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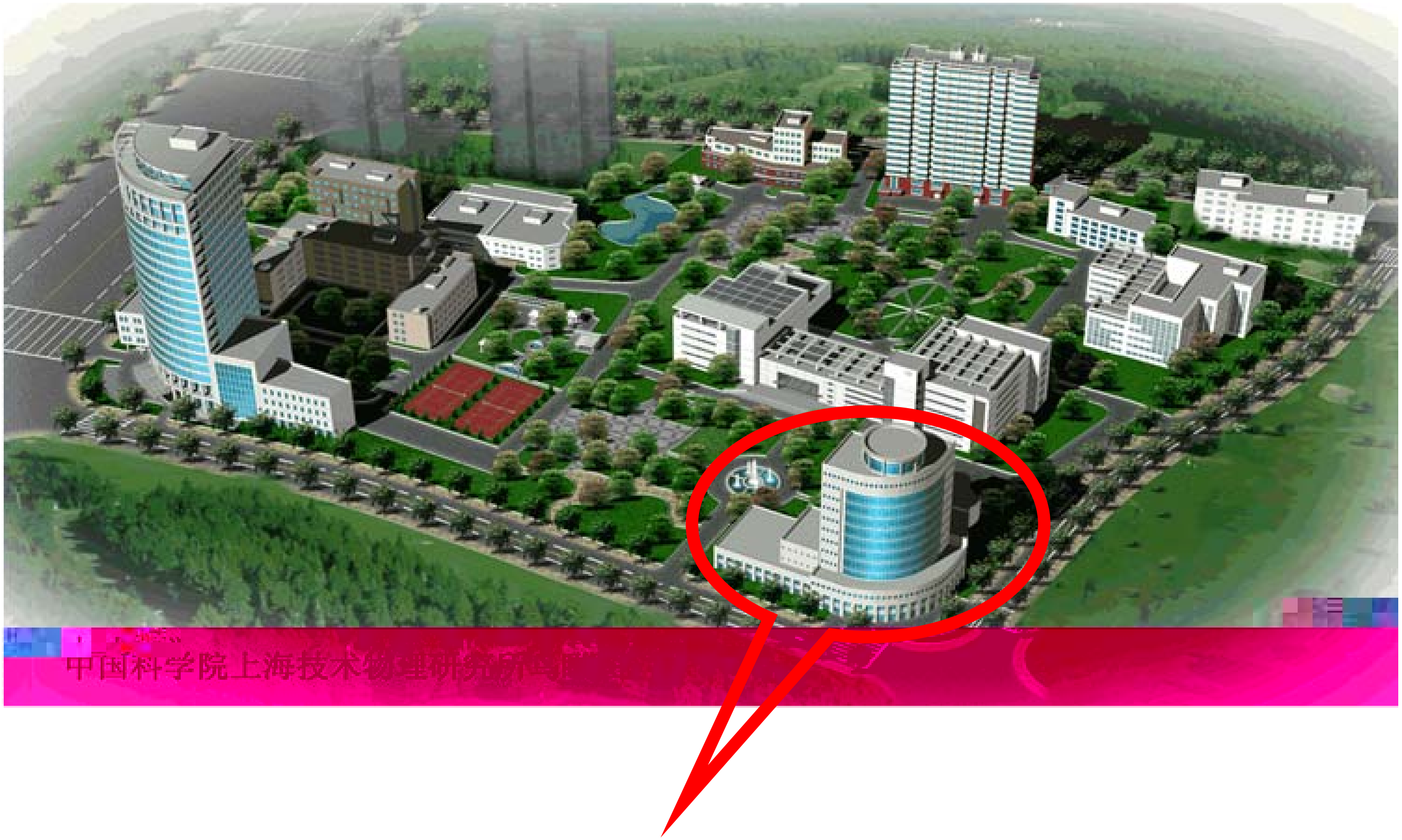

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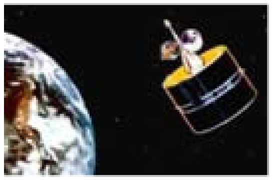

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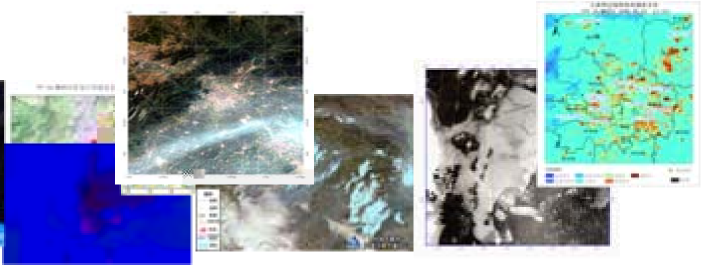

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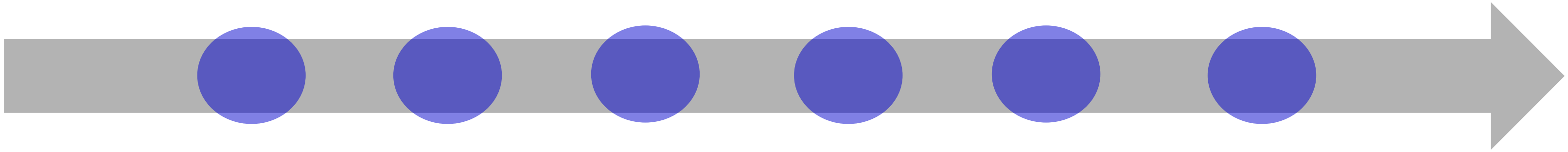

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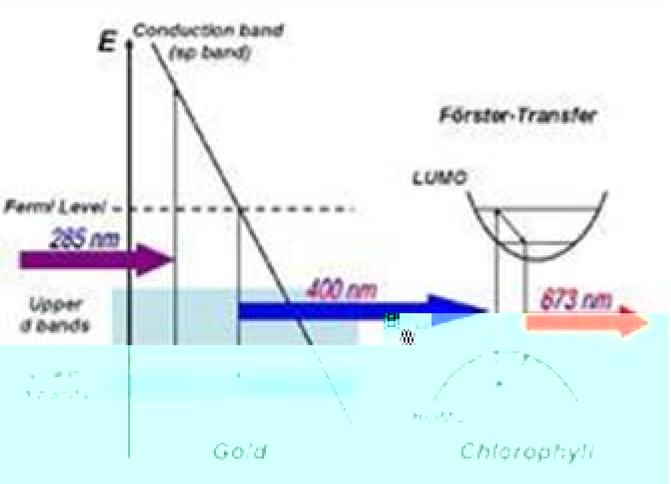
E
Conduction band
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Förster-Transfer
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285 nm
400 nm
673 nm
Upper
d bands
Gold
Chlorophyll

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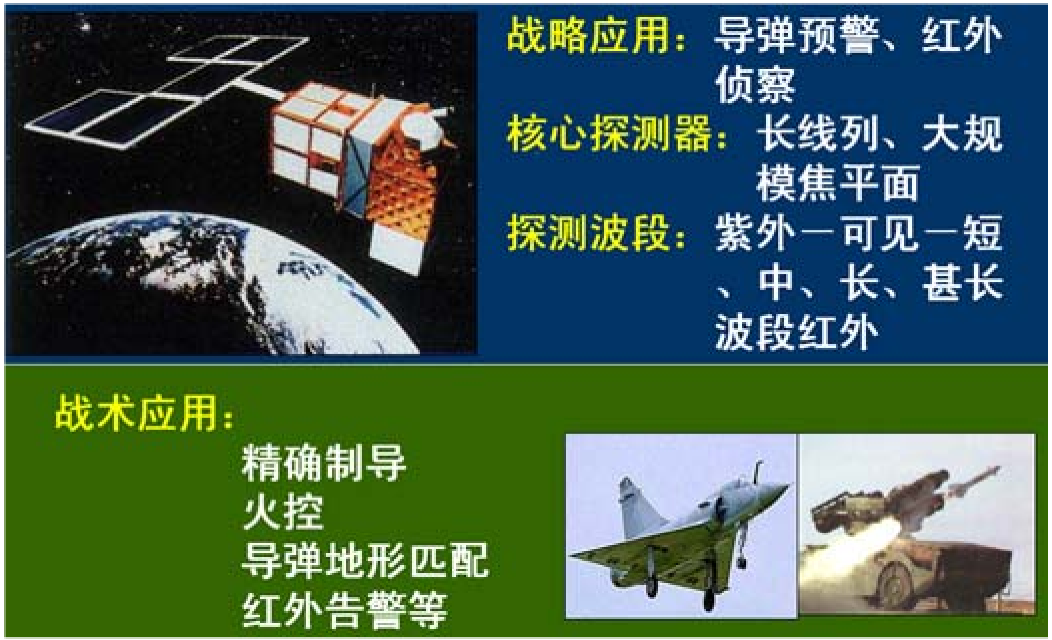


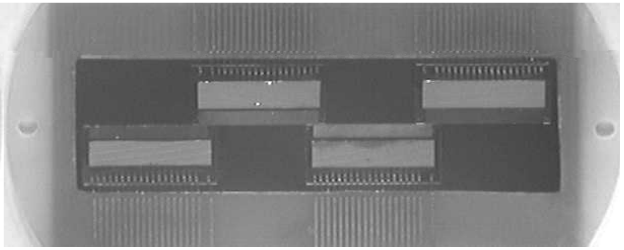
战略应用： 导弹预警、红外侦察

核心探测器： 长线列、大规模焦平面

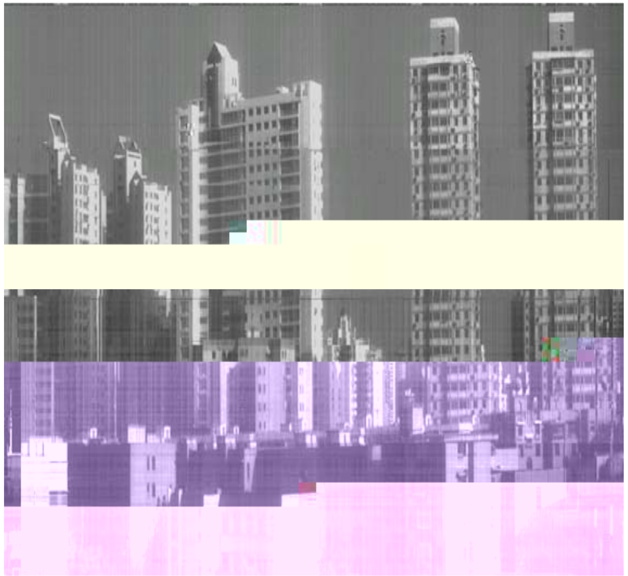
探测波段： 紫外－可见－短、中、长、甚长波段红外

战术应用：

精确制导
火控
导弹地形匹配
红外告警等



1024X1元探测器件



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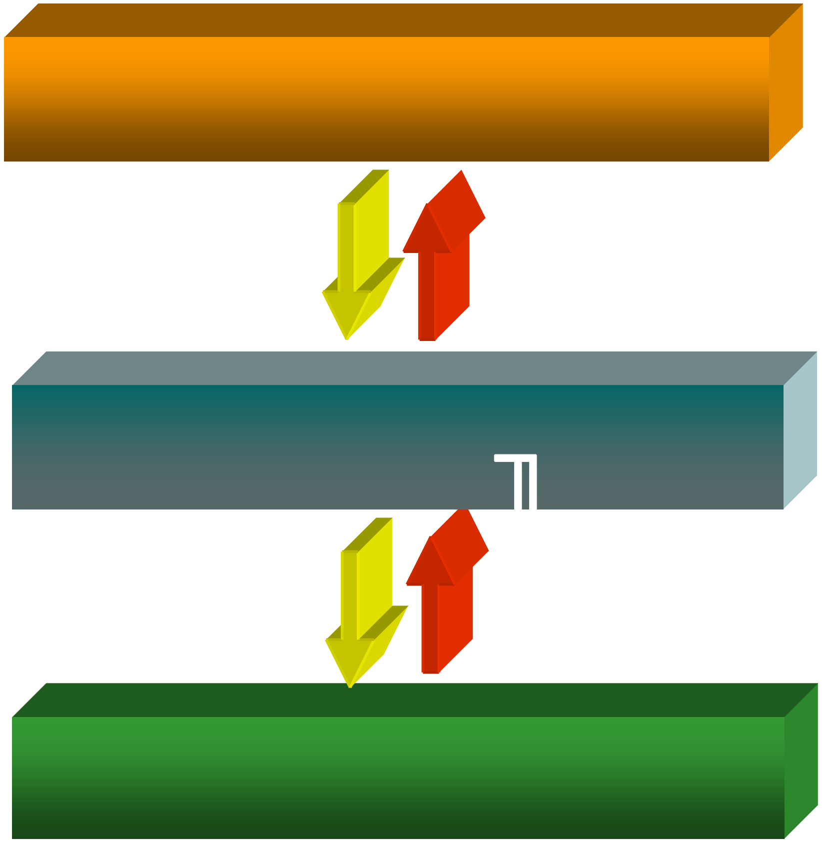

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成像速度：慢速(分)→快速(秒)　t　10^{-2}

探测距离：百公里→千公里　$1/R^2$　10^{-2}

空间分辨率：公里→米　L^2　10^{-6}

光谱分辨率（Δλ/λ）：10^{-3}→10^{-4}　Δλ 10^{-1}

能量的急剧下降：10^{-1} - 10^{-11}

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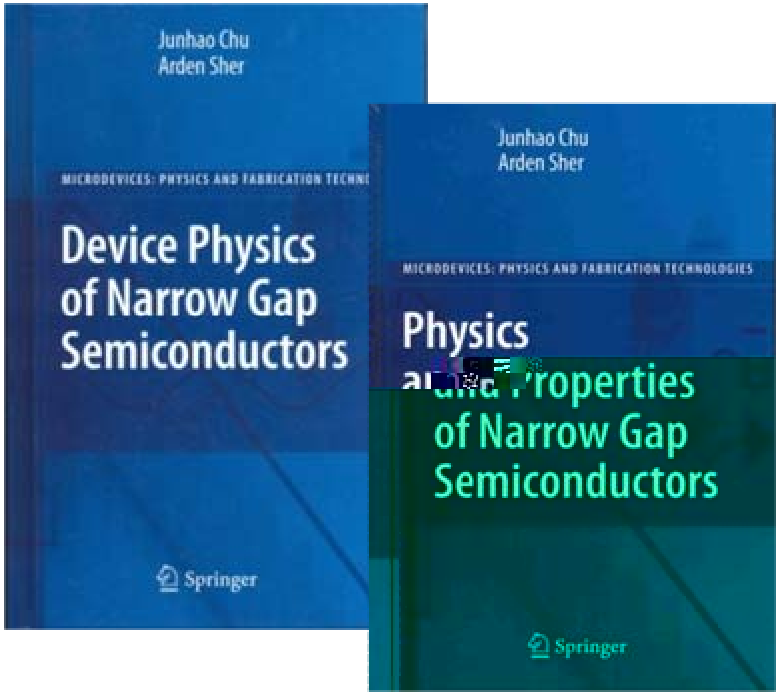

Junhao Chu
Arden Sher

MICRODEVICES: PHYSICS AND FABRICATION TECHNO

Device Physics of Narrow Gap Semiconductors

Springer

Junhao Chu
Arden Sher

MICRODEVICES: PHYSICS AND FABRICATION TECHNOLOGIES

Physics and Properties of Narrow Gap Semiconductors

Springer

国家技术发明奖
证　书

为表彰国家技术发明奖获得者，特
颁发此证书。

项目名称：
奖励等级：二等奖
获 奖 者：褚　浩（中国科学院上海技术物
研究所）

证书号：2010-F-24301

上海市科学技术奖
证　书

为表彰上海市自然科学奖获得者，特颁发此证书。

项目名称：红外探测器中局域化机理与调控及其应用研究

获 奖 者：中国科学院上海技术物理研究所

奖励等级：一等奖

上海市人民政府

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Prof. D.Y. Tang
Narrow gap semiconductor material

