EPSRC GRANT GR/J10495 FINAL REPORT
MODELLING OF HIGH SPEED SEMICONDUCTOR LASERS

Summary

This EPSRC research grant was awarded to Prof R A Abram and Dr S Brand of the Physics Department, Durham University, to carry out research on the modelling of high speed semiconductor lasers. The main objective of the research was to develop a model based on Monte Carlo simulation of carrier transport and capture/emission in quantum well lasers, including VCSELs. The simulation was also to be used in conjunction with rate equation models to investigate the limitations imposed on the modulation bandwidth of the devices by carrier transport effects, and to study the damping of the frequency response due to nonlinear gain derived from spectral hole burning and carrier heating. The research grant provided funds for a HP735 workstation and one postdoctoral research assistant for three years.

The computer model developed under this grant combines the speed advantage of solving laser rate equations at the quantum wells with a detailed model for carrier injection and transport to the wells, and can be used to study cross-layer transport effects in InGaAsP, AlGaInP or InGaAlAs based edge-emitting lasers. The simulation was used to predict the intrinsic frequency response of a range of InGaAsP lasers with varied geometry, and also to model charge capture into InGaAs/InGaAsP quantum well structures. The results of this work have been extensively reported. A special feature of the project was the adaptation of the model to investigate the temperature sensitivity of AlGaInP laser diodes. Results from this work were recently reported at the Thirteenth International Semiconductor Laser Conference (Israel 1996).

Monte Carlo software written for the laser simulation was developed in collaboration with Dr M Walmsley and Dr D Hoare, who were employed at the Physics Department, Durham University funded by other device modelling grants. These grants investigated carrier transport in HBTs (GR/H45094) and MESFETs/HEMTs (GR/J41642) respectively, and also demanded use of Monte Carlo transport simulation techniques. Hence it was decided that a general Monte Carlo computer program should be written, which could be applied to devices of arbitrary geometry and therefore served all three projects. Such a computer code, named SLURPS, was compiled as a library of Fortran-77 routines, and versions have been supplied to DRA (Malvern), GEC-Marconi (Towcester) and the Computational Condensed Matter Physics Group at UEA (Norwich). SLURPS will continue to be supported and developed under a new EPSRC grant at Durham, concerned with Si/SiGe quantum devices.

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