SERC/MOD GRANT GR/F30314 FINAL REPORT
MODELLING OF HETEROJUNCTION BIPOLAR TRANSISTORS

Summary

This SERC/MOD grant was awarded to Dr R A Abram in January 1989 to carry out research on the modelling of heterojunction bipolar transistors (HBTs). The main objectives of the research were (i) to develop a one-dimensional model of HBTs based on Monte Carlo simulation of carrier transport and realistic band structure, and (ii) to use the model to investigate electronic processes in HBTs with the aims of furthering understanding of their operation and devising methods of enhancing their performance. The research grant provided funds to support one postdoctoral research assistant for three years and we were fortunate to be able to appoint a very able researcher for the full period of the grant. An important feature of the project was the informal collaboration with GEC-Marconi Materials Technology which had been proposed in the original grant application.

During the course of the project we developed a one-dimensional simulation of an HBT using realistic band structure and a self-consistent ensemble Monte Carlo description of the dynamics of *both holes and electrons*, and used it to investigate the properties of the device. The simulation was applied to GaAs/AlGaAs and SiGe transistors but is readily adaptable to a wide range of new materials systems. Particular attention was devoted to phenomena in the base and collector regions of HBTs, including the factors influencing base transit time, base pushout at high current densities, and transient velocity overshoot as electrons enter the collector. It was also demonstrated for the first time how the total electron transit time can be calculated *for different current densities*. The results of the research have been freely shared with our UK industrial collaborators and, when appropriate, disseminated to a wider community. All the main objectives were realized in what turned out to be an extremely fruitful project. Work on a two-dimensional simulation with further refinements to the physical model will begin under a new SERC grant later this year.

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