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Courses » Semiconductor Devices and Circuits

Announcements **Course** Ask a Question Progress Mentor FAQ

Unit 6 - Week 5 : Metal-Semiconductor Junctions

Assignment 5

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2018-09-12, 23:59 IST.

1) Assume an arbitrary metal forms a Schottky contact with an n-type semiconductor. How does the Schottky barrier height vary if the doping in the semiconductor decreases? ***1 point***

- increases
- decreases
- remains unchanged
- becomes zero

No, the answer is incorrect.
Score: 0

Accepted Answers:
remains unchanged

2) An arbitrary metal is deposited on a lightly doped n-type semiconductor. Work-function of the metal is much higher than the work-function of the semiconductor. Which of the following steps will make the metal-semiconductor contact an ohmic one? ***1 point***
Assume an ideal contact with no surface states.

- Doping the semiconductor heavily (degenerate doping) with an n-type impurity near the contact region.
- Doping the semiconductor heavily with a p-type impurity far away from the contact .
- Doping the semiconductor lightly with a p-type impurity near the contact to make the semiconductor an intrinsic one.
- No further processing is required, as it is already an ohmic contact.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Doping the semiconductor heavily (degenerate doping) with an n-type impurity near the contact region

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Assignment 5 Solution
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- increases, decreases
- decreases, decreases
- increases, increases

No, the answer is incorrect.
Score: 0

Accepted Answers:
increases, increases

4) Consider a (chromium) - (n-type silicon) metal-semiconductor junction. The semiconductor is doped with $N_D = 10^{17}\ cm^{-3}$. Calculate the Shottky barrier height (in eV) and the built-in potential (in V) at $T = 300\ K$. ***1 point***
Use the following parameters, if required:
Work-function of chromium $= 4.5\, eV$
Electron affinity of silicon $= 4.05\, eV$
Band gap of silicon $= 1.12\, eV$
$N_C = 2.82 \times 10^{19}\ /cc,\ N_V = 1.83 \times 10^{19}\ /cc$ (for silicon)
Dielectric constant of silicon $= 11.9$.

- 0.35, 0.2
- 0.45, 0.3
- 0.67, 0.53
- 0.76, 0.62

No, the answer is incorrect.
Score: 0

Accepted Answers:
0.45, 0.3

5) Consider the metal-semiconductor junction given in the previous question (question no. 4). Instead of n-type doping, now consider the p-type doped Si with the dopant concentration, $N_A = 10^{17}\ cm^{-3}$. What will be the Schottky barrier height (in eV) and the buit-in potential (in V)? ***1 point***

- 0.35, 0.2
- 0.45, 0.3
- 0.67, 0.53
- 0.76, 0.62

No, the answer is incorrect.
Score: 0

Accepted Answers:
0.67, 0.53

6) Consider the (chromium) - (n-type Si) MS junction given in the question number 4. ***1 point***
Calculate the following quantities when the junction is reverse biased with $5\ V$:
i) the depletion layer width (in μm)
ii) the electric field at the metal semiconductor interface (in V/cm)

- i) 0.26
  ii) 3.95e5
- i) 0.53
  ii) 1e5
- i) 0.06
  ii) 9.12e4

i) 0.02
ii) 1e4

No, the answer is incorrect.
Score: 0

Accepted Answers:
i) 0.26
ii) 3.95e5

7) Consider the (chromium) - (n-Si) MS junction given in question 4. The junction is subjected to a $5\,V$ reverse bias. Calculate i) the potential drop across the semiconductor (in V) and the junction capacitance per unit area (in nF/cm^2). ***1 point***

i) zero
ii) zero

i) 0.3
ii) 100

i) 4.7
ii) 28.9

i) 5.3
ii) 40.5

No, the answer is incorrect.
Score: 0

Accepted Answers:
i) 5.3
ii) 40.5

8) The capacitance, C of a Schottky diode is given by the relation $\frac{1}{C^2} = a - bV$, with V the applied voltage. a and b are constant coefficients. Calculate i) the built-in potential (ϕ_{bi}) and ii) the donor concentration (N_D). ***1 point***
Assume, the permittivity of semiconductor $= \epsilon_s$ and the junction cross-section area $= A$.

i) $\phi_{bi} = \frac{\epsilon_s q N_D}{2b}$ ii) $N_D = \frac{2}{\epsilon_s N_D q a}$

i) $\phi_{bi} = \frac{\epsilon_s A^2 q N_D a}{2}$ ii) $N_D = \frac{2}{\epsilon_s A^2 q b}$

i) $\phi_{bi} = \frac{2}{\epsilon_s q N_D a}$ ii) $N_D = \frac{abA^2}{\epsilon_s q b}$

i) $\phi_{bi} = \frac{2N_D}{\epsilon_s q A a}$ ii) $\frac{\epsilon_s}{q N_D A b}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
i) $\phi_{bi} = \frac{\epsilon_s A^2 q N_D a}{2}$ ii) $N_D = \frac{2}{\epsilon_s A^2 q b}$

9) A metal semiconductor contact is made with Au (work function $= 5.1\,eV$) and n doped Si with $N_D = 1e15/cc$. If the metal contact is kept $5\,V$ below the semiconductor, what is the electric field in the semiconductor at the distance of $1\,\mu m$ from the junction at $T = 300\,K$? ***1 point***
Assume, $N_C = 2.82e19\,/cc$, electron affinity of Si $= 4.05\,eV$ and the relative permittivity of Si $= 11.8$

$-1.52\,kV/cm$

$1.52\,kV/cm$

$-26.76\,kV/cm$

$26.76\,kV/cm$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$-26.76\,kV/cm$

10) Which of the following is **not** correct regarding an M-S junction? ***1 point***

Thermionic emission depends on the shape of the band bending inside the semiconductor near the junction.

Tunneling current through a triangular barrier at the junction increases with the doping concentration in the semiconductor.

Diffusion transport through a junction is negligible in case of reverse bias.

Thermionic emission transport enhances with the increase in temperature.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Thermionic emission depends on the shape of the band bending inside the semiconductor near the junction.

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