EEE 333 - Optical Communication Devices

LED structures MCQ Questions

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MCQ Questions

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1. Q **Which of the following is a drawback of LEDs compared to injection lasers?**

(a) Higher optical power coupled into a fiber

(b) Higher modulation bandwidth

(c) Harmonic distortion

(d) Simpler fabrication process

1. A (c)

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2. Q **LEDs typically have lower .... compared to injection lasers.**

(a) Optical power coupled into a fiber

(b) Fabrication cost

(c) Modulation bandwidth

(d) all of the above

2. A (d)

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3. Q **What is the purpose of using a double-heterojunction (DH) structure in an LED?**

(a) To enhance the light emission efficiency

3. A (a)

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4. Q **Which layers are sandwiched around the p-type GaAs layer in the double-heterojunction LED?**

(a) n-type AlGaAs and p-type AlGaAs layers

4. A (a)

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5. Q When a forward bias is applied to the double-heterojunction LED, where do the injected electrons from the n-type layer go?

(a) They are injected into the p-type GaAs layer

5. A (a)

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6. Q What happens to the minority carriers (electrons) once they are injected into the p-type GaAs layer?

(a) They recombine with majority carriers (holes)

6. A (a)

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7. Q What is the energy of the produced photons in the double-heterojunction LED?

(a) Equal to the bandgap energy of the p-type GaAs layer

7. A (a)

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8. Q Why are the injected electrons inhibited from diffusing into the p-type AlGaAs layer?

(a) Due to the presence of a potential barrier at the p–p heterojunction

8. A (a)

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9. Q electroluminescence only occurs in ....

(a) GaAs junction layer

9. A (a)

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10. Q electroluminescence only occurs in the GaAs junction layer, providing ....

(a) good internal quantum efficiency

(b) high-radiance emission

(c) (a) and (b)

10. A (c)

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11. Q What is the reason for light being emitted from the device without reabsorption?

(a) The bandgap energy in the AlGaAs layer is larger than that in GaAs

11. A (a)

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12. Q Why is the DH structure preferred for applications in optical fiber communications?

(a) It provides the most efficient incoherent light sources

12. A (a)

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13. Q What type of emission does forward current flow through the junction in a Planar LED produce?

(a) Lambertian spontaneous emission

13. A (a)

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14. Q Why is the radiance of a Planar LED low?

(a) Due to total internal reflection, only a limited amount of light escapes the structure

14. A (a)

15. Q Which surfaces of the Planar LED emit light?

(a) All surfaces

(b) Only the top surface

(c) Only the side surfaces

15. A (a)

16. Q What is the structure of the Dome LED?

(a) A hemisphere of n-type GaAs surrounding a diffused p-type region

(b) A flat plane of p-type GaAs with a diffused n-type region

(c) A cylindrical shape with alternating n-type and p-type regions

16. A (a)

17. Q Why is the diameter of the dome chosen in the Dome LED?

(a) To maximize the amount of internal emission reaching the surface within the critical angle

(b) To minimize the amount of internal emission reaching the surface within the critical angle

17. A (a)

18. Q How does the external power efficiency of the Dome LED compare to the planar LED?

(a) The Dome LED has a higher external power efficiency than the planar LED

(b) The Dome LED has a lower external power efficiency than the planar LED

18. A (a)

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19. Q What is the impact of the dome's geometry on the radiance of the Dome LED?

(a) The radiance is reduced due to the larger size of the dome compared to the active recombination area.

(b) The radiance is increased due to the larger size of the dome compared to the active recombination area.

(c) The radiance remains unaffected by the dome's geometry.

19. A (a)

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20. Q Why does the larger size of the dome reduce the radiance of the Dome LED?

(a) To increases the internal reflections within the LED structure.

20. A (a)

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21. Q What is the purpose of having a larger effective emission area in the Dome LED?

(a) To reduce the radiance of the LED

21. A (a)

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22. Q What is the key approach to achieving high radiance in Surface emitter LEDs?