Prof. S.C. Shen
Low-dimensional semiconductor and Spectroscopy

Prof. J.H. Chu
Narrow gap semiconductor and Ferroelectric Film

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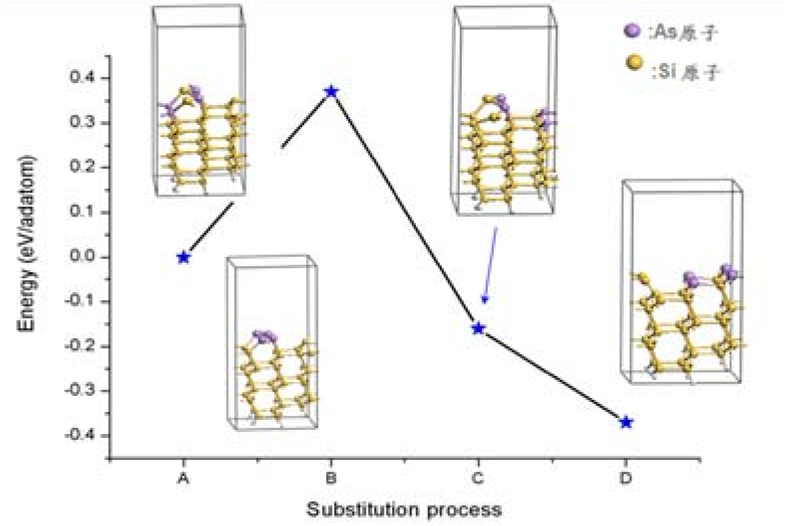

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HgCdTe

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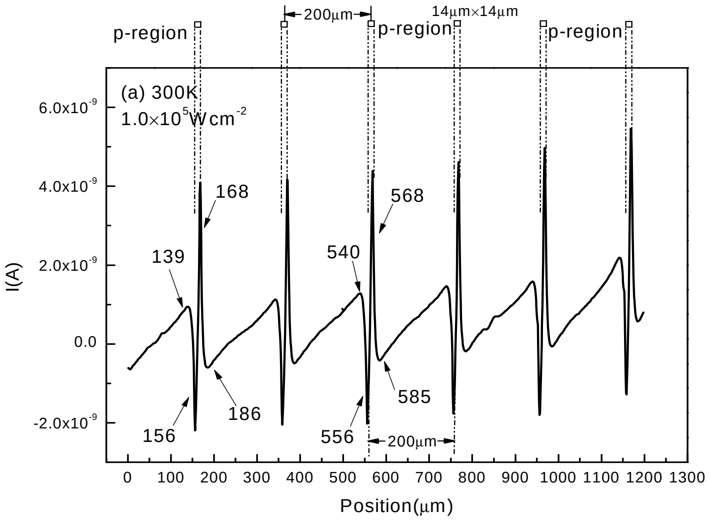

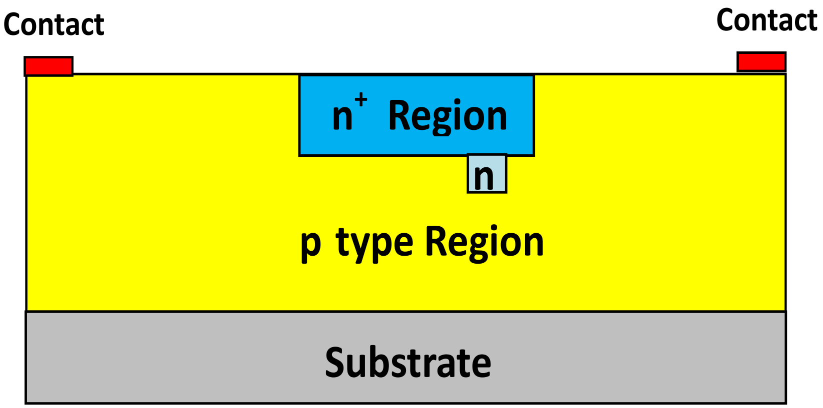

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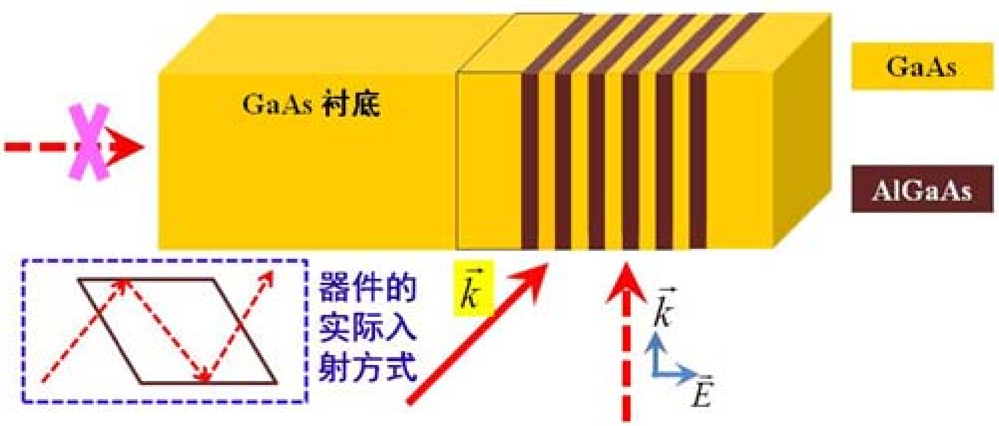

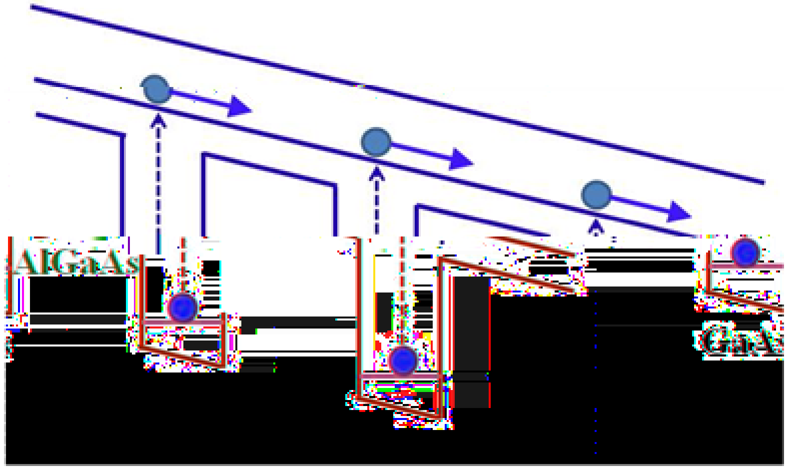

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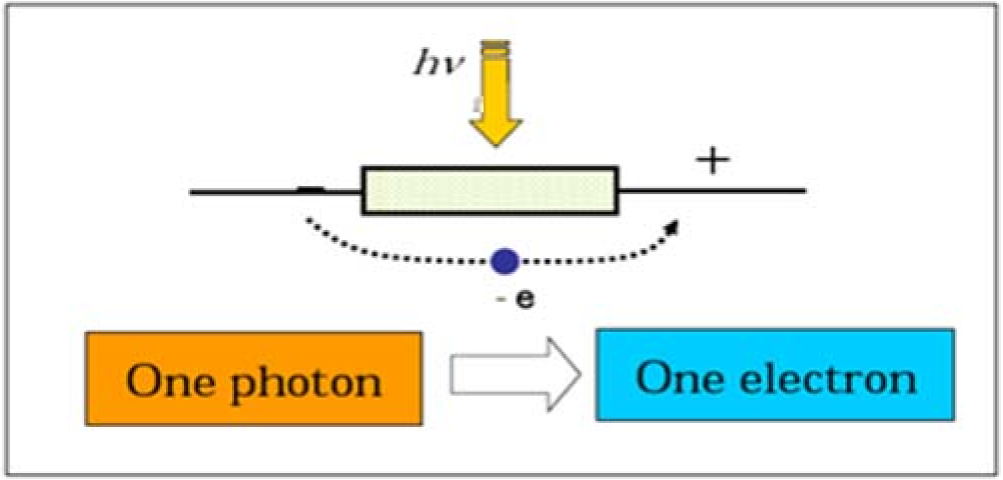
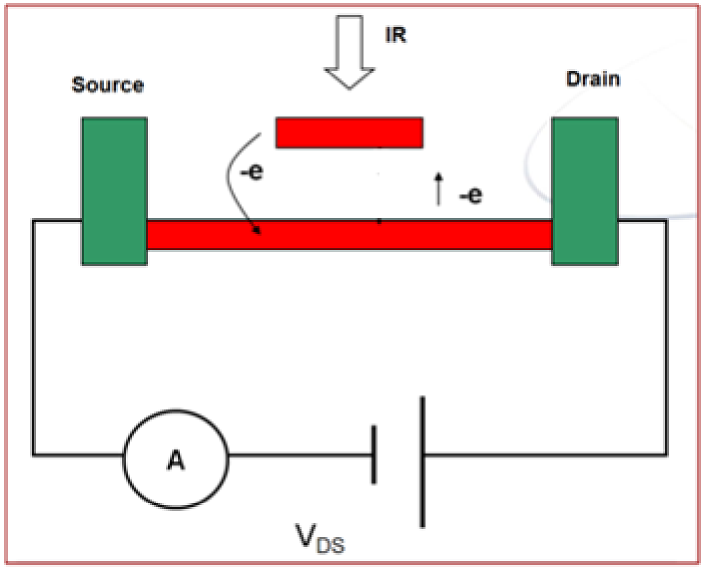
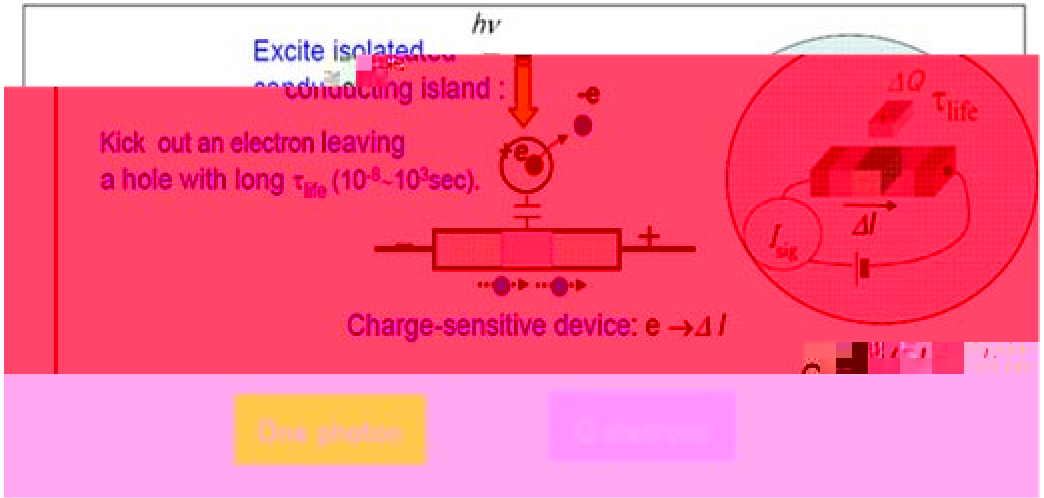

hν
+
- e
One photon
One electron


IR
Source
Drain
-e
-e
A
V_DS


hν
Excite isolated conducting island :
Kick out an electron leaving a hole with long τ_life (10^-8~10^3sec).
-e
+e
+
Charge-sensitive device: e → ΔI
ΔQ
τ_life
I_sig
ΔI
One photon

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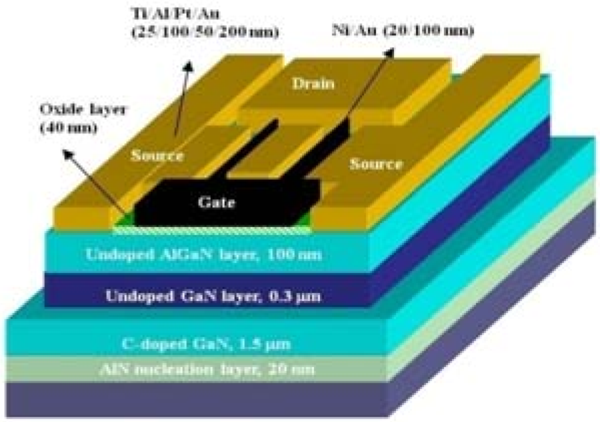

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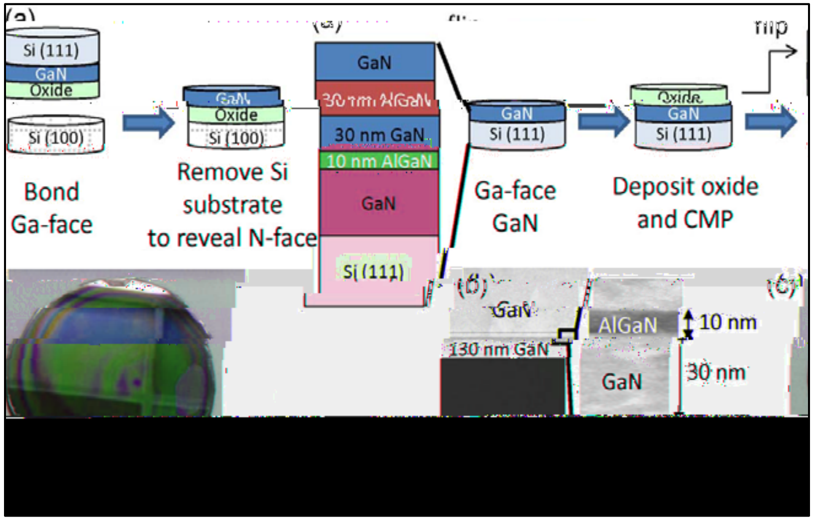

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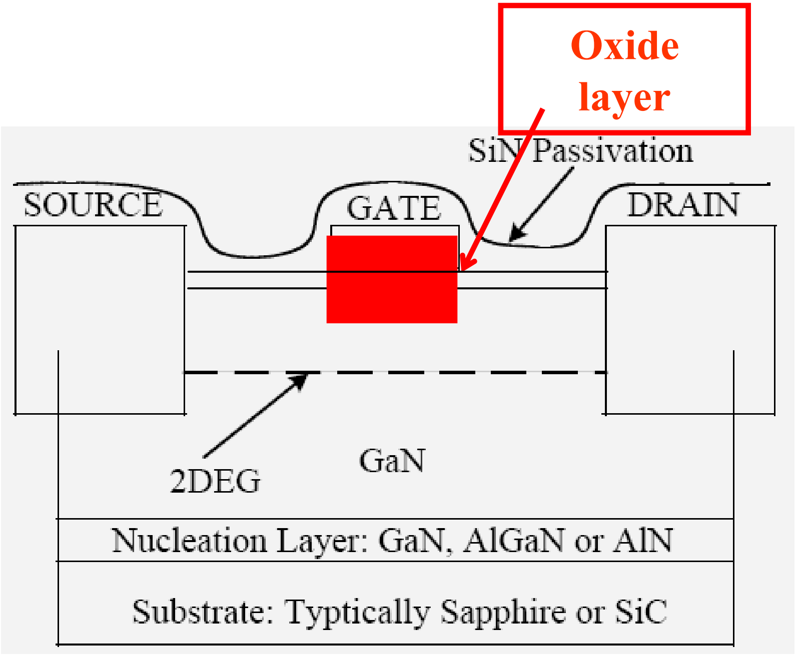

MOS-HEMTs

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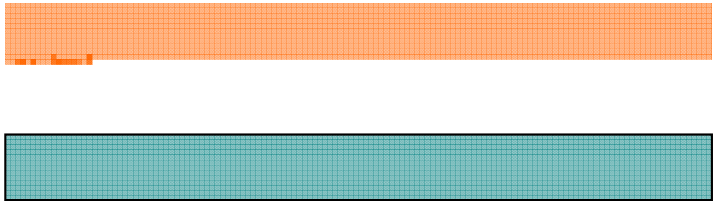
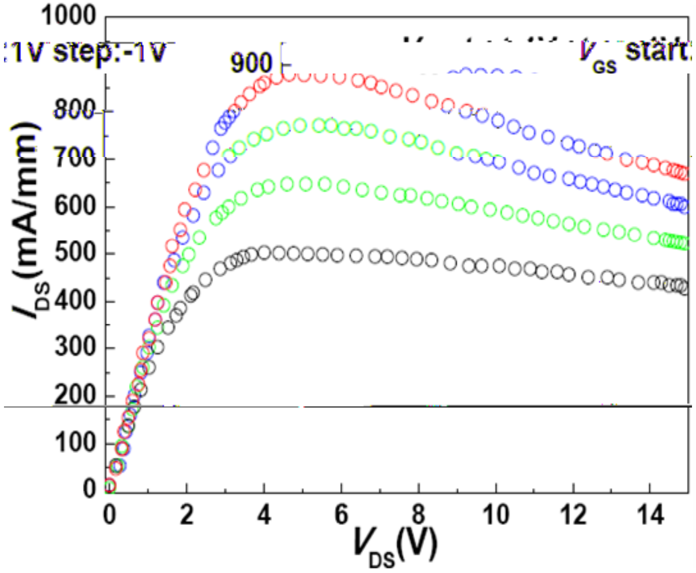
1ằ ˧ GaN HEMT

