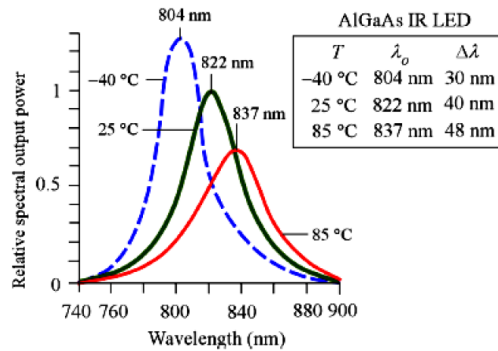


NTHU Electrical Engineering Department
EE3360 Optoelectronic Devices Spring 2019
HW #5

- An AlGaAs LED emitter for a local optical fiber network has the output spectrum shown below. It is designed for peak emission at about 822 nm at 25°C.
 - What is the bandgap of AlGaAs in this LED?
 - The bandgap, E_g , of the ternary $\text{Al}_x\text{Ga}_{1-x}\text{As}$ alloys follows the empirical expression, $E_g(\text{eV}) = 1.424 + 1.266x + 0.266x^2$. What is the composition of the $\text{Al}_x\text{Ga}_{1-x}\text{As}$ in this LED?



- We discussed in class that the modulation bandwidth of LED can be described by the cut-off frequency f_c and is estimated to be $f_c = \frac{1}{2\pi\tau}$, where τ is the total recombination lifetime, including radiative and nonradiative, and $\frac{1}{\tau} = \frac{1}{