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6.3 Admittance plots of (a) Si and (b) GaN SDR IMPATT diodes at D-band.

6.4 Negative resistivity plots of (a) GaN and (b) Si SDR IMPATT diodes at D-band.

6.5 Impedance plot of Wz-GaN based SDR IMPATT at D-band.

6.6 Electric field profile of GaN flat profile SDR IMPATT at 0.5 THz.

6.7 Normalised current density profile of GaN SDR IMPATT diode at 0.5 THz.

6.8 Effect of series resistance of negative conductance of GaN SDR IMPATT diode at 0.5 THz.

6.9 Impedance plot of GaN SDR IMPATT diode at 0.5 THz.

6.10 Negative resistivity profile of GaN SDR IMPATT diode at 0.5 THz.

6.11 Plots of electric field profile for (a) WZ phase and (b) ZB phase GaN (flat-profile) SDR IMPATT Diodes in the THz region. The distance of the n-side from the metallurgical junction has been shown as negative.

6.12 Normalized current density P(x) profiles of (a) WZ-GaN and (b) ZB-GaN based SDR IMPATT diodes in the Terahertz region. The distance of the n-side from the metallurgical junction has been shown as negative.

6.13 Conductance (G) - Susceptance (B) plots of (a) WZ-GaN and (b) ZB GaN based IMPATT diodes in the Terahertz region.

6.14 Effect of series resistance on the negative conductance of unilluminated WZ-GaN (flat type) SDR IMPATT diode.

6.15 Effect of series resistance on \( P_{\text{max}} \) of unilluminated WZ-GaN (flat-type) SDR IMPATT diode.

6.16 (a) Diode impedance vs. frequency plots of WZ-GaN flat profile SDR THz IMPATT diode.

6.16 (b) Diode impedance vs. frequency plots of ZB-GaN flat profile SDR THz IMPATT diode.

6.17 Negative resistivity profiles of (a) WZ-GaN and (b) ZB - GaN based flat profile SDR IMPATT diodes in the Terahertz region.

6.18 Plots of electric field profiles for (a) flat profile and (b) SLHL type GaN SDR IMPATT diodes. The distance of the n-side from the metallurgical junction has been considered as negative.

6.19 Normalised current density P(x) profiles of WZ-GaN SDR IMPATT diode at THz region (a) Flat profile IMPATT, (b) SLHL IMPATT diode. The distance of the n-side from the metallurgical junction has been considered as negative.
6.20 Conductance (G) – Susceptance (B) plots of GaN (a) SLHL and (b) flat type SDR THz IMPATT diodes.

6.21 Effect of series resistance on the negative conductance of WZ-GaN (SLHL type) SDR IMPATT diode in the Terahertz region.

6.22 Effect of series resistance on $P_{\text{max}}$ of WZ-GaN (SLHL) SDR IMPATT diode in the Terahertz region.

6.23 Diode impedance vs. frequency plot of WZ-GaN SLHL SDR THz IMPATT diode.

6.24 (a) Conductance (G) – Susceptance (B) plots of unilluminated GaN SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_n$ at D-band.

6.24 (b) Conductance (G) – Susceptance (B) plots of unilluminated GaN SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_p$ at D-band.

6.25 (a) Negative resistivity profiles of the unilluminated GaN flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_n$ and corresponding different values of optimum frequencies, $f_p$ in GHz: a: $M_n = 10^6$, $M_p = 10^6$, $f_p = 145$ GHz; b: $M_n = 50$, $M_p = 10^6$, $f_p = 147$ GHz; c: $M_n = 25$, $M_p = 10^6$, $f_p = 149$ GHz.

6.25 (b) Negative resistivity profiles of the unilluminated GaN flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_p$ and corresponding different values of optimum frequencies, $f_p$ in GHz: a: $M_n = 10^6$, $M_p = 10^6$, $f_p = 145$ GHz; b: $M_n = 10^5$, $M_p = 50$, $f_p = 149$ GHz; c: $M_n = 10^5$, $M_p = 25$, $f_p = 151$ GHz.

6.26 (a) Conductance (G) - Susceptance (B) plots of unilluminated WZ-GaN flat profile SDR THz IMPATT diode (a) and the illuminated diode (b-d) for different values of $M_n$.

6.26 (b) Conductance (G) - Susceptance (B) plots of unilluminated WZ-GaN flat profile SDR THz IMPATT diode (a) and the illuminated diode (b-d) for different values of $M_p$.