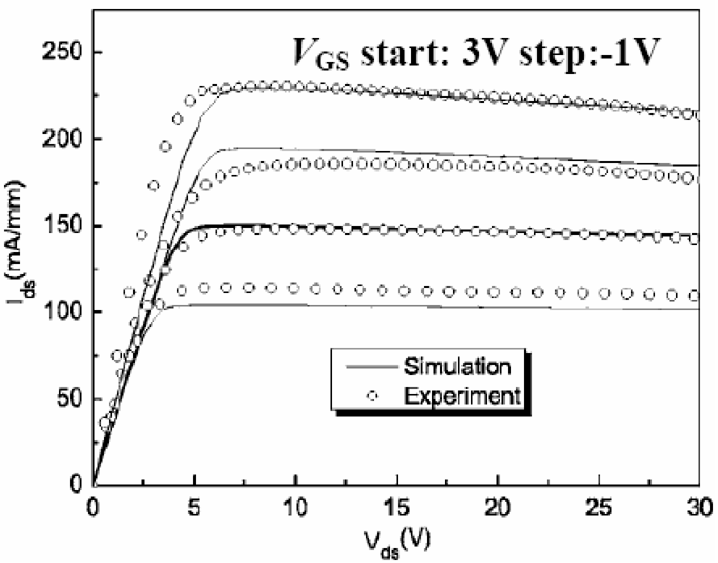


Xiaodong Wang, et al., IEEE Transactions on Electron Devices, 59, 1393 (2012)

1 ầ ˧ GaN HEMT

HEMT

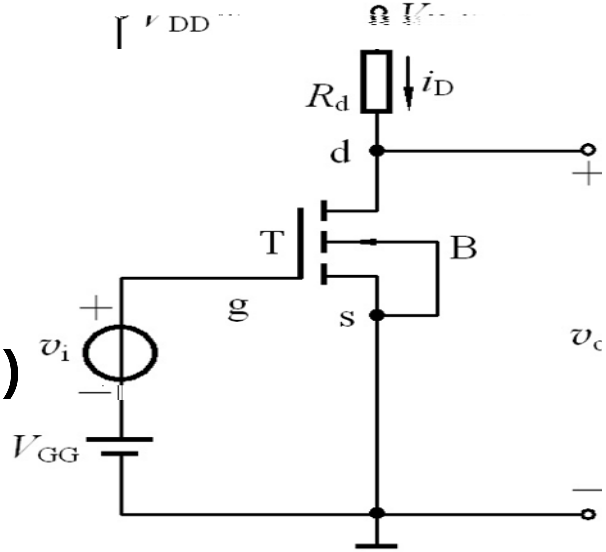




HEMT

V_{GS}= 0V	**750**	**110**
V_{GS}= 1V	**900**	**150**

(mA/mm)



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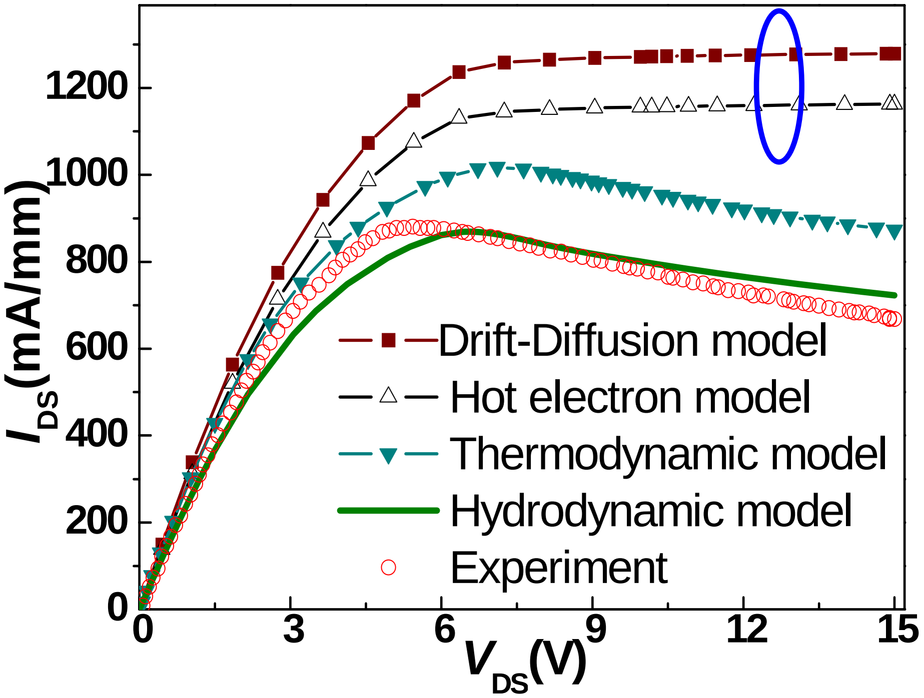

Xiaodong Wang, et al., IEEE Transactions on Electron Devices, 59, 1393 (2012)

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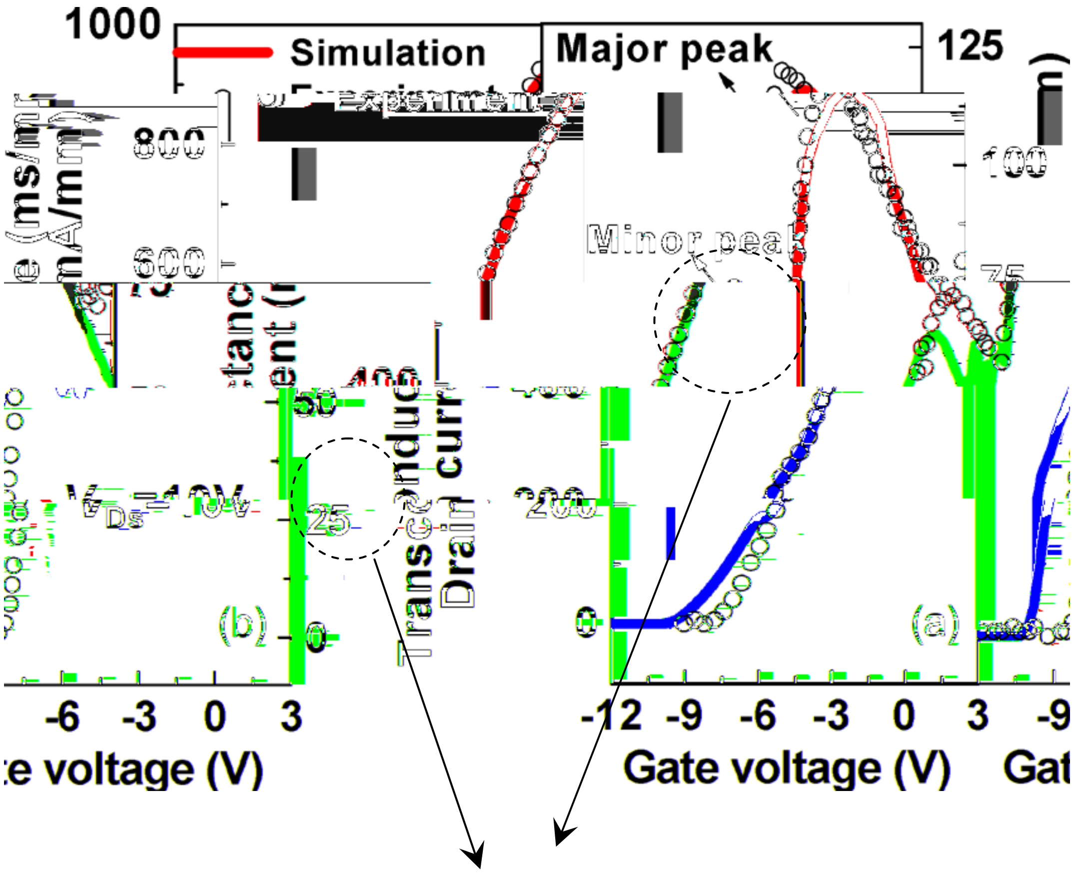

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Xiaodong Wang, et al., IEEE Transactions on Electron Devices, 59, 1393 (2012)

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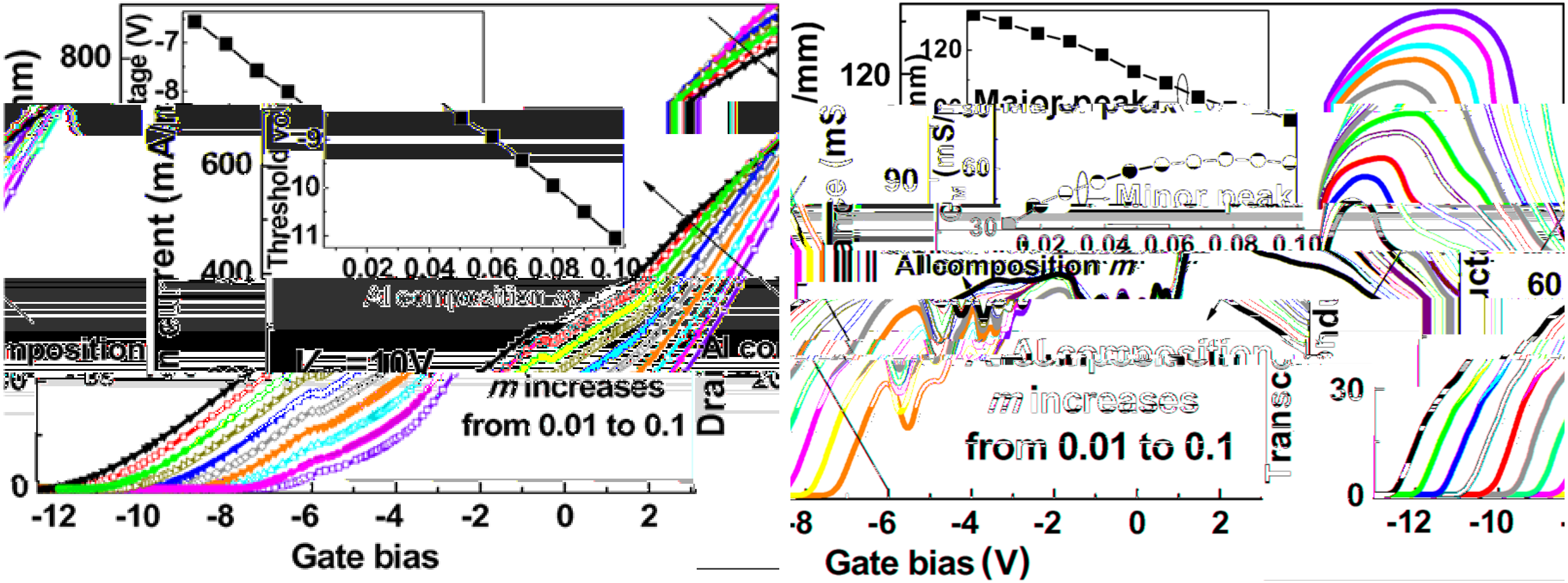

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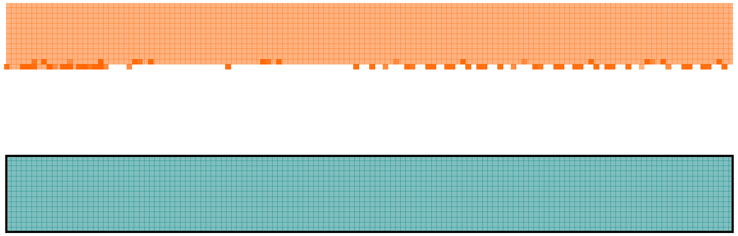
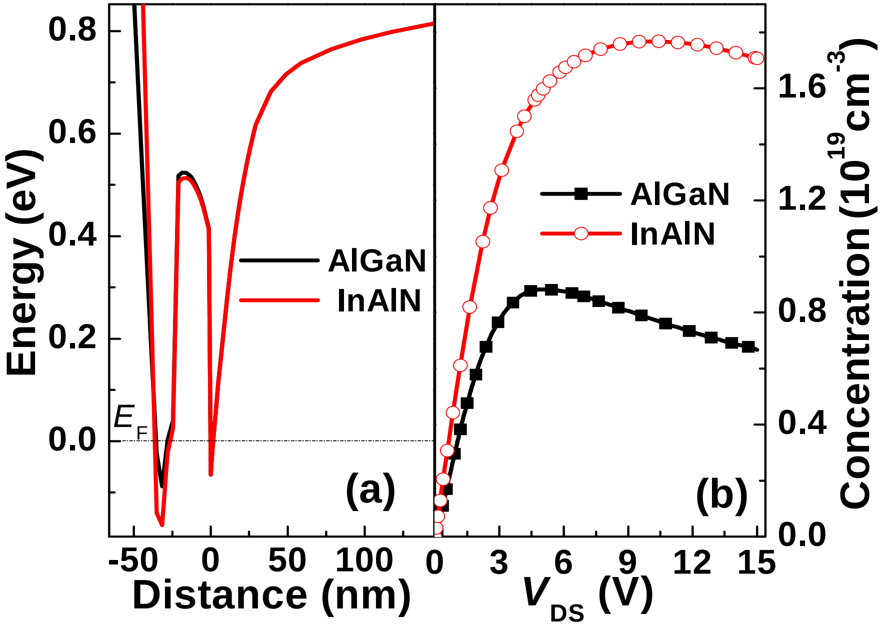
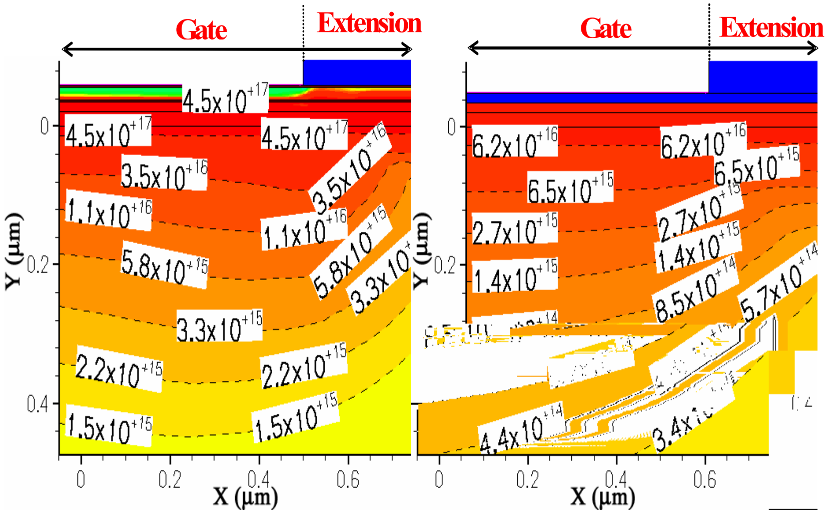
Xiaodong Wang, et al., IEEE Transactions on Electron Devices, 59, 1393 (2012)



