SERC GRANT GR/F55300 **FINAL REPORT**

CALCULATIONS OF IMPACT IONIZATION IN SEMICONDUCTORS AND SUPERLATTICES

Summary

This SERC grant was awarded in 1989 to Drs Abram and Brand at the University of Durham and Dr Beattie at UWCC to carry out research into the theory of impact ionization in bulk semiconductors and heterostructures. The main objective of the proposed research was to develop a computational method of calculating impact ionization rates, which is capable of giving an accurate description of all significant ionization processes in the relatively wide band gap semiconductors such as InP and GaAs. The award of a grant to pursue the research followed a previous, successful SERC funded Durham-UWCC collaboration which concerned impact ionization and Auger recombination in narrow band gap semiconductors. The research grant provided funds to support one postdoctoral research assistant to be based in Durham for three years. There was a delay before the appointed research assistant could begin his contract and then disappointingly he departed after only five months in the job. However, once the replacement was in post, the research rapidly gathered pace so that all the main objectives were realized in what turned out to be a very fruitful project.

The main achievement of the project has been the development of a method of calculating impact ionization thresholds, antithresholds and rates in semiconductors, which is based on empirical nonlocal pseudopotential band structure. It has been applied to electron and hole-initiated processes in InP, GaAs and AlGaAs. The approach can be used to study impact ionization in other bulk semiconductors of any band gap and, to our knowledge, the method is at least as advanced and powerful as any other calculation of its type. Another useful development is a lucky drift-based Monte Carlo simulation of transport that can be used to describe the approach of carriers to the impact ionization thresholds. This is a useful tool in extracting information on the microscopic properties of impact ionization from the results of transport experiments. It has also been used to investigate spatial and temporal impact ionization transients in bulk material and avalanche multiplication in photodiode structures. The results of the research have been disseminated in a number of papers for learned journals, in conference presentations, and in discussions with academic and industrial colleagues.

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