NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Department of Physics

Second series test, (IVth, Sem) 2015

BTech

PH 4022 INTRODUCTION TO OPTOELECTRONICS

Time: 1Hr. Max.Marks: 20

*Answer all questions*

1. The p-side of an LED has to be sufficiently narrow. Explain with sketches of the energy band diagram of a p-n junction without and with bias. (2)

2. What are isoelectronic centers? How these work ? Explain with the help of E-k diagrams (2)

3. What are heterojunctions and double heterojunctions in LEDs? Explain their action and advantage with the help of band diagrams. (2)

4. Why the efficiency of OLEDs are generally not greater than 25% and how this can be improved. What is the principle behind this technique (2)

5. What are the major efficiencies of an LED. Give expressions for them. (2)

6. Given that the width of the relative intensity vs Photon energy spectrum of an LED is typically around $3K_BT$. What is the line width $\Delta\lambda_{½}$ in the output spectrum in terms of $\lambda$ (2)

7. Explain with neat sketches, the principle of LED formation explaining various parameters. Also give a schematic illustration of typical planar surface emitting LED devices. (3)

8. Is it possible to have light emission from indirect band gap semiconductors? Explain a typical case and also why GaAsP alloys are used in inexpensive green light emission (3)

9. The Ternary alloy $In_{1-x}Ga_xAs_yP_{1-y}$ grown on an InP crystal substrate is used for infrared wave length LED applications. The device requires that the InGaAsP layer is lattice matched to the InP crystal substrate to avoid crystal defects in the InGaAsP layer. For this $y$ should be equal to 2.2 x. The bandgap $E_g$ of the ternary alloy in $eV$ is then given by the empirical relationship, $E_g = 1.35 - 0.72y + 0.12y^2$ ; $0 \leq x \leq 0.47$. Calculate the compositions of InGaAsP ternary alloys for peak emissions at a wavelength of 1.3μm (2)

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