1 à ⊣ GaN HEMT



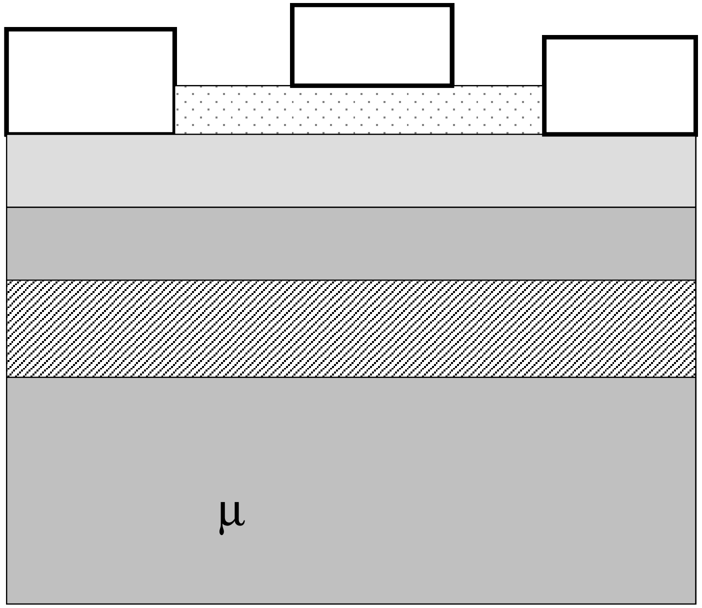


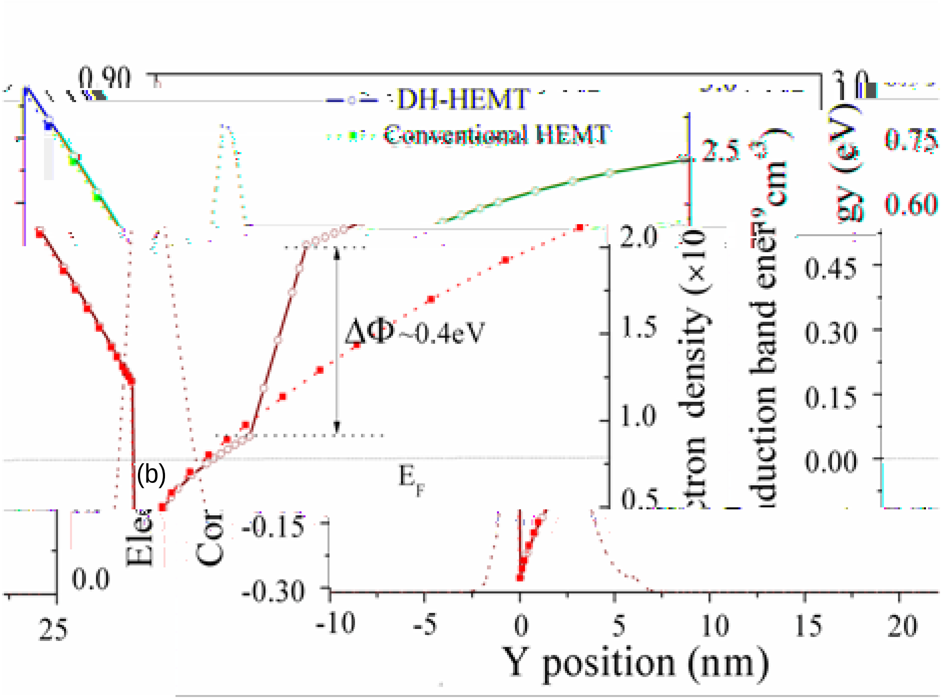
InAlN/GaN

InAlN

HEMT

Xiaodong Wang, et al., IEEE Transactions on Electron Devices, 59, 1393 (2012)





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AIN ㅓ HEMT AlGaN/GaN ( )

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Lin Wang et al, J. Appl. Phys. 5, 054501(2010)

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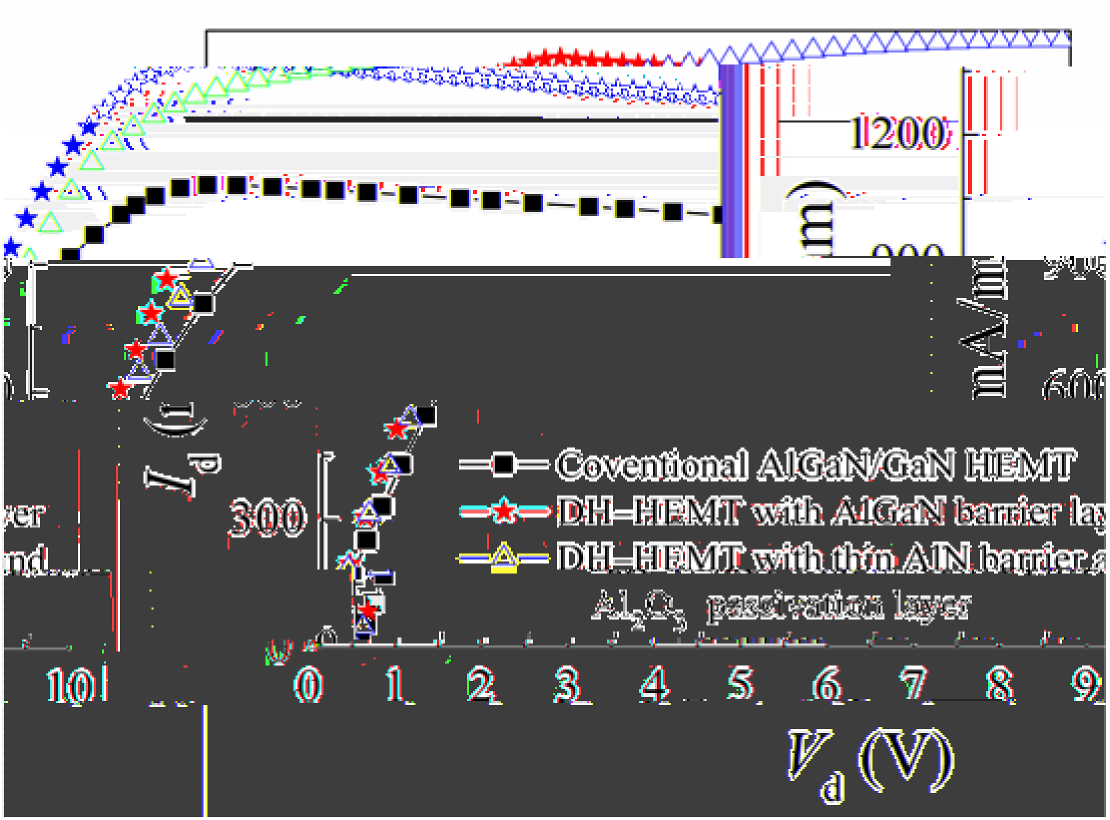

a (I_d)— (V_d) ˇ AlN

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Lin Wang et al, J. Appl. Phys. 5, 054501(2010)

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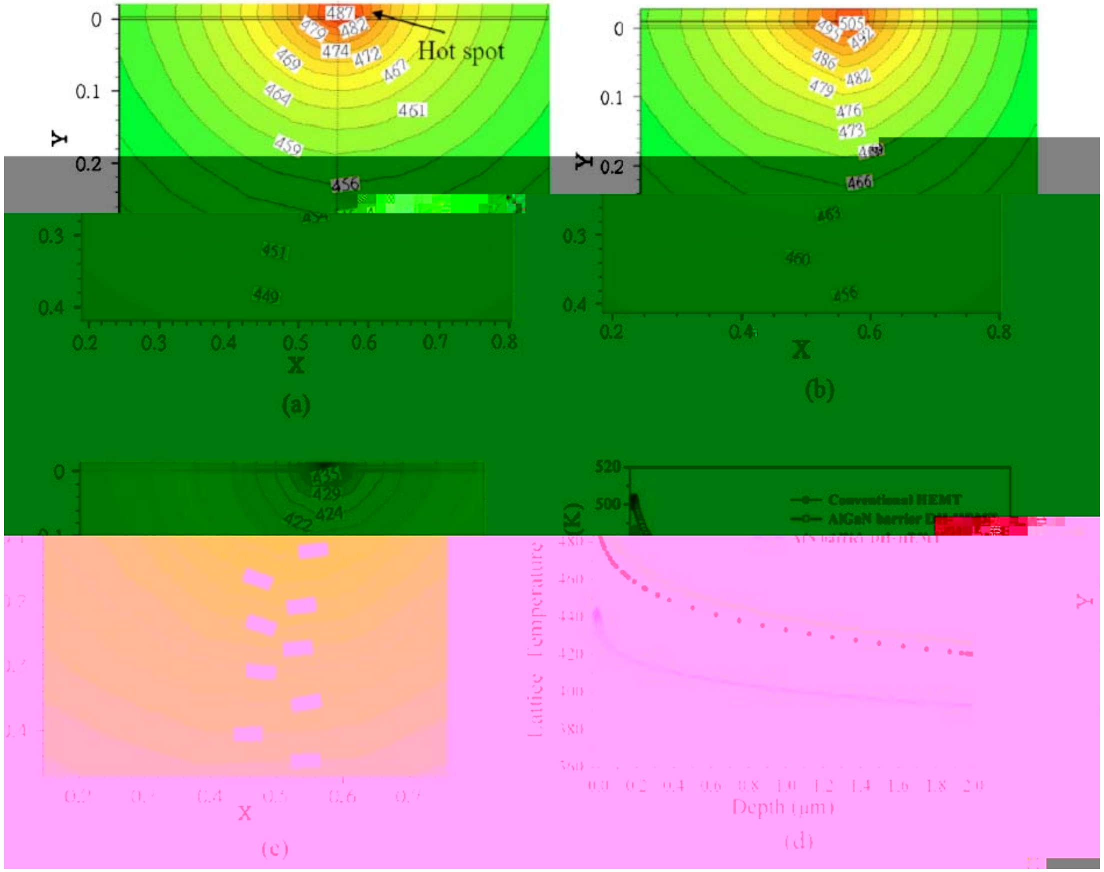

AlN AlGaN

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(a)AlGaN ˧ ’

(b)AlGaN/GaN ’ (c) AlN

˧ ’ (d)

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Lin Wang et al, J. Appl. Phys. 5, 054501(2010)

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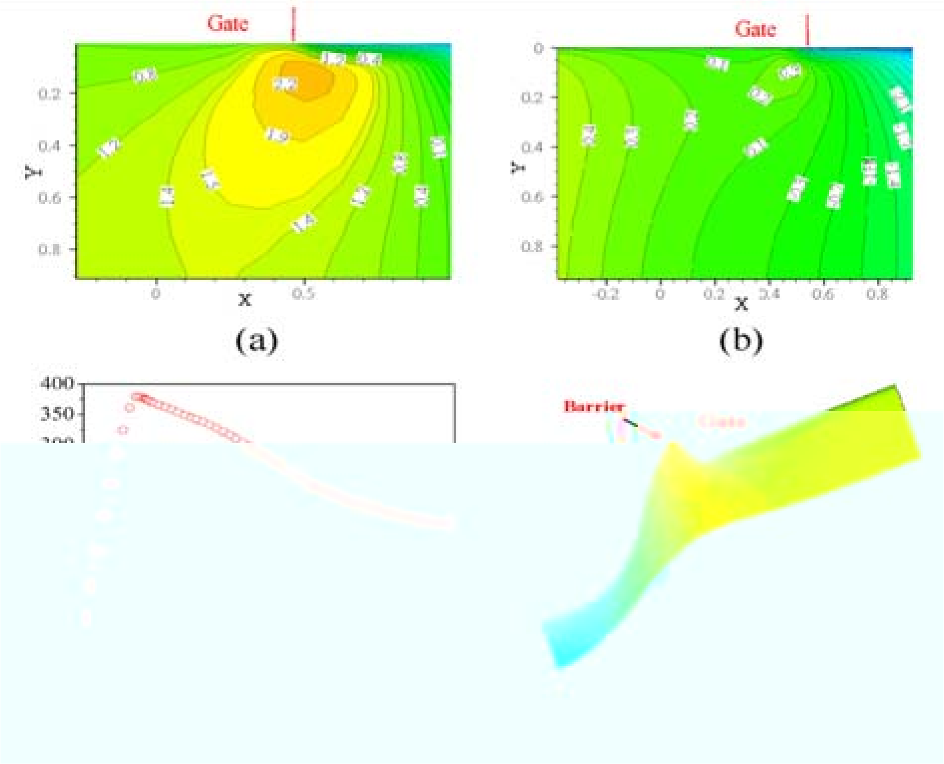

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ǐ ʽ (a) ѝ AlGaN ǐ

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AlN ǐ ʼ (c)

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Lin Wang et al, J. Appl. Phys. 5, 054501(2010)

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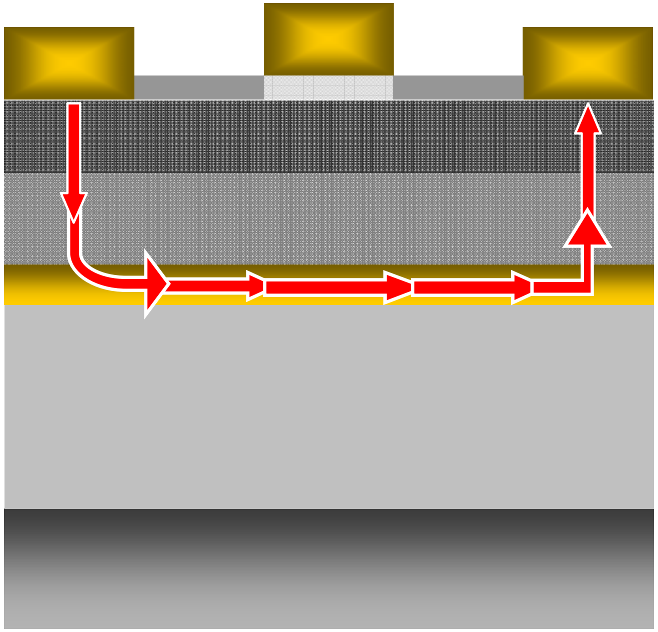
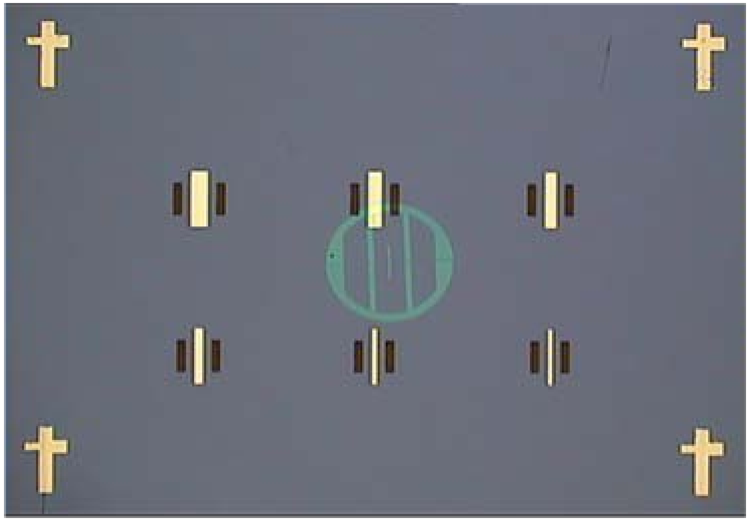
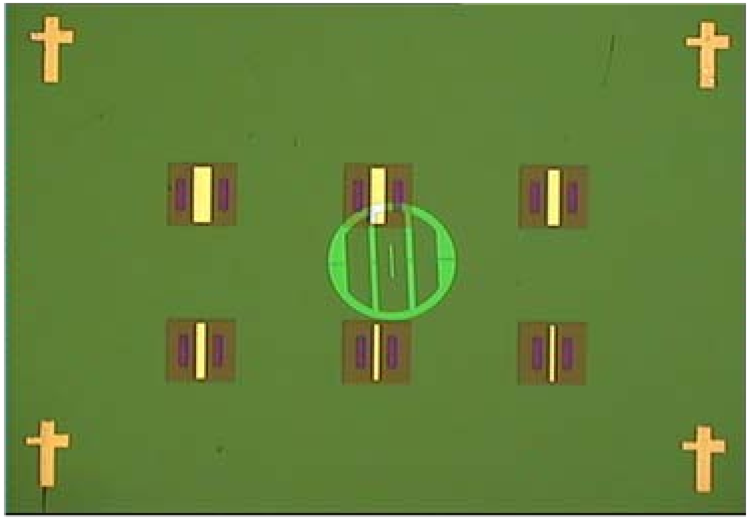




ICP



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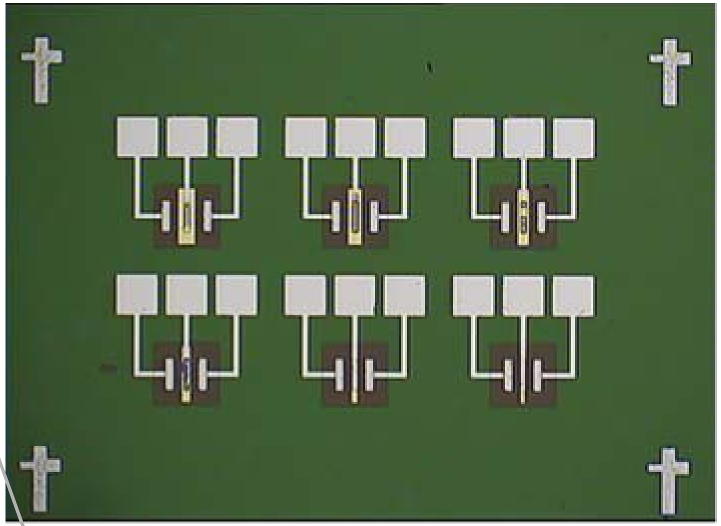