6.27 (a) Negative resistivity profiles of the unilluminated WZ-GaN flat profile SDR IMPATT diode (a) and the illuminated diode (b-d) for different values of $M_n$ and corresponding different values of optimum frequencies, $f_p$ in THz: a: $M_n = 10^6$, $M_p = 10^6$, $f_p = 1.4170$ THz; b: $M_n = 100$, $M_p = 10^6$, $f_p = 1.4188$ THz; c: $M_n = 50$, $M_p = 10^6$, $f_p = 1.4197$ THz; d: $M_n = 25$, $M_p = 10^6$, $f_p = 1.4230$ THz.

6.27 (b) Negative resistivity profiles of the unilluminated GaN flat profile SDR IMPATT diode (a) and the illuminated diode (b-d) for different values of $M_p$ and corresponding different values of optimum frequencies, $f_p$ in THz: a: $M_n = 10^6$, $M_p = 10^6$, $f_p = 1.4170$ THz; b: $M_n = 100$, $M_p = 10^6$, $f_p = 1.4520$ THz; c: $M_n = 50$, $M_p = 10^6$, $f_p = 1.4606$ THz; d: $M_n = 25$, $M_p = 10^6$, $f_p = 1.570$ THz.

6.28 (a) Conductance (G) - Susceptance (B) plots of unilluminated WZ-GaN SLHL SDR THz IMPATT diode (a) and the illuminated diode (b-d) for different values of $M_n$.

6.28 (b) Conductance (G) - Susceptance (B) plots of unilluminated WZ-GaN SLHL SDR THz IMPATT diode (a) and the illuminated diode (b-d) for different values of $M_p$.

6.29 (a) Negative resistivity profiles of the unilluminated WZ-GaN SLHL SDR IMPATT diode
(a) and the illuminated diode (b-d) for different values of $M_n$ and corresponding different values of optimum frequencies, $f_p$ in THz: 
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<th>Optimum Frequency, $f_p$ (THz)</th>
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<tr>
<td>25</td>
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</table>

6.29 (b) Negative resistivity profiles of the unilluminated WZ-GaN SLHL SDR IMPATT diode 

6.30 Plots of electric field profiles for WZ- GaN and 4H-SiC SDR IMPATT diodes. The distance of the n-side from the metallurgical junction has been shown as negative.

6.31 Normalized current density $P(x)$ profiles of (a) WZ GaN and (b) 4H-SiC SDR IMPATT diodes at THz region. The distance of the n-side from the metallurgical junction has been shown as negative.

6.32 Admittance plots of IMPATT diodes: a. WZ-GaN, b. 4H-SiC.

6.33 Effect of series resistance on maximum power output of SiC and GaN IMPATT diodes in the THz region.

6.34 Impedance plots of WBG IMPATT diodes at Terahertz region.

6.35 Admittance plots of WZ-GaN and 4H-SiC based photo-illuminated Top Mounted SDR THz IMPATTs.

6.36 (a) Admittance plots of WZ-GaN based photo-illuminated Flip Chip SDR THz IMPATTs.

6.36 (b) Admittance plots of 4H-SiC based photo-illuminated Flip Chip SDR THz IMPATTs.

6.37 (a) Negative resistivity profiles of the unilluminated WZ-GaN flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_n$ and corresponding different values of optimum frequencies, $f_p$ in THz: 

6.38 (a) Negative resistivity profiles of the unilluminated 4H-SiC flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_n$ and corresponding different values of optimum frequencies, $f_p$ in THz: 

6.38 (b) Negative resistivity profiles of the unilluminated 4H-SiC flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_p$ and corresponding different values of optimum frequencies, $f_p$ in THz: 


\[ M_n = 10^6, M_p = 50, f_p = 1.18 \text{ THz}, c: M_n = 10^6, M_p = 25, f_p = 1.20 \text{ THz}. \]

7.1 Plots of electric field profile for WZ phase GaN SDR IMPATT diode for different doping concentration at the same bias current density. The distance of the n-side from the metallurgical junction has been considered as negative.

7.2 Normalized current density \( P(x) \) profiles of WZ GaN SDR IMPATT diodes under different doping concentration at THz region. The distance of the n-side from the metallurgical junction has been considered as negative.

7.3 Effect of punch-through on admittance plots of WZ-GaN based SDR IMPATT in the THz region.

7.4 Negative resistivity profiles of the WZ-GaN based flat profile SDR IMPATT diode:
Set I: \( 2.00 \times 10^{24} \text{ m}^{-3} \), Set II: \( 2.85 \times 10^{24} \text{ m}^{-3} \), Set III: \( 3.2 \times 10^{24} \text{ m}^{-3} \).

