

Course "Large-area electronics: Materials"

Multiple choice test, spring 2022.

Cross the correct answer. More than one answer may be correct!

1. **What type of order is prevalent in amorphous semiconductors?**
 O Static short range order
 O Long range order
 O Translational invariance
2. **In an amorphous semiconductor, is the atomic network totally random?**
 O Yes
 O No
3. **How does doping allow to vary dark conductivity of a-Si:H?**
 O by varying the average state of charge of dangling bonds
 O doping does not occur in a-Si:H due to network flexibility
 O by decreasing the activation energy down to a few hundreds of meV
4. **At room temperature, electronic charge transport in a-Si:H is similar to that of**
 O c-Si
 O polymers and amorphous insulators
5. **At low temperature, electronic charge transport in a-Si:H is similar to that of**
 O c-Si
 O an insulator
6. **Dangling bonds are the main electronic defects in a-Si:H**
 O yes
 O No
7. **If the defect density is very high, what are the possible consequences on the material quality?**
 O reduced electronic transport quality
 O reduced $\mu\tau$ -product
 O increased recombination rate
8. **Why has a-Si:H a higher absorption coefficient than c-Si in the visible range of wavelength?**
 O because it is non-direct gap material.
 O because it contains hydrogen.
 O because c-Si is an indirect bandgap material.
9. **What is the role of Hydrogen in a-Si:H?**
 O It passivates dangling bonds.
 O It makes a-Si:H a direct bandgap material.
 O It reduces the defect density.
10. **The residual absorption (shoulder) in a-Si:H at low photon energy relates to:**
 O density of recombination centers
 O density of dangling bonds
 O bandtails
11. **Can the extrapolated optical gap be taken as a useful value for the bandgap of a-Si:H?**
 O yes
 O no
12. **Would this be also the case for a degenerated transparent conductive oxide (TCO)?**
 O yes

O no

13. **In order to increase the conductivity of a TCO layer without degrading its optical properties, which layer properties have to be enhanced?**
 - O the free carrier mobility
 - O the free carrier density
 - O the sheet thickness
14. **After a few hours of illumination, defect related absorption of a-Si:H is increased. To which effect does this observation relate?**
 - O Hall effect
 - O Staebler-Wronski effect
15. **After very long exposure of a-Si :H layers to sun light (months), what happens?**
 - O the defect-density reaches a quasi-stable value
 - O the defect density increases exponentially
16. **What is approximately the defect density in device grade hydrogenated amorphous silicon?**
 - O 10^{19} cm^{-3}
 - O 10^{22} cm^{-3}
 - O 10^{16} cm^{-3}
17. **Doping leads to an increasing dangling bond density in a-Si:H.**
 - O yes
 - O no
18. **How is a glass defined with respect to an amorphous material?**
 - O A glass is an amorphous material obtained by rapid cooling from the liquid phase
 - O A glass is not amorphous.
 - O A glass is a highly viscous material with a continuous variation of specific heat with respect to temperature
19. **Does carrier lifetime increase with increasing dangling bond density?**
 - O yes.
 - O no.
20. **By measuring the activation energy of the dark conductivity above room temperature in a-Si:H, one can evaluate:**
 - O whether it is doped or intrinsic.
 - O if variable range hopping is the dominant transport mechanism.
21. **Why is it impossible to push the Fermi level closer than ~0.2 eV to the conduction band edge of a-Si:H with Phosphorus doping**
 - O because of the presence of bandtails states in the gap
 - O because of the presence of hydrogen
22. **The main recombination mechanism in a-Si:H at room temperature occurs by successive trapping of an electron/hole pair on a dangling bond**
 - O yes
 - O no
23. **Does the simplest Shockley-Read recombination model generally apply to a-Si:H?**
 - O Yes
 - O No
24. **Do all localized states in the gap play the role of recombination centers?**
 - O yes
 - O no

25. The slope of the exponential decrease of the absorption yields information on
 O the dangling bond density
 O the bandtail states density

26. Which states are acting as traps in a-Si:H?
 O Bandtail states
 O Dangling bonds

27. Why does a-Si:H remain a semiconductor even if it has lost crystallinity?
 O Because short range order is sufficient to maintain an optical gap
 O Because Si is a metal
 O Because crystallinity is not required to observe a gap

28. The Urbach energy of the valence band tail in a-Si:H is typically 50 meV. The Urbach energy of the conduction band is:
 O higher
 O equal
 O lower

29. Which type of hydrogen bonding is favorable in a-Si:H?
 O SiH
 O SiH₂
 O SiH₃

30. Does photoconductivity decrease with increasing dangling bond density?
 O yes
 O no

31. Which particles are present in a plasma?
 O photons
 O ions
 O electrons
 O neutral atoms/molecules

32. What happen to an (isolated) surface exposed to a plasma?
 O it charges positively
 O it charges negatively
 O nothing happens

33. Which one is higher in the plasma used for PE-CVD?
 O electron temperature
 O ion temperature
 O neutral species temperature