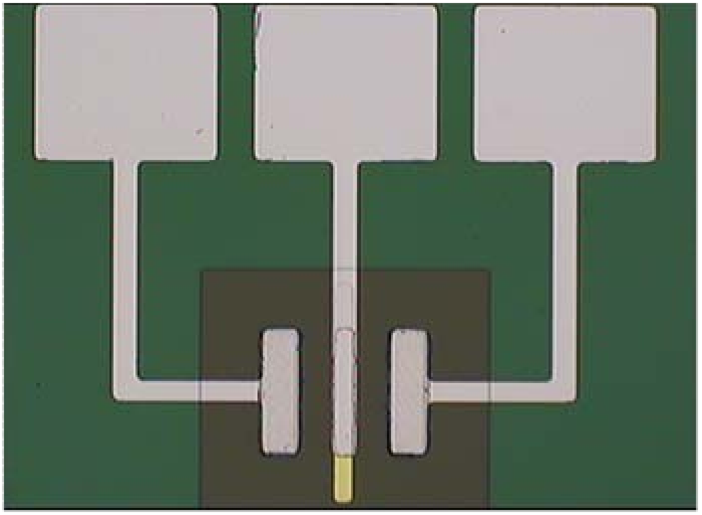

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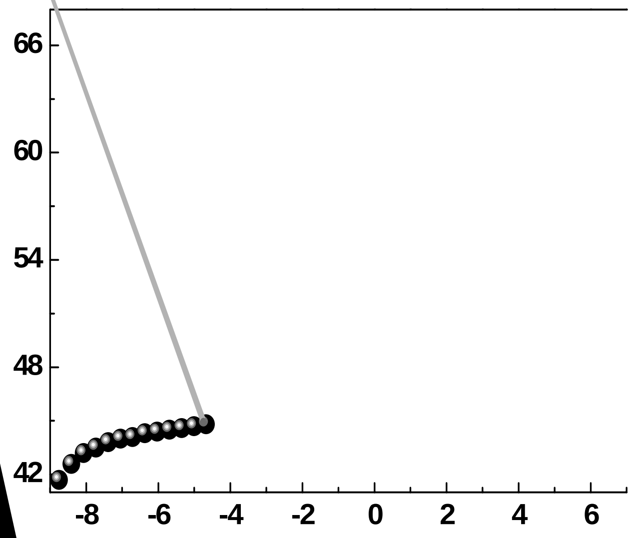

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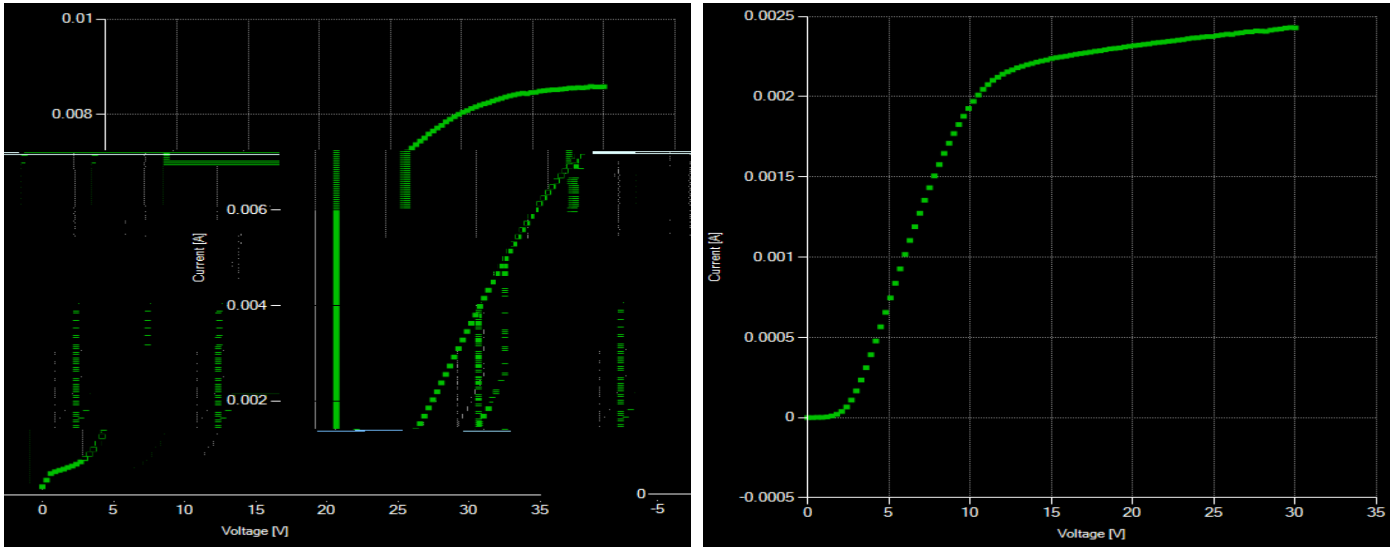

(a)0V (b)-2V

HEMT

- **80mA/mm (Peter. Ye, 110mA/mm (*J. Appl. Phys.*, 100, 074501))**
- **(G_M / ε_r) 2.56mS/mm (Peter. Ye, 5ms/mm)**
- **-3.6V (Peter. Ye, -3V)**

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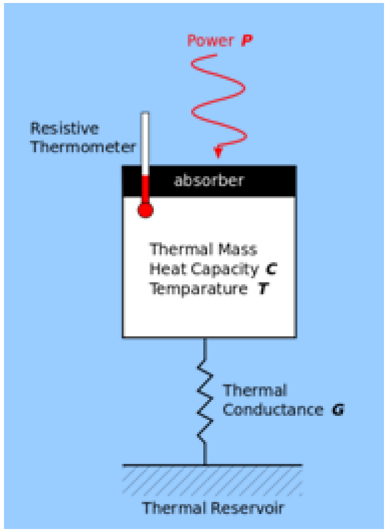
Bolometer



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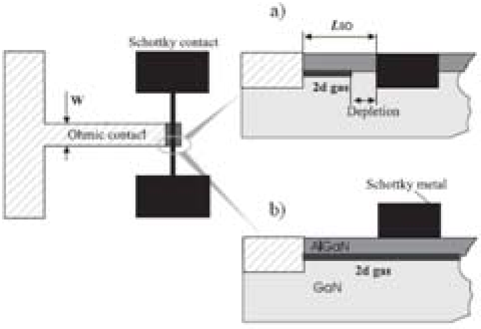

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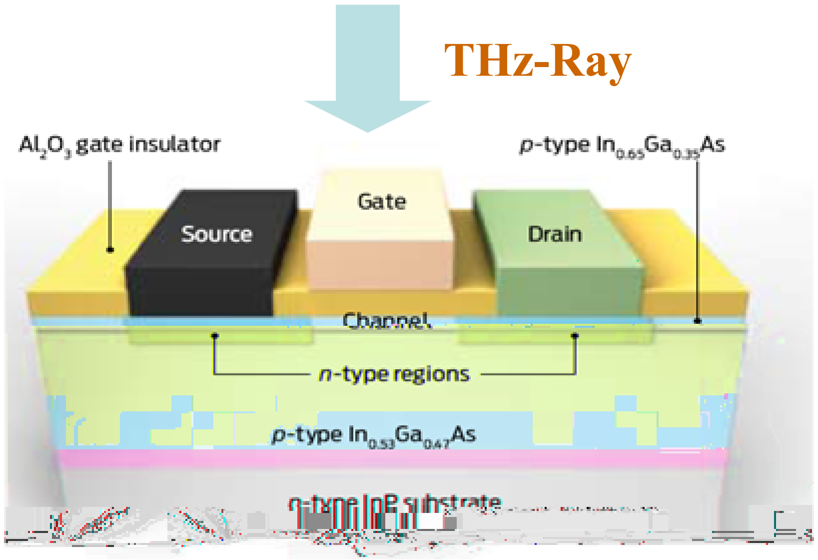

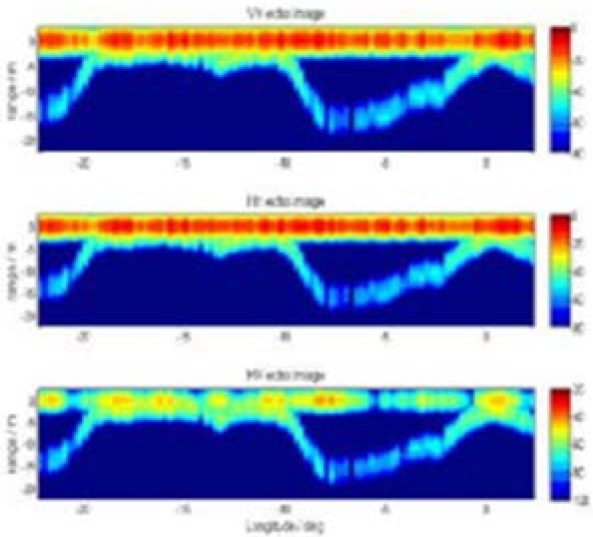

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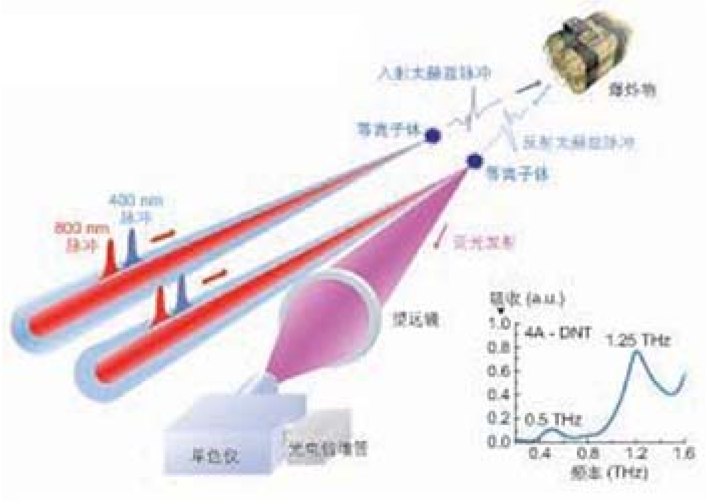

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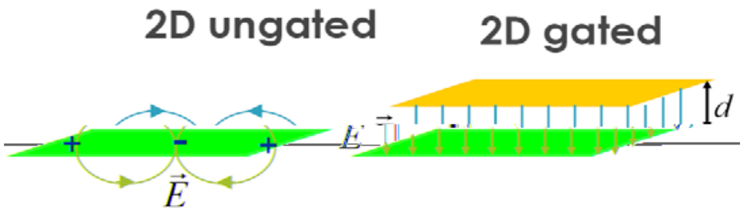
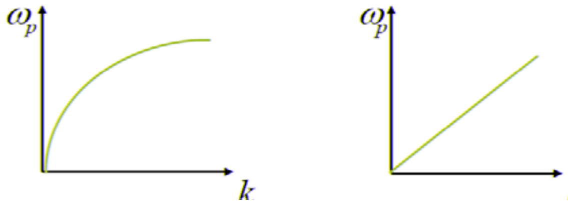
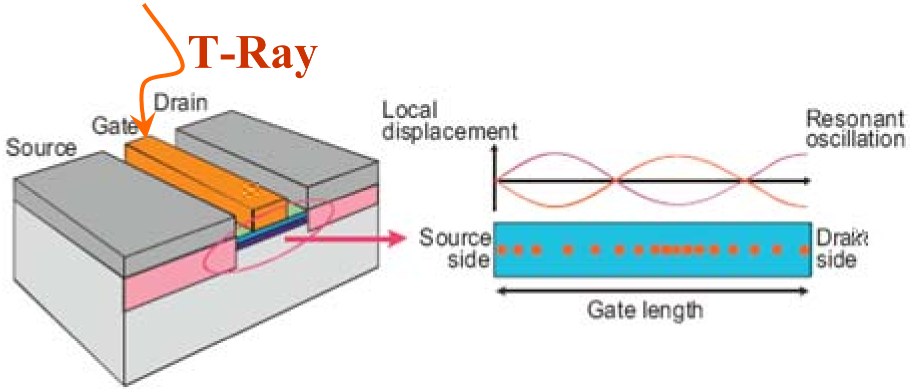


$$\omega_p = \sqrt{\frac{e^2 N_{2D}}{2\varepsilon\varepsilon_0 m}k} \qquad \omega_p = \sqrt{\frac{e^2 N_{2D} d}{\varepsilon\varepsilon_0 m}k} \quad kd<<1$$





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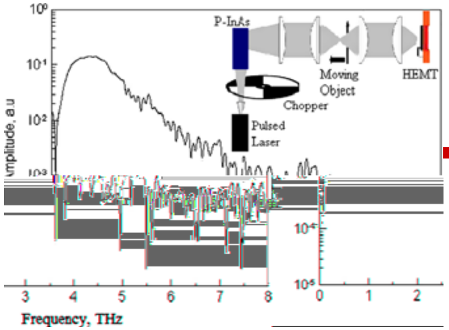

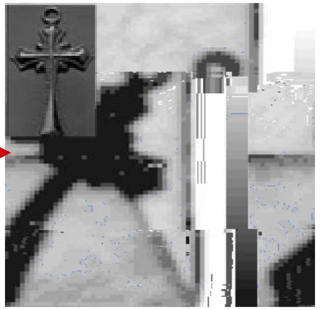

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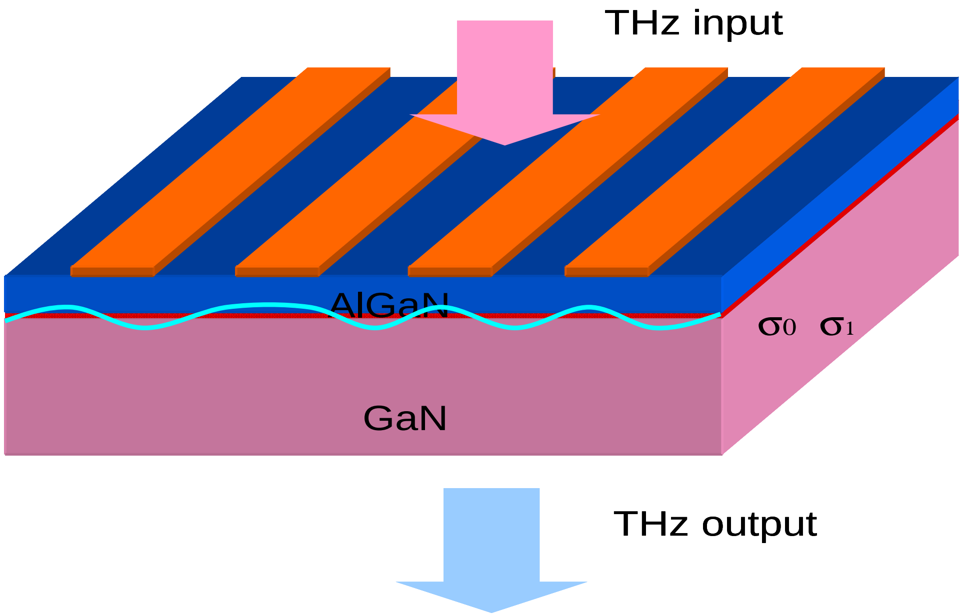
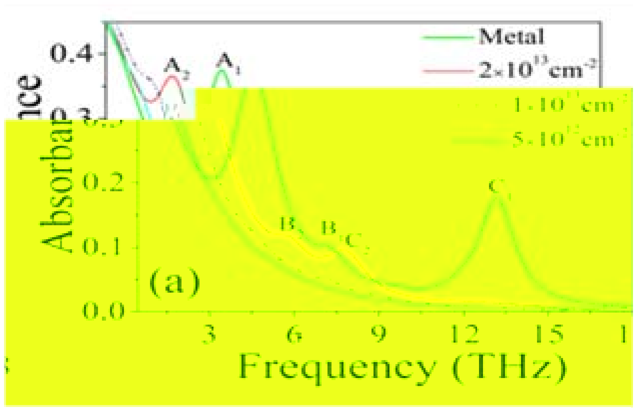
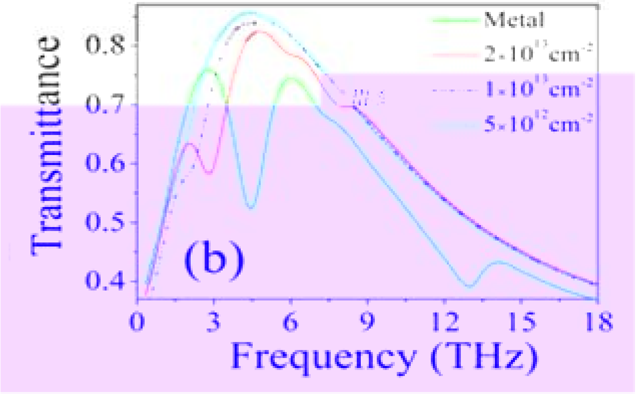
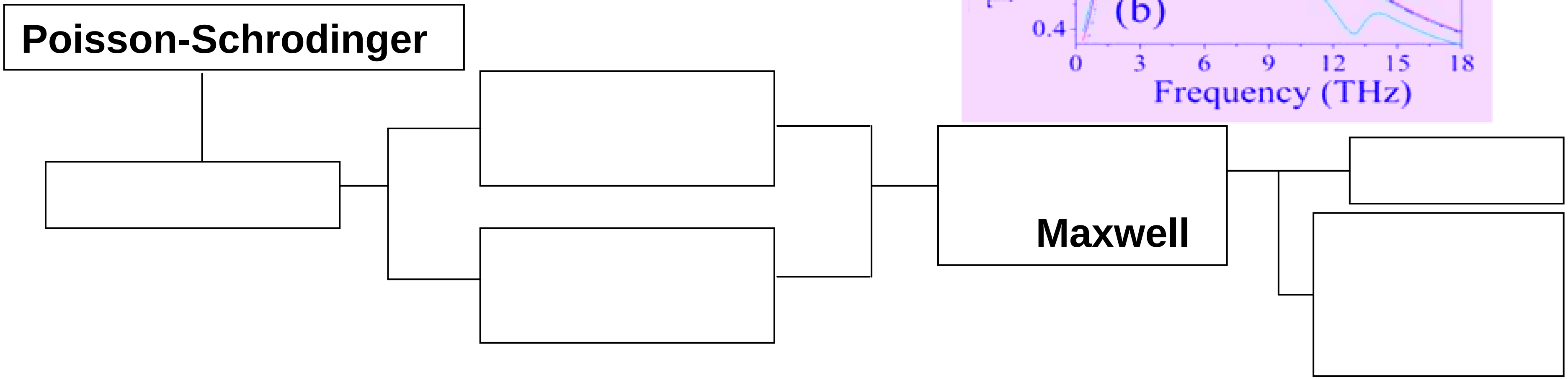
1 à GaN ή