7.5 Effect of punch through on electric field profiles of 4H-SiC DDR IMPATT diodes in the THz region.

7.6 Effect of punch through on normalized current density profiles \( P(x) \) of 4H-SiC DDR IMPATT diodes, in the THz region: \( P = (J_p - J_n)/ J \), where, \( J_p \) = hole current density, \( J_n \) = electron current density and \( J \) = total current density.

7.7 Effect of punch through on the admittance characteristics of 4H-SiC DDR IMPATT diode in the THz region.

7.8 Effect of punch through on negative resistivity profiles of 4H-SiC DDR IMPATT diodes in the THz region.

8.1 Plots of electric field profiles for WZ-GaN SDR IMPATT diodes for different values of current multiplication factors. The distance of the n-side from the metallurgical junction has been considered as negative.

8.2 Variation of avalanche zone width with current multiplication factors, \( M_n \) and \( M_p \) in WZ-GaN IMPATT.

8.3 Variation of \( Z_{AV} \) and \( Q_p \) with \( M_n \) and \( M_p \) in WZ-GaN IMPATTs in the THz region: (a, c) corresponds to TM illumination and (b, d) corresponds to FC illumination.

8.4 Negative resistivity profiles of the unilluminated WZ-GaN flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of \( M_n \) and corresponding different values of optimum frequencies, \( f_p \) in THz: a: \( M_n = 10^6, M_p = 10^6, f_p = 1.126 \text{ THz} \); b: \( M_n = 50, M_p = 10^6, f_p = 1.128 \text{ THz} \), c: \( M_n = 25, M_p = 10^6, f_p = 1.132 \text{ THz} \).

8.5 Negative resistivity profiles of the unilluminated WZ-GaN flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of \( M_p \) and corresponding different values of optimum frequencies, \( f_p \) in THz: a: \( M_n = 10^6, M_p = 10^6, f_p = 1.126 \text{ THz} \); b: \( M_n = 10^6, M_p = 50, f_p = 1.180 \text{ THz} \), c: \( M_n = 10^6, M_p = 25, f_p = 1.300 \text{ THz} \).

8.6 Variation of ATT phase delay shift in WZ-GaN IMPATT with multiplication factors, \( M_n \) and \( M_p \).
8.7 Plots of electric field profiles for 4H-SiC-based IMPATT diodes for different values of current multiplication factors. The distance of the n-side from the metallurgical junction has been considered as negative.

8.8 Variation of avalanche zone width with multiplication factors, $M_n$ and $M_p$ in 4H-SiC IMPATT diode.

8.9 Variation of $Z_{Sp}$ and $Q_p$ with $M_n$ and $M_p$ in 4H-SiC IMPATTs in the THz region: (a, c) corresponds to TM illumination and (b, d) corresponds to FC illumination.

8.10 Negative resistivity profiles of the unilluminated 4H-SiC flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_n$ and corresponding different values of optimum frequencies, $f_p$ in THz: a: $M_n = 10^6$, $M_p = 10^8$, $f_p = 1.050$ THz; b: $M_n = 50$, $M_p = 10^6$, $f_p = 1.085$ THz, c: $M_n = 25$, $M_p = 10^5$, $f_p = 1.090$ THz.

8.11 Negative resistivity profiles of the unilluminated 4H-SiC flat profile SDR IMPATT diode (a) and the illuminated diode (b-c) for different values of $M_n$ and corresponding different values of optimum frequencies, $f_p$ in THz: a: $M_n = 10^6$, $M_p = 10^8$, $f_p = 1.050$ THz; b: $M_n = 10^5$, $M_p = 50$, $f_p = 1.18$ THz, c: $M_n = 10^5$, $M_p = 25$, $f_p = 1.20$ THz.

8.12 Variation of ATT phase delay shift in 4H-SiC THz IMPATT with current multiplication factors, $M_n$ and $M_p$.

9.1 Electric field profiles of Si and InP DDR IMPATT diodes at 35 GHz.

9.2 Electric field profiles of Si and InP DDR IMPATT diodes at 220 GHz.

9.3 Normalized current density profiles $P(x)$ of InP DDR IMPATT diodes, $P = (J_p - J_n)/J$, where, $J_p$ = hole current density, $J_n$ = electron current density and $J$ = total current density.

