# CONTENTS

<table>
<thead>
<tr>
<th>PREFACE</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFACE</td>
<td></td>
</tr>
</tbody>
</table>

## CHAPTER-I

INTRODUCTION AND SCOPE OF THE THESIS

1.1 INTRODUCTION 1

1.2 AIM AND SCOPE OF THE THESIS 4

## CHAPTER-II

A BRIEF REVIEW OF MILLIMETER WAVE IMPATTS AND OPTICAL CONTROL FUNCTIONS OF THE DEVICE

2.1 INTRODUCTION 8

2.2 a. Flat profile single drift structures of Impatt diodes 8

b. Flat profile double drift structures

c. Thermal Limitation

d. Quasi Read Structures of Impatt diodes

2.3 A BRIEF REVIEW OF THE EXPERIMENTAL RESULTS OF FLAT PROFILE AND QUASI READ SDR AND DDR IMPATT OSCILLATORS 17

a. Flat profile SDR Silicon Impatts

b. Flat profile DDR Silicon Impatts

c. Quasi Read DDR Silicon Impatts

d. Oscillator performance of flat profile and Read type GaAs Impatts for mm-wave frequency bands

e. GaAs MITATT and TUNNETT diodes at 100 GHz and above

f. Millimeter wave InP Impatts

2.4 OPTICAL CONTROL OF IMPATT DEVICES 31

a. Experimental studies on the composition of leakage current

b. Experimental studies on the electron versus hole photocurrent

c. Optical injection locking

d. Optical modulation of amplitude and frequency of Impatts

## CHAPTER III

COMPUTER MODELLING AND SIMULATION OF IMPATT DEVICES

3.1 INTRODUCTION 36

CONTENT (CONT'D.)
3.2 COMPUTER SIMULATION METHOD TO STUDY THE D.C. PROPERTIES OF InP IMPATTS 38

3.3 THEORETICAL BACKGROUND FOR THE COMPUTER SIMULATION OF HIGH FREQUENCY NEGATIVE RESISTIVITY AND REACTANCE PROFILES IN THE DEPLETION LAYER OF THE DIODE 42

3.4 COMPUTER METHOD TO STUDY THE SHIFT OF AVALANCHE TRANSIT TIME PHASE DELAY OF IMPATTS DUE TO OPTICAL ILLUMINATION 45

CHAPTER-IV
BIAS CURRENT DEPENDENCE OF THE MM-WAVE PROPERTIES OF SINGLE DRIFT INDIUM PHOSPHIDE IMPATTS AT THE ATMOSPHERIC WINDOW FREQUENCIES 50-83

4.1 INTRODUCTION 50

4.2 DOPING PROFILE, MATERIAL PARAMETERS AND COMPUTATIONAL TECHNIQUE 51
   a. Design of doping profile
   b. Material parameters
   c. Computer simulation technique

4.3 RESULTS AND DISCUSSION 55
   a. Bias current dependence of the DC properties of p⁺nn⁺ InP Impatts
   b. Bias current dependence of the negative resistivity and reactance profiles

4.4 CONCLUSION 82

CHAPTER V
STUDIES OF THE INFLUENCE OF SPACE CHARGE AT HIGH BIAS CURRENTS ON THE PERFORMANCE OF FLAT PROFILE DOUBLE DRIFT INDIUM PHOSPHIDE IMPATT OSCILLATORS AT THE MILLIMETER WAVE WINDOW FREQUENCIES 84-110
5.1 INTRODUCTION
5.2 DESIGN OF DOPING PROFILE
5.3 COMPUTER SIMULATION TECHNIQUE
5.4 RESULTS AND DISCUSSION
   a. Space charge dependence of the DC properties of flat profile DDR InP Impatts
   b. Space charge limitation of the RF performance of flat profile DDR InP Impatts at the window frequencies
   c. Space charge modulation of negative resistivity profiles of DDR InP Impatts at the window frequencies.
   d. Negative resistance contributions of avalanche and drift layers
5.5 CONCLUSION

CHAPTER-VI
COMPUTER STUDIES ON THE DESIGN AND ANALYSIS OF 94 GHz QUASI READ SDR AND DDR InP IMPATTS

6.1 INTRODUCTION
6.2 COMPUTER DESIGN AND ANALYSIS
6.3 RESULTS AND DISCUSSION
   a. Single drift low high low (SDR LHL) InP Impatts at a 94 GHz window
   b. Symmetrical LHL DDR InP Impatts
   c. DC and RF Properties of asymmetrical LHL DDR diodes with some novel doping profiles
   d. Performance of Quasi Read DDR structures having much simpler doping profiles
6.4 SUMMARY AND CONCLUSION
CHAPTER-VII
STUDIES ON THE OPTICAL MODULATION OF THE RF PROPERTIES OF MILLIMETER WAVE SDR AND DDR InP IMPATTs AT THE WINDOW FREQUENCIES 144–177

7.1 INTRODUCTION 144

7.2 THEORETICAL BACKGROUND 146

7.3 COMPUTER MODELLING TECHNIQUE FOR DIFFERENT ILLUMINATION CONFIGURATIONS. 147

7.4 RESULTS AND DISCUSSION 149

a. Effect of hole dominated photocurrent on p⁺nn⁺ Flip Chip InP Impatts
b. Effect of electron dominated photocurrent on p⁺nn⁺ (TM) InP Impatts
c. The negative resistivity profiles of p⁺nn⁺ InP Impatts for FC and TM illumination configurations at 35, 94 and 140 GHz frequencies
d. Effect of hole dominated photocurrent on flat profile DDR InP Impatts
e. Effect of electron dominated photocurrent on the RF properties of p⁺nn⁺ DDR InP Impatts
f. The effects of hole versus electron photocurrents on the negative resistivity profiles of DDR InP Impatts at the window frequencies
g. The optical modulation of admittance characteristics at the window frequencies

7.5 CONCLUSION 176

CHAPTER-VIII
STUDIES ON THE OPTICALLY INDUCED SHIFTS OF AVALANCHE PHASE DELAY IN FLIP CHIP AND TOP MOUNTED CONFIGURATIONS OF p⁺nn⁺ InP IMPATTs AT 35, 94 AND 140 GHz WINDOW FREQUENCIES 178–200

8.1 INTRODUCTION 178

8.2 COMPUTER DESIGN, SIMULATION AND ANALYSIS 179
## CONTENT

<table>
<thead>
<tr>
<th>PAGE NO.</th>
<th>CONT'D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>181</td>
<td></td>
</tr>
<tr>
<td>198</td>
<td></td>
</tr>
<tr>
<td>201-209</td>
<td></td>
</tr>
<tr>
<td>210</td>
<td></td>
</tr>
</tbody>
</table>

### 8.3 RESULTS

a. Variations of ATT Phase delays with $M_p$ and $M_n$

b. Admittance characteristics

### 8.4 DISCUSSION AND CONCLUSION

BIBLIOGRAPHY

LIST OF RESEARCH PUBLICATIONS ON WHICH THE THESIS IS BASED