1μm





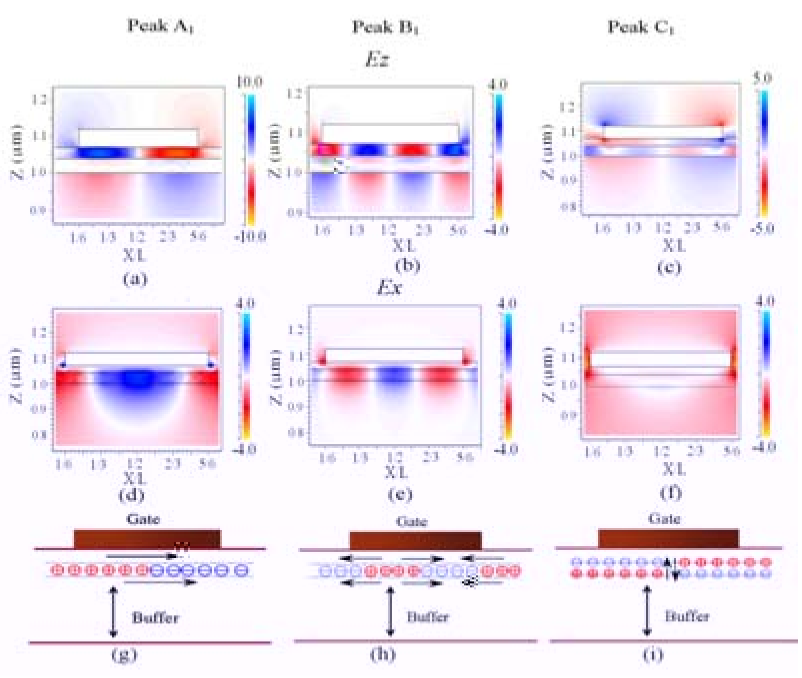


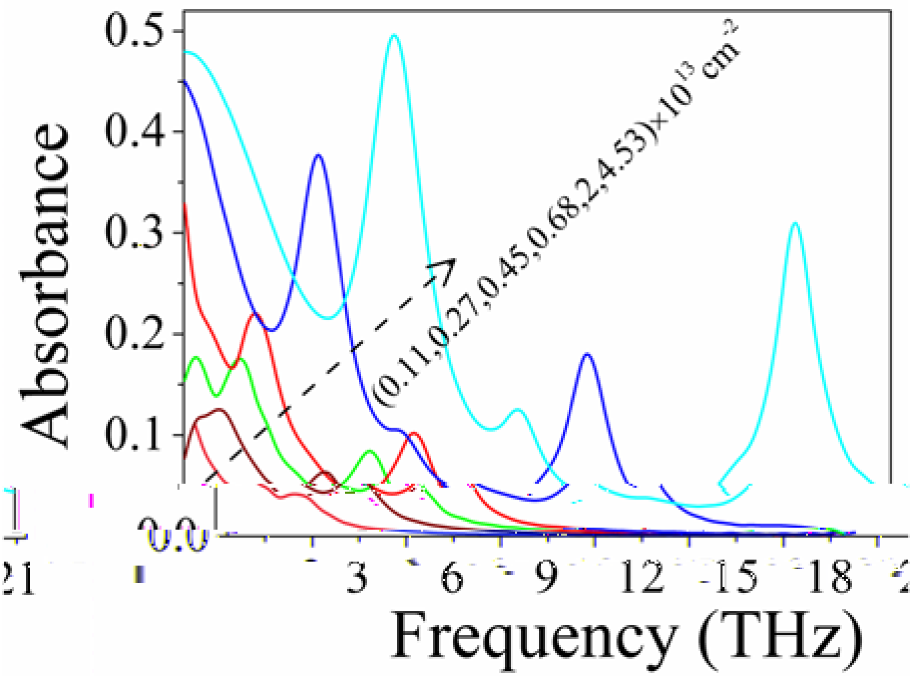
Poisson-Schrodinger

Maxwell

Lin Wang et al Appl. Phys. Lett. 99, 063502(2011)

1 à GaN ή





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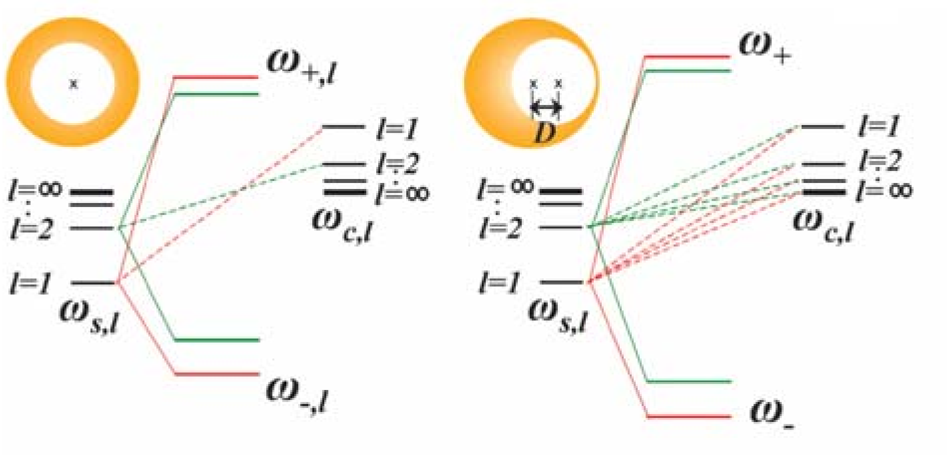
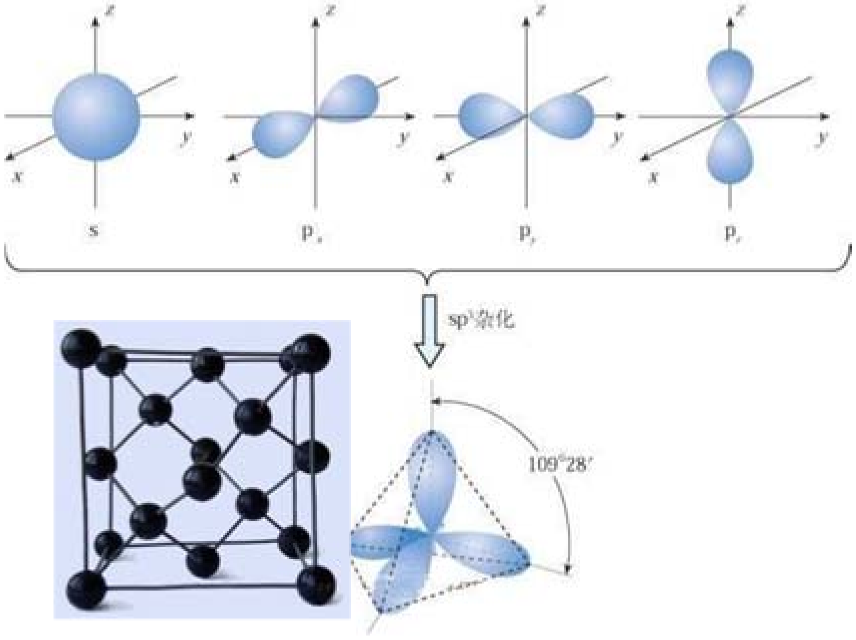
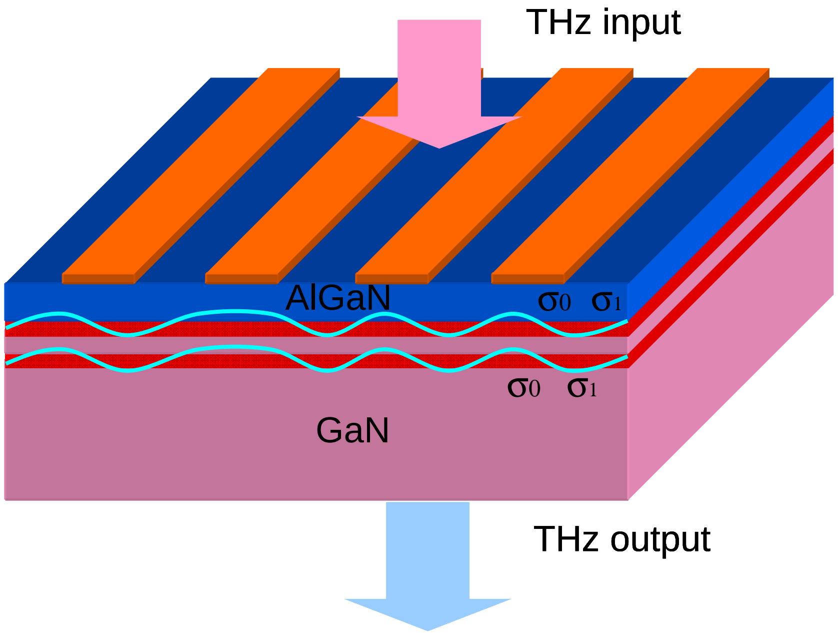
Lin Wang et al Appl. Phys. Lett. 99, 063502(2011)

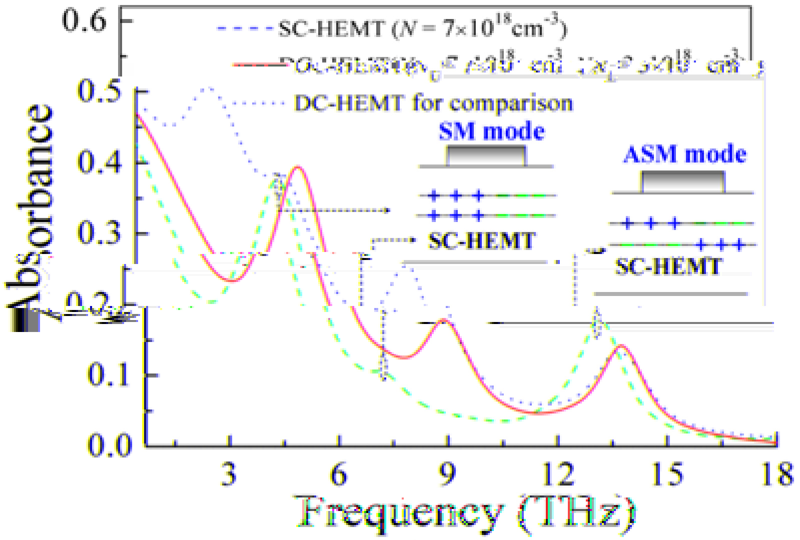

D
$\omega_{+,l}$
$l=1$
$l=2$
$l=\infty$
$\omega_{c,l}$
$l=\infty$
$l=2$
$l=1$
$\omega_{s,l}$
$\omega_{-,l}$
ω_+
ω_-


z
y
x
s
p_x
p_y
p_z
sp³杂化
109°28′

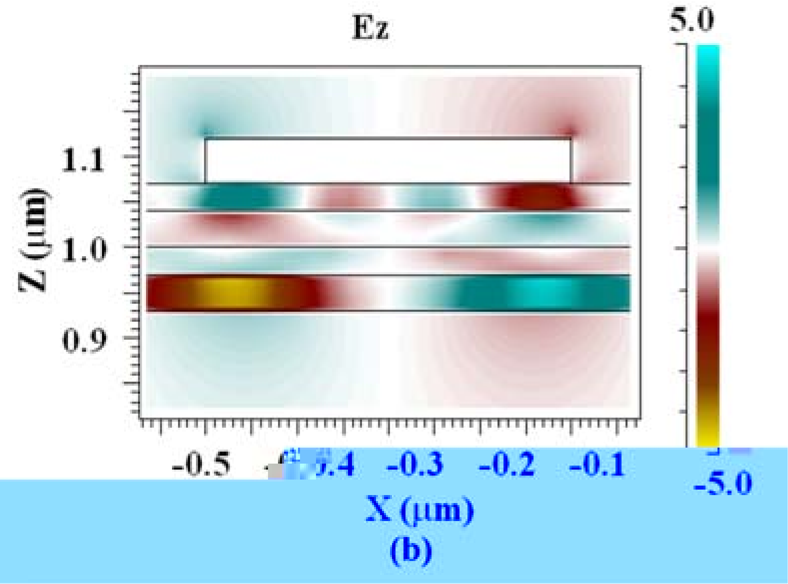

THz input
AlGaN
σ0 σ1
σ0 σ1
GaN
THz output

- **THz** λ>> *d*

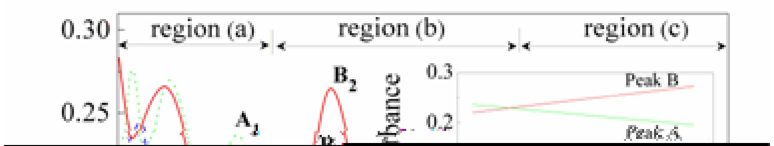
2à ˧ THz



(a)



(b)



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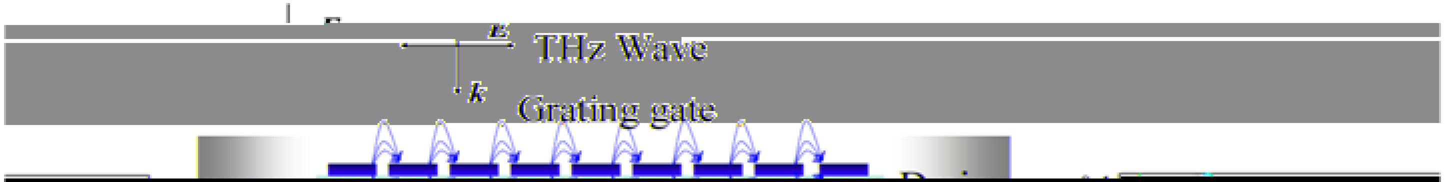
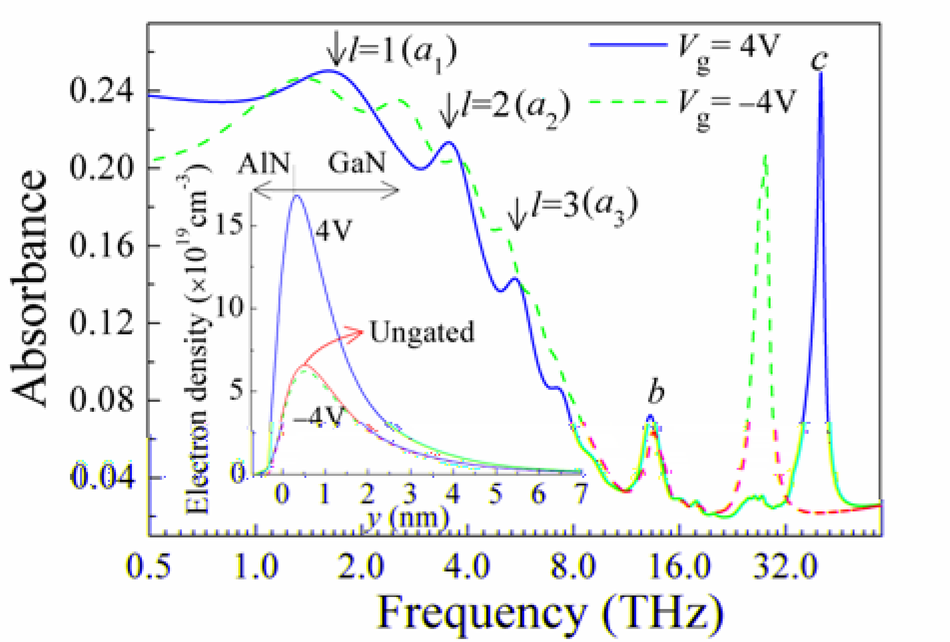
Lin Wang et al APL 100, 123501 (2012)