9.4 Normalized current density profiles $P(x)$ of InP DDR IMPATT diodes, $P = (J_p - J_n)/J$, where, $J_p$ = hole current density, $J_n$ = electron current density and $J$ = total current density.

9.5 Admittance plots of Si and InP DDR IMPATT diodes at 35 GHz.

9.6 Admittance plots of Si and InP DDR IMPATT diodes at 220 GHz.

9.7 Negative resistivity profiles of Si and InP flat profile DDR IMPATTs at 35 GHz.

9.8 Negative resistivity profiles of Si and InP flat profile DDR IMPATTs at 220 GHz.

9.9 Electric field profiles of InP DDR IMPATTs at THz frequencies.

9.10 Normalised current density profiles $P(x)$ of InP DDR IMPATT diodes at THz frequencies: $P = (J_p - J_n)/J$, where, $J_p$ = hole current density, $J_n$ = electron current density and $J$ = total current density. IX-20 9.11 Admittance plots of InP flat profile DDR IMPATT diodes in the THz region.

9.12 Effect of series resistance on output power density of InP flat type IMPATT diodes in the THz region.

9.13 Impedance plots of InP DDR IMPATT diode at 0.3 THz.

9.14 Impedance plots of InP DDR IMPATT diode at 0.5 THz.

9.15 Negative resistivity profiles of InP flat-profile DDR IMPATT diodes at THz frequencies.
9.16 Electric field profiles of InP flat and SLHL DDR IMPATTs at 35 GHz.
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9.17 Electric field profiles of InP flat and SLHL DDR IMPATTs at 0.5 THz.
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9.18 Normalized current density profiles $P(x)$ of InP flat and SLHL DDR IMPATT diodes at 35 GHz,
$P = (J_p - J_n)/J$, where, $J_p$ = hole current density, $J_n$= electron current density and $J$ = total current density.
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9.19 Normalized current density profiles $P(x)$ of InP flat and SLHL DDR IMPATT diodes at 0.5 THz,
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9.20 Admittance plots of InP based flat and SLHL DDR IMPATTs at 35 GHz.
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9.21 Admittance plots of InP based flat and SLHL DDR IMPATTs at 0.5 THz.
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9.22 Effect of series resistance on output power density of InP flat and SLHL type IMPATT diodes at 0.5 THz.
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9.23 Impedance plots of InP flat and SLHL IMPATT diodes at 0.5 THz.
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9.24 Negative resistivity profiles of InP flat and SLHL DDR IMPATTs at 35 GHz.
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9.26 (a) Effect of electron (TM) and hole (FC) dominated photo-currents on admittance plots of InP flat profile DDR IMPATT diodes at 220 GHz.
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9.26 (b) Effect of electron (TM) and hole (FC) dominated photo-currents on admittance plots of Si flat profile DDR IMPATT diodes at 220 GHz.
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9.27 (a) Negative resistivity profiles of InP DDR IMPATT diode a : $f_p = 222$ GHz, b : $f_p = 235$ GHz,
c : $f_p = 238$ GHz, d : $f_p = 242$ GHz, e : $f_p = 265$ GHz.
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9.27 (b) Negative resistivity profiles of Si DDR IMPATT diode a : $M_n = M_p = 10^{5}$, $f_p = 215$ GHz b :
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9.28 (a) Effect of optical illumination on admittance plots of InP DDR Top Mounted IMPATT at 0.3 THz.
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9.29 Effect of electron (TM) and hole (FC) dominated photo-currents on admittance plots of InP flat profile DDR IMPATT diodes at 0.5 THz.
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9.30 Effect of optical-illumination on negative resistivity profiles of InP flat-profile Top Mounted and Flip Chip IMPATT diodes at 0.3 THz. a: $f_p = 0.3$ THz, b : $f_p = 0.315$ THz and c: $f_p = 0.330$ THz.
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9.31 Effect of optical-illumination on negative resistivity profiles of InP flat-profile Top Mounted and Flip Chip IMPATT diodes at 0.5 THz. a: $f_p = 0.5$ THz, b : $f_p = 0.515$ THz and c: $f_p = 0.522$ THz.
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9.32 Effect of optical illumination on admittance plots of InP TM and FC type SLHL DDR IMPATTs at 0.5 THz.
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9.33 Effect of optical illumination on negative resistivity profiles of InP TM and FC type SLHL DDR IMPATTs at 0.5 THz. a: $f_p = 0.550$ THz, b : $f_p = 0.570$ THz and (c): $f_p =0.600$ THz.
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