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?**
   - x Static short range order
   - O Long range order
   - O Translational invariance

2. **In an amorphous semiconductor, is the atomic network totally random?**
   - O Yes
   - x No

3. **How does doping allow to vary dark conductivity of a-Si:H?**
   - x by varying average state of charge of dangling bonds
   - O doping does not occur in a-Si:H due to network flexibility
   - x by decreasing 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**
   - x 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
   - x an amorphous insulator

6. **Dangling bonds are the main electronic defects in a-Si:H**
   - x yes
   - O No

7. **If the defect density is very high, what are the possible consequences on the material quality?**
   - x reduced electronic transport quality
   - x reduced $\mu\tau$-product
   - x increased recombination rate

8. **Why has a-Si:H a higher absorption coefficient than c-Si in the visible range of wavelength?**
   - x because it is non-direct gap material.
   - O because it contains hydrogen.
   - x because c-Si is an indirect bandgap material.

9. **What is the role of Hydrogen in a-Si:H?**
   - x It passivates dangling bonds.
   - O It makes a-Si:H a direct bandgap material.
   - x It reduces the defect density.

10. **The residual absorption (shoulder) in a-Si:H at low photon energy relates to:**
    - x density of recombination centers
    - x 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?**
    - x yes
    - O no

12. **Would this be also the case for a degenerated transparent conductive oxide (TCO)?**
    - O yes

x no

13. **In order to increase the conductivity of a TCO layer without degrading its optical properties, which layer properties have to be enhanced?**
    x 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
    x Staebler-Wronski effect

15. **After very long exposure of a-Si :H layers to the sun light (months), what happens?**
    x 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}
    x 10^{16} cm^{-3}

17. **Doping leads to an increasing dangling bond density in a-Si:H.**
    x yes
    O no

18. **How is a glass defined with respect to an amorphous material?**
    x A glass is an amorphous material obtained by rapid cooling from the liquid phase
    O A glass is not amorphous.
    x 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.
    x no.

20. **By measuring the activation energy of the dark conductivity above room temperature in a-Si:H, one can evaluate:**
    x 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**
    x 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**
    x yes
    O no

23. **Does the simplest Schockley-Read recombination model generally apply to a-Si:H?**
    O Yes
    x No

24. **Do all localized states in the gap play the role of recombination centers?**
    O yes
    x no

25. The slope of the exponential decrease of the absorption yields information on

O the dangling bond density
x the bandtail states density

26. Which states are acting as traps in a-Si:H?

x Bandtail states
O Dangling bonds

27. Why does a-Si:H remain a semiconductor even if it has lost crystallinity?

x Because short range order is sufficient to maintain an optical gap
O Because Si is a metal
x 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
x lower

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

x SiH
O SiH_2
O SiH_3

30. Does photoconductivity decrease with increasing dangling bond density?

x yes
O no

31. Which particles are present in a plasma?

x photons
x ions
x electrons
x neutral atoms/molecules

32. What happen to an (isolated) surface exposed to a plasma?

O it charges positively
x it charges negatively
O nothing happens

33. Which one is higher in the plasma used for PE-CVD?

x electron temperature
O ions temperature
O neutral species temperature