3 à Ю THz





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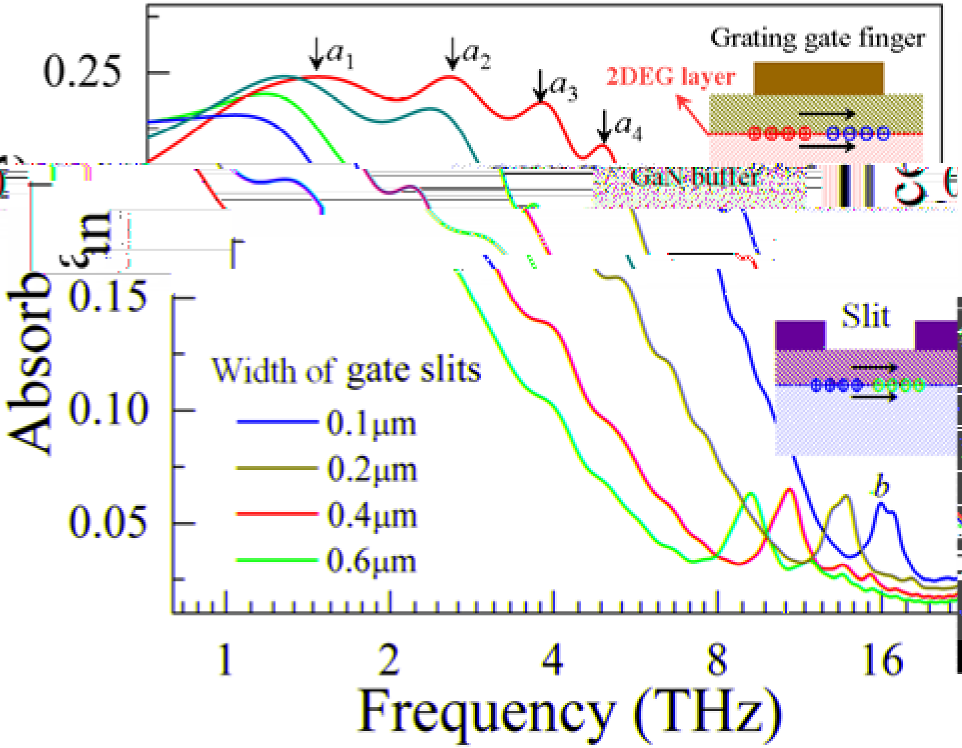
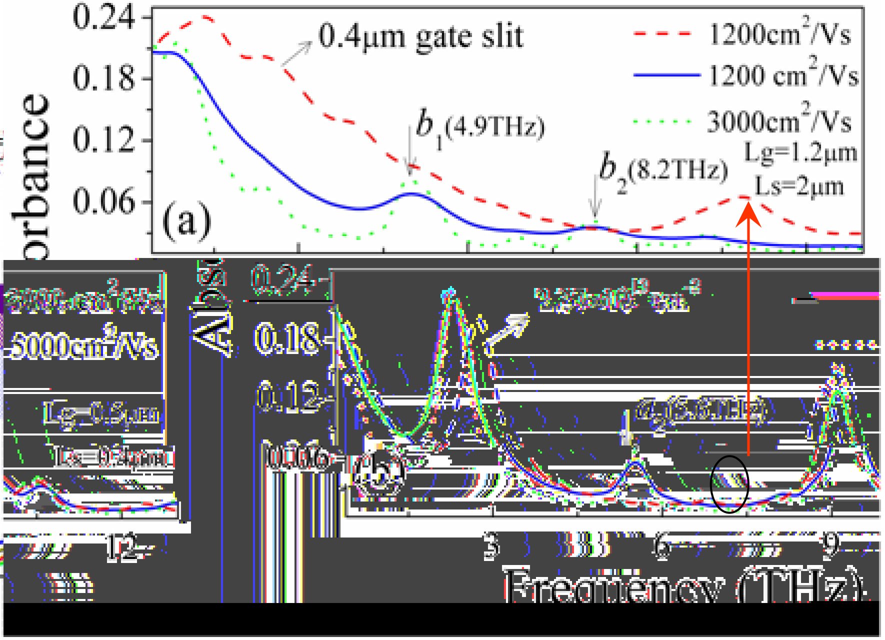
Lin Wang et al IEEE J Quantum Electron.19, 8400507 (2013)
OE21 10821 (2013)

3 à Ю THz





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- 9THz Æ
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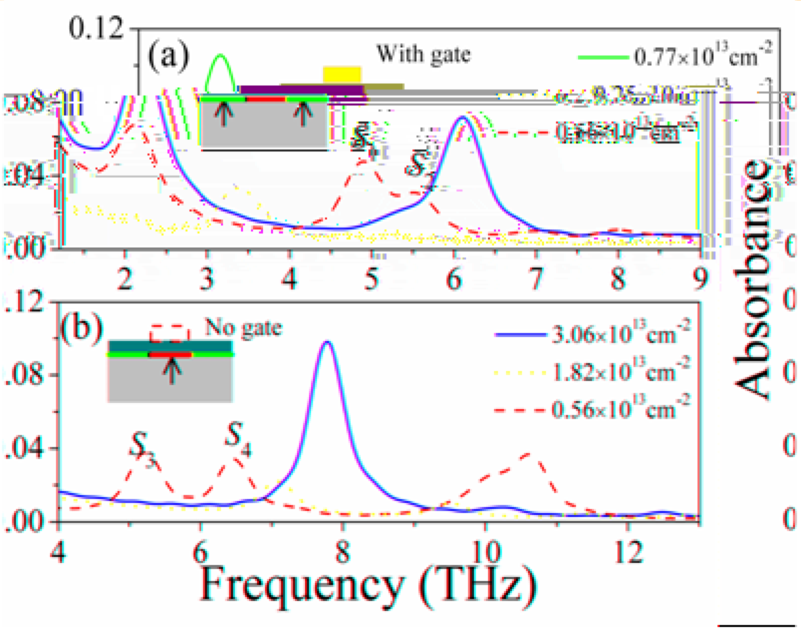
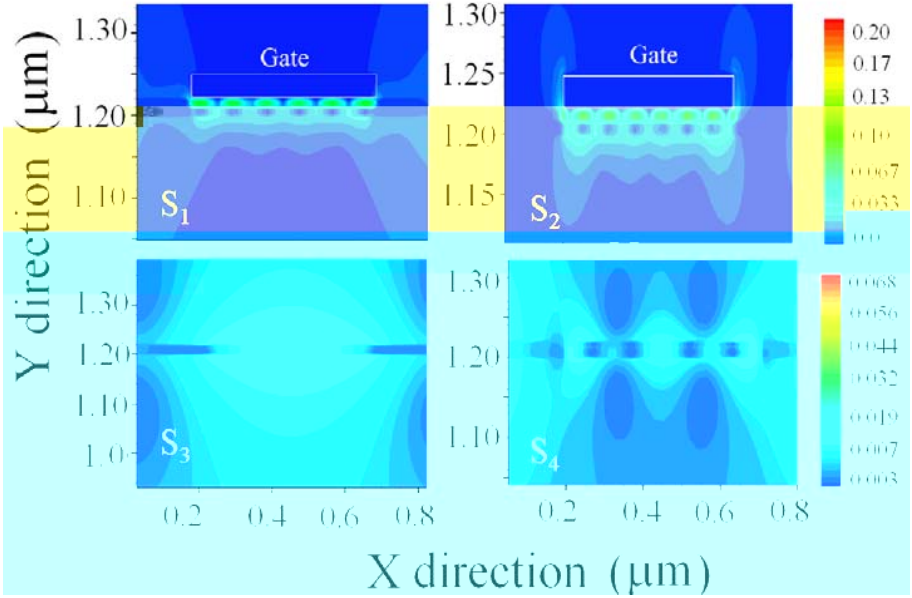
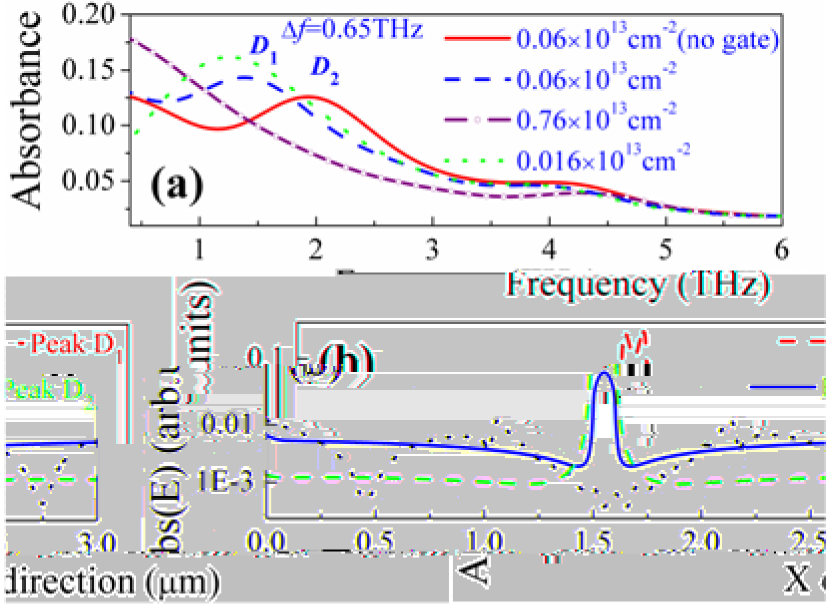
OE21 10821 (2013)

3 à Ю THz







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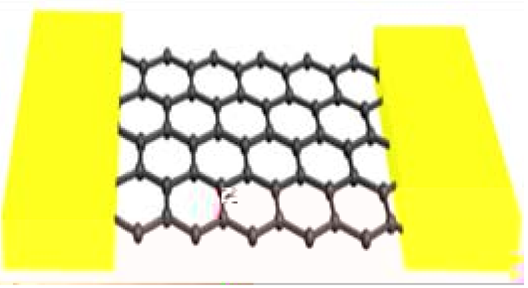
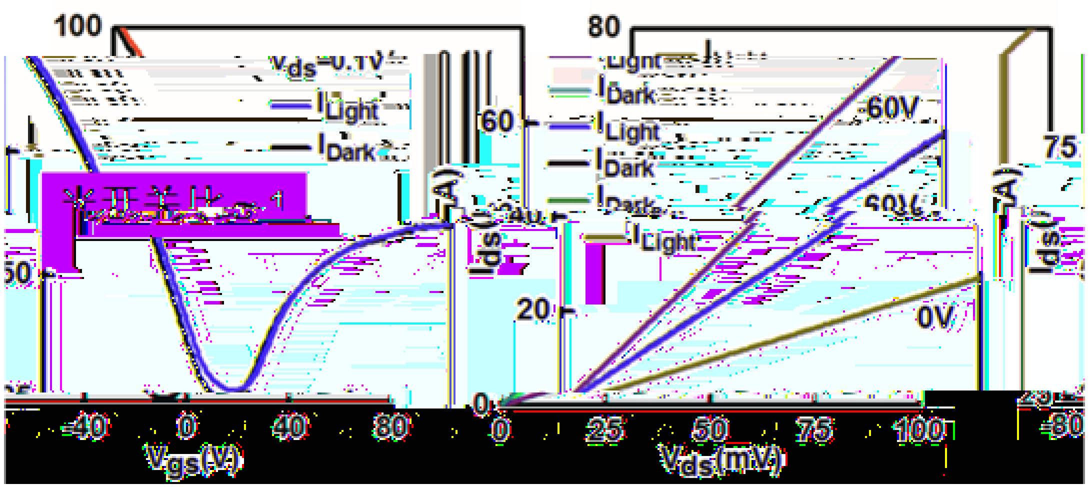
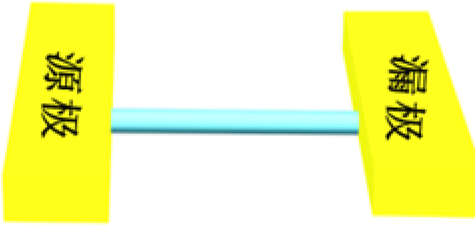
Lin Wang et al IEEE J Quantum Electron.19, 8400507 (2013) OE21 10821 (2013)