(a) Restricting the emission to a small active region within the device

22. A (a)

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23. Q **What technique was pioneered by Burrus and Dawson to improve radiance in homostructure Surface emitter LEDs?**

(a) Using an etched well in a GaAs substrate

23. A (a)

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24. Q **What purpose does the etched well in a GaAs substrate serve in Surface emitter LEDs?**

(a) Preventing heavy absorption of emitted radiation

(b) Accommodate the fiber.

24. A (a)

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25. Q **What advantages are gained by employing DH structures in Surface emitter LEDs?**

(a) Both (b) and (c)

(b) Reduced absorption of emitted radiation

(c) Increased efficiency from electrical and optical confinement

25. A (a)

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26. Q **Why is the internal absorption in DH structures very low?**

(a) Due to the larger bandgap-confining layers

26. A (a)

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27. Q **What contributes to good forward radiance in DH-based Surface emitter LEDs?**

(a) **High reflection coefficient at the back crystal face**

27. A (a)

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28. Q **How can the emission from the active layer in Surface emitter LEDs be described?**

(a) **Isotropic (same value in all directions)**

28. A (a)

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29. Q **What causes the external emission distribution of Surface emitter LEDs to appear Lambertian with a beam width of 120°?**

(a) **Refraction from a high to a low refractive index at the GaAs–fiber interface**

29. A (a)

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30. Q **How does the addition of epoxy resin in the etched well affect the external power efficiency of the device?**

(a) **Reduce the refractive index mismatch and increases the external power efficiency**

30. A (a)

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31. Q What is the purpose of using transparent guiding layers in Edge emitter LEDs?

(a) To reduce self-absorption in the active layer

31. A (a)

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32. Q What is the advantage of having a very thin active layer in Edge emitter LEDs?

(a) It allows the light produced in the active layer to spread into the transparent guiding layers, reducing self-absorption.

32. A (a)

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33. Q Why is most of the propagating light in Edge emitter LEDs emitted at one end face only?

(a) Due to a reflector on the other end face

33. A (a)

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34. Q How does the effective radiance at the emitting end face of Edge emitter LEDs compare to surface emitters?

(a) It can be very high, giving increased coupling efficiency into small-NA fiber

34. A (a)

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35. Q Why do surface emitters generally radiate more power into air compared to edge emitters?

(a) The emitted light in surface emitters is less affected by reabsorption and interfacial recombination.

35. A (a)

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36. Q In terms of coupling optical power into low numerical aperture (NA) fibers, which type of LED performs better?

(a) Edge emitters

36. A (a)

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37. Q For large numerical aperture (NA) fibers, which type of LED performs better in terms of power coupling?

(a) Surface emitters

37. A (a)

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38. Q What is the relationship between the optical bandwidth and the electrical bandwidth ?

(a) The optical bandwidth is significantly greater than the electrical bandwidth.

38. A (a)

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39. Q What is the relationship between the optical bandwidth and the electrical bandwidth, assuming a Gaussian system response?

(a) The optical bandwidth is a factor of $\sqrt{2}$ greater than the electrical bandwidth.

39. A (a)

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40. Q What is one of the mechanisms that generally determines the modulation bandwidth of LEDs?

(a) The doping level in the active layer.

(b) The size of the LED package.

(c) The forward voltage applied to the LED.

40. A (a)

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41. Q How does the reduction in radiative lifetime due to injected carriers affect the modulation bandwidth of LEDs?

(a) It increases the modulation bandwidth.

(b) It decreases the modulation bandwidth.

(c) It has no effect on the modulation bandwidth.

41. A (a)

42. Q **What is one of the mechanisms that generally determines the modulation bandwidth of LEDs?**

(a) **The doping level in the active layer.**

(b) **The reduction in radiative lifetime due to the injected carriers**

(c) **The parasitic capacitance of the device.**

(d) **All of the above**

42. A **(d)**