

ME4252 Nanomaterials for Energy Engineering (AY2022-23)

Quiz – 1

Marks: 25 (Grade 20%)

29 September 2022

This is a closed book quiz,

Please attempt all questions in this quiz. You are given 40 min to complete the quiz.

Write your Metric Number and answers on the quiz question sheets and submit this document at the end of the quiz.

No need to provide drawing for any question below.

Matric No.:_____

1. A photocell has a short circuit current of 25 mA, an open circuit voltage of 0.6 V and a maximum power output of 12 mW. What is its fill factor?

- (a) 40%
- (b) 50%
- (c) 60%
- (d) 80%
- (e) 90%

Mention the correct answer above:

(1 marks)

2. During production of monocrystalline Si wafer, trichlorosilane is treated with H₂ gas at 900 °C. What is the purpose? (1-2 sentence)

(1 marks)

3. Nature of the Schottky barrier in a *p-Si* and *n-Si* junction is the following:

- (a) Allows both majority and minority carriers to pass through this region
- (b) Does not allow both majority and minority carriers to pass through this region
- (c) Allows only minority carrier to pass through this region
- (d) Allows only majority carrier to pass through this region.

(i) Select the correct answer above:

(ii) Explain the reason for the answer you provided. (1-2 sentence)

(2 marks)

4. (a) In ionic conductors, increasing temperature increases number of _____ defect concentrations.

(b) Another means of increasing ionic conduction is to increase _____ defect concentration by doping.

(1 marks)

5. (a) Mention three processes that could happen when photons of visible light interact with *Si* having bandgap of 1.12eV.

(b) Mention the conditions at which these three processes occur.

(c) Explain the reason why such processes happen at these conditions (1-2 sentence for each).

(3 marks)

6. When *n-Si* and metal (work function of metal is higher than *n-Si*) are brought together to form a junction, we form Schottky contact. Upon formation of such a contact, the Fermi levels are aligned.

(a) Explain why Fermi level of *n-Si* is aligned with Fermi level of metal. (1-2 sentence)

(b) Provide three different changes that happen in energy levels of *n-Si*.

(c) Explain the reason for each observed change. (1-2 sentence)

(3 marks)

7. (a) When light is illuminated on n -Si/ p -Si junction, we generate the current I_L which flows in the external circuit from _____ (n -Si or p -Si) to _____ (n -Si or p -Si).
(b) Mention all components of I_L
(b) Mention the condition at which I_L will be the same as I_{sc} (short circuit current).
(3 marks)
8. At high doping, the mobility of electron in Si drops substantially.
(a) Provide one cause for this observation.
(b) Explain the reason. (1-2 sentence)
(2 marks)
9. Mention one top down approach for synthesis of nanomaterials which induces chemical reaction to form the final product. Explain why this process is efficient in the formation of final product in nanosized. (2-3 sentence)
(2 marks)

10. $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ is a superconductor and has conductivity due to both ions and electrons. This create _____ (Schottky / ohmic) contact when used with ZrO_2 single crystal for electrical measurements.
Explain the reason for the type contact created. (1-2 sentence)
(2 marks)
11. During synthesis of nanomaterial by hydrothermal method using autoclave, we make use of internal pressure within the autoclave in addition to the temperature. What is the role of high pressure. (1-2 sentence)
(1 marks)
12. Consider AgCl single crystal placed between two Pt electrodes.
(a) Upon impedance measurement how many semicircles you would observe?
(b) Explain the reason for the observed semicircle(s). (1-2 sentence)
(2 marks)
13. By doping CaCl_2 by CdCl_2 we create the following defect:
(a) Defect at Ca site
(b) Defect at Cl site
(c) No defect formation
(d) Defect at both Ca and Cl sites.
(i) Select the correct answer above:
(ii) Provide your reason. (1-2 sentence)
(2 marks)
