT
MONTE CARLO MODELLING OF PSEUDOMORPHIC HIGH ELECTRON MOBILITY TRANSISTORS

Summary

This Cooperative Research Grant with GEC Marconi Materials Technology (formerly Plessey Research, Caswell) was awarded to Drs Abram and Brand in 1989 to carry out research on the modelling of high electron mobility transistors (HEMTs). In particular the main objectives were to develop a two-dimensional (2D) selfconsistent Monte Carlo simulation of pseudomorphic HEMTs, including pseudomorphic structures, and to use the simulations to understand the important physical processes and predict device characteristics with a view to optimising device design. An integral feature of the project was the collaboration with GEC-Marconi Materials Technology (GMMT) at Caswell where the strong research and development programme on HEMTs provided a practical context for the modelling. The research began in September 1989. The grant provided funds to support one postdoctoral research assistant for three years and we were fortunate to be able to appoint a top class researcher for the full period of the grant.

During the course of the project we developed two-dimensional simulation models of HEMTs using a selfconsistent ensemble Monte Carlo description of the electron dynamics. The simulators were applied to conventional and pseudomorphic GaAs-based HEMTs but are readily adaptable to related structures and to a wide range of materials systems. As originally anticipated the project involved a long period developing the physical description and the simulation software. Nevertheless the simulators were also used for a number of investigations of device problems, with particular attention devoted to studying (i) the effect of gate length on device behaviour, (ii) the relative importance of real and **k**-space transfer in the channel and its vicinity, (iii) a comparison of gate-drain capacitance in HEMTs and MESFETs, and (iv) the effects responsible for the premature transconductance observed near threshold in many fabricated HEMTs. Throughout the project we maintained close contact with GMMT in what turned out to be an extremely fruitful collaboration. Wherever appropriate we have disseminated the results of the research to the wider community. All the main objectives were achieved and copies of the device simulation software have been installed and successfully run on the VAX cluster at GMMT. Many opportunities exist for exploitation of the research and for further development of the models, and an application for further funding has been submitted to SERC.

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