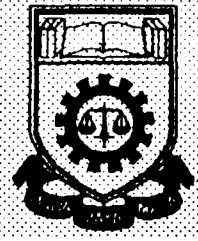
PC BASED PHYSICAL MODELLING OF HETEROJUNCTION BIPOLAR TRANSISTOR

Thesis is presented in partial fulfilment for the award of the Advanced Diploma in Electrical Engineering of INSTITUT TEKNOLOGI MARA



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> All perfect praises belong to Allah alone, Lord of the world. May His blessings be upon Prophet Muhammad s.a.w and members of his family and companion.

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ABSTRACT

A PC based physical modelling of AlGaAs/GaAs Heterojunction Bipolar Transistor (HBT) is used to investigate physical processes which have an impact on device performance. A Drift-Diffusion modelling has been employed and Turbo Pascal is used in its implementation. The programme incorporates Fermi-Dirac statistics, electric field dependent mobilities and Shockley-Read-Hall recombinations. The Scharfetter-Gummel expressions for both electron and hole current densities are used. The simulation can be used to study the influence of conduction band spike, recombination effects and junction misalignment on current voltage characteristics.

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CONTENTS

CHAPTER 1

1.0 INTRODUCTION

1.1 Heterojunction Devices

A heterojunction is a junction between two different semiconductor materials with different energy band-gaps. Heterojunctions are also described as being isotype or anisotype depending on whether the carriers are of the same or different species on each side of the junction. For the present work, we are simulating a GaAs/AlGaAs system used in high frequency Heterojunction Bipolar Transistor (HBTs).

In order to gain a better understanding of heterojunction operation it is useful to consider the energy band diagrams. The exact form of the energy-band diagram for heterojunction is still the subject of some controversy centred around whether the vacuum level, intrinsic level or conduction band edge respectively should be continuos. Consider an abrupt p-N heterojunction shown in Figure 1.1. Band bending occurs because of charge redistribution caused by the requirement to maintain continuity of the Fermi-level. A similar bending occurs in homojunctions. However, as the band-gaps are different for the two materials in the case of the heterojunction, a discontinuity occurs at the interface producing a 'spike' and 'notch' in the conduction band.