ESP5403 Nanomaterials for Energy Systems (AY2021-22)

Mock Quiz

8 Septem 2021

This is a closed book quiz,

Please attempt all 15 questions in this quiz. You are given 25 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. To produce electron rich Si we do extrinsic doping by ----- ------ valance atoms. Give an example of a suchdonor atom and explain how this doping results in excess electrons (in 1-2 sentence).
2. (a) Mention three processes that could happen when photons of visible light interact with a semiconductor, say n-type Si with 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).

1. -- ---------------- (Direct/Indirect)bandgap semiconductor such as InP (Indium Phosphide) has efficient optical absorption while –----------------- (direct/indirect)bandgap semiconductor such as Si does not exhibit efficient absorption process. Explain reason for each (1-2 sentence each).
2. The LED device uses the principle of emission of -------------- (electrons/photons/ phonons/ holes) from a ------------------ (direct/indirect) bandgap semiconductor during the process of ------------------ (absorption/recombination/change separation).
3. When n-Si and metal (work function of metal is higher than n-Si) are brought together to form a junction, we form ------------------- contact. Upon formation of such a contact, the Fermi levels are aligned.
4. Explain why Fermi level of n-Si is aligned with Fermi level of metal (1-2 sentence).
5. Provide three different changes that happen in energy levels of n-Si.
6. Explain the reason for each observed change (1-2 sentence).
7. (a) If light falls on the surface of a semiconductor, its intensity falls exponentially within the semiconductor from the surface due to the process, called --------------.

(b) Mention two such possible relevant processes in n-Si.

(c) Provide the conditions at which these two above mentioned processes predominate in n-Si semiconductor.

1. (a) When light is illuminated on n-Si/p-Si junction, we generate the current IL which flows in the external circuit from --------------------- (n-Si or p-Si) to ------------------------ (n-Si or p-Si).

(b) Mention all components of IL

(b) Mention the condition at which IL will be the same as Isc (short circuit current).

1. At high doping the mobility of electron in Si drops substantially, provide one cause and explain the reason (1-2 sentence).
2. The direction of drift currents of electron and hole in a semiconductor is -  --------------- (same/opposite), while the direction of diffusion currents of electron and hole in a semiconductor is --------------  (same / opposite). Explain the reason for each of your answer above (1-2 sentence).
3. KCl (potassium Chloride) crystal exhibits ------------------- (Schottky / Frenkel) defects. Possible defects are: ------------------ and ----------------------.
4. By doping CaCl2 by CdCl2 we create the following defect, provide your reason (1-2 sentence).
5. Defect at Ca site
6. Defect at Cl site
7. No defect formation
8. Defect at both Ca and Cl sites.
9. Consider AgCl single crystal placed between two Pt electrodes. Upon impedance measurement how many semicircles you would observe. Explain the reason for the observed semicircle(s).
10. 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 nanomaterials (2-3 sentence).
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. YBa2Cu3O7-δ is a superconductor and has conductivity due to both -- -------- and ----------. This create ---------. (Schottky / ohmic) contact when used with Y2O3 doped ZrO2 single crystal for electrical measurements. Explain the reason for the type contacts created (1-2 sentence).