4 ȁ / InAs ή

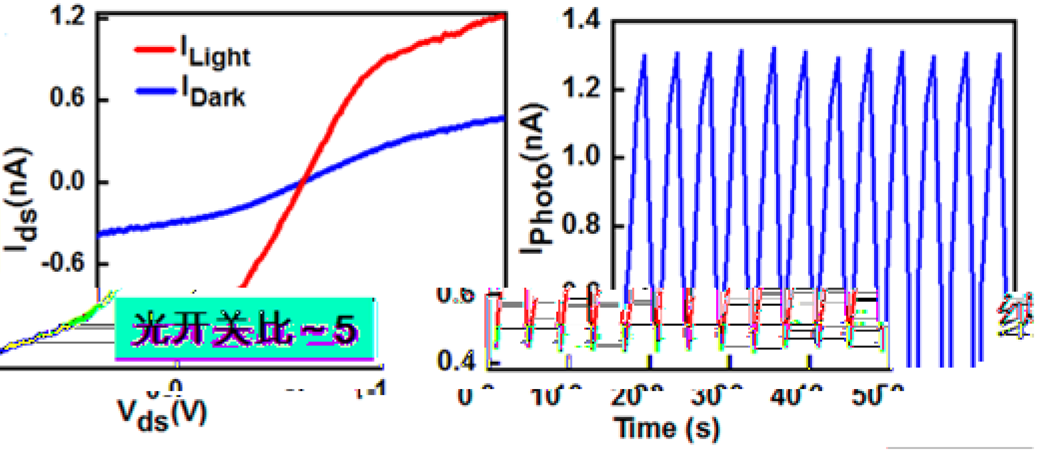




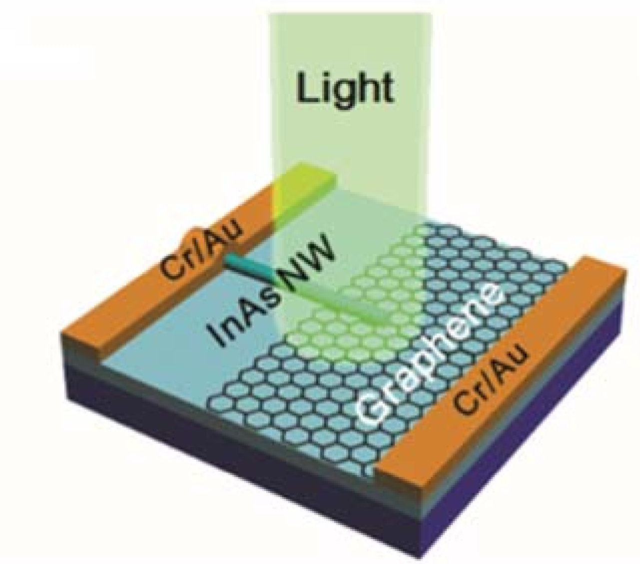
I_{light}/I_{dark}

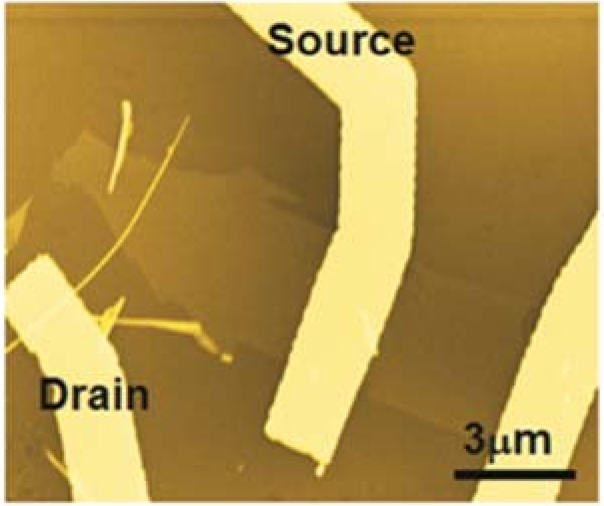


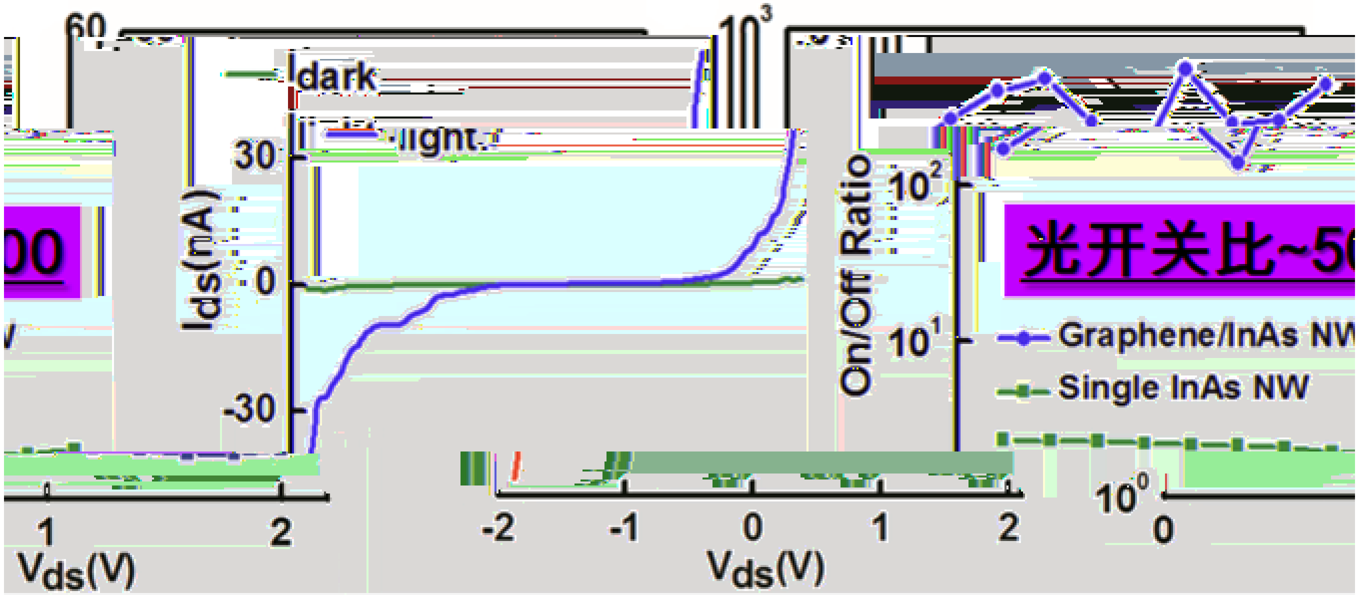
米线光探测器



4 ầ / InAs ή


Light
Cr/Au
InAs NW
Graphene
Cr/Au


Source
Drain
3μm


60
30
0
-30
Ids(nA)
Idark
Ilight
00
1
2
Vds(V)
-2
-1
0
1
2
Vds(V)
10^3
10^2
10^1
10^0
On/Off Ratio
0
光开关比~5
Graphene/InAs NW
Single InAs NW

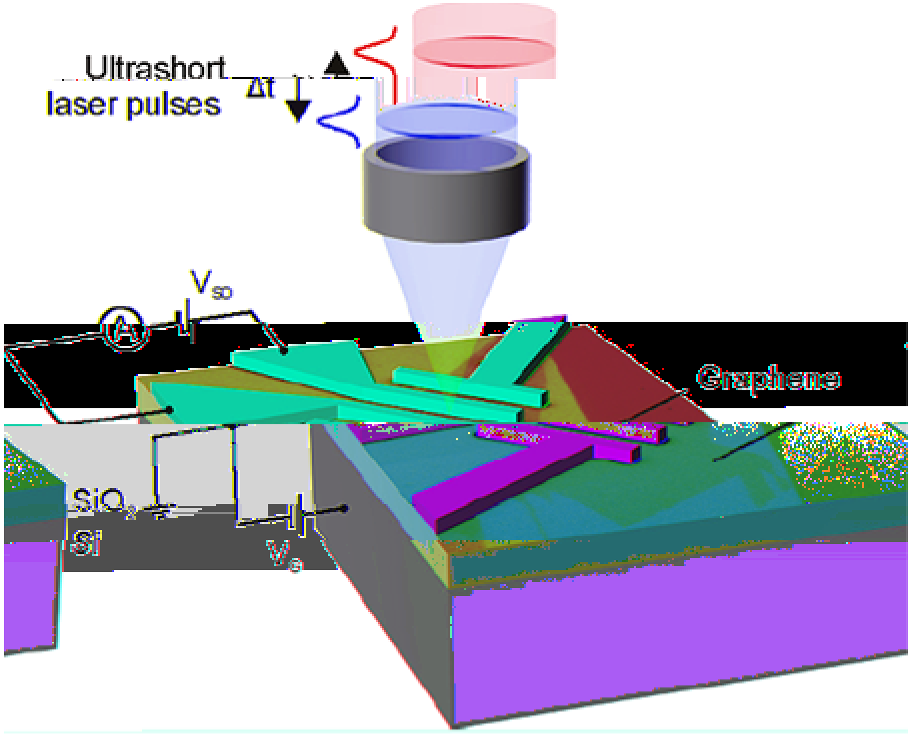
4 à / InAs ή

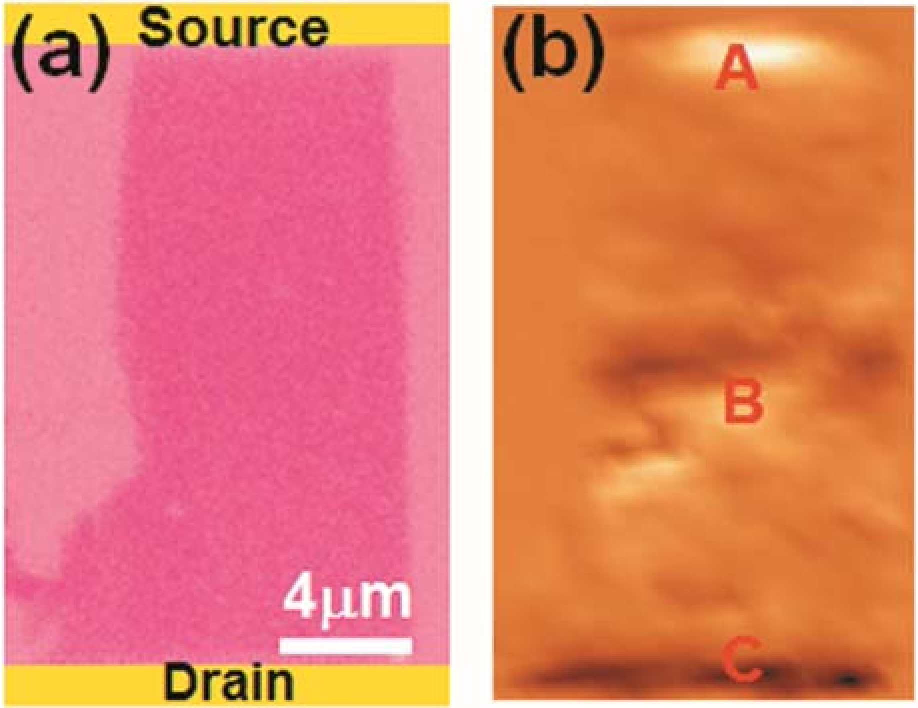
(a)

(b)

[redacted]

4 à / InAs ή

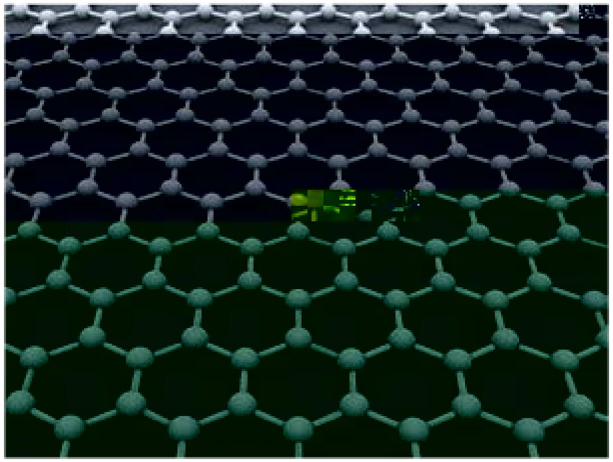


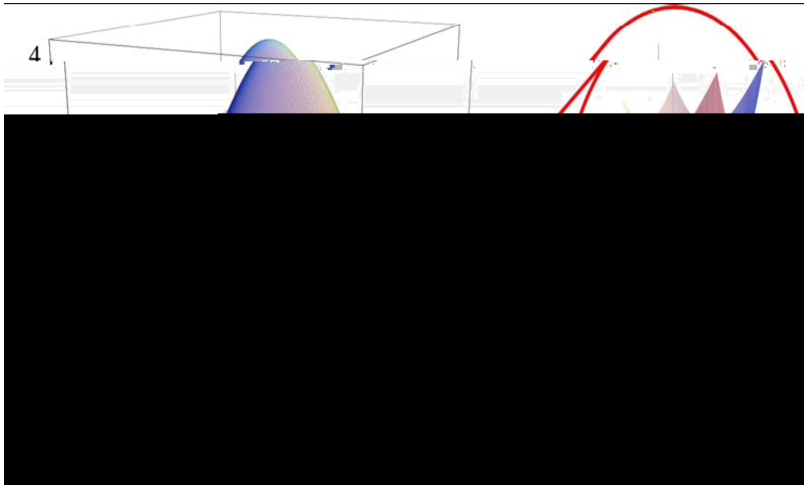


”l SPM

THz

1 à





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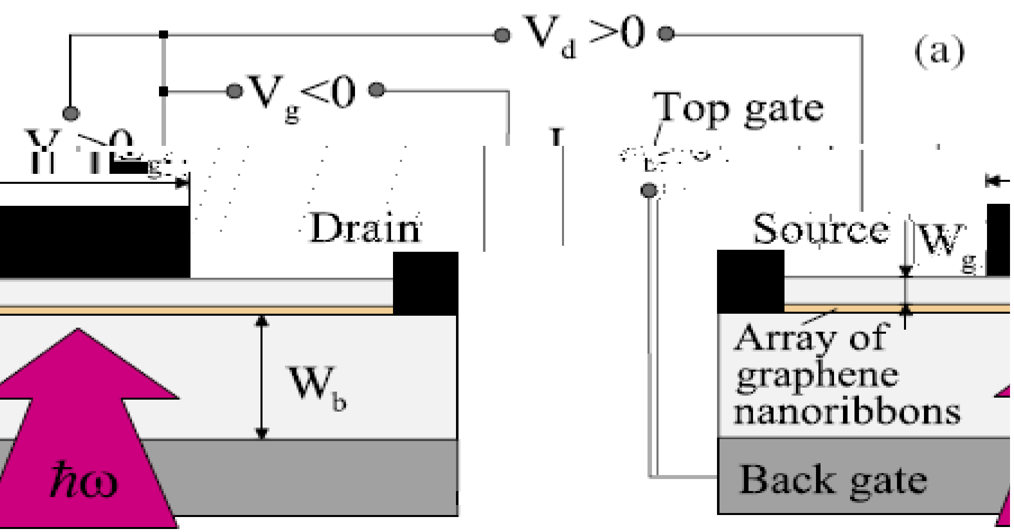
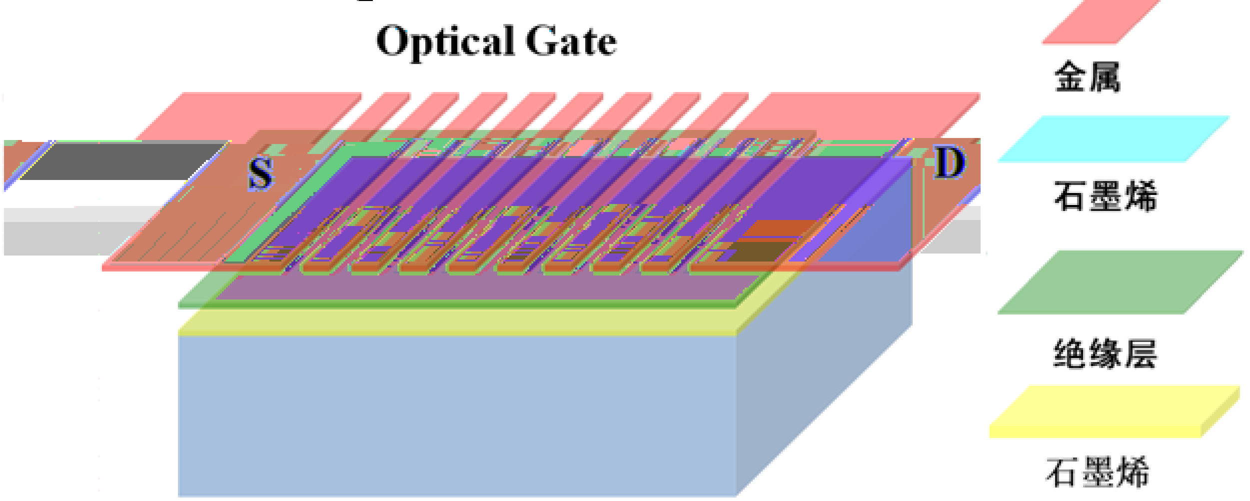
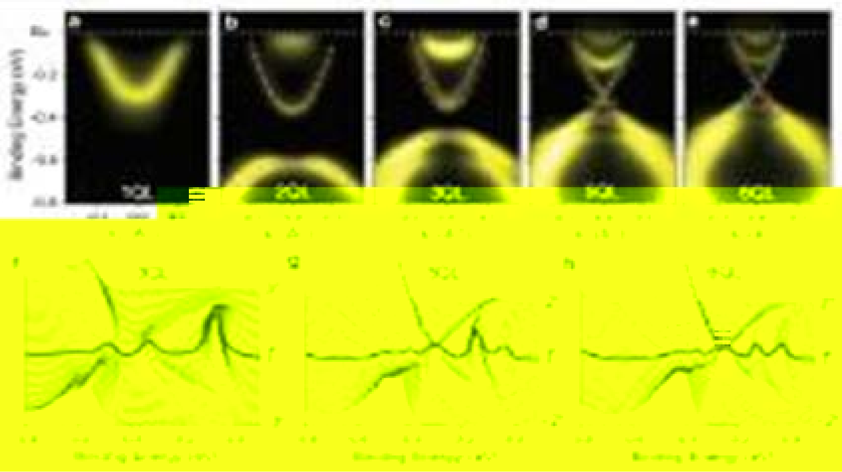


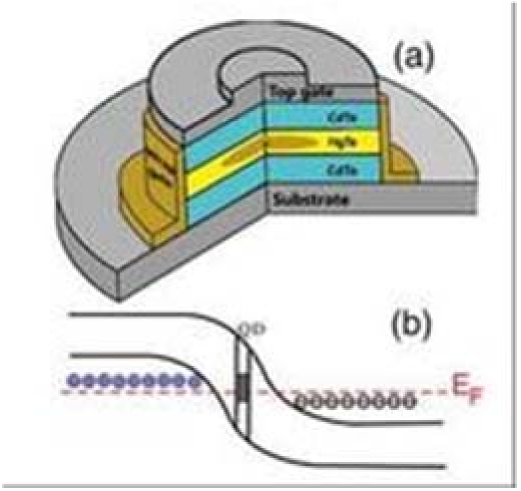
Optical Gate

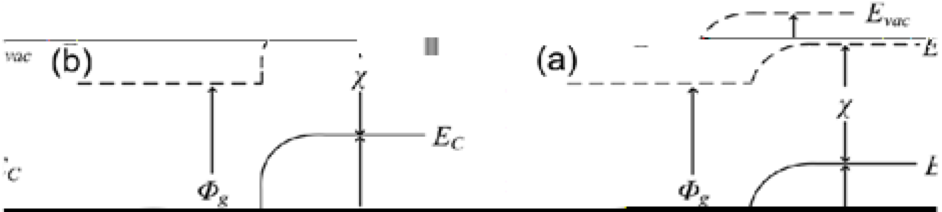


C-based Narrow Gap Semiconductor Physics

2 à


a
b
c
d
e
1QL
2QL
3QL
5QL
6QL
f
g
h


(a)
Top gate
CdTe
HgTe
CdTe
Substrate
(b)
QD
E_F


vac
(b)
χ
E_C
Φ_g
C
(a)
E_vac
E
χ
Φ_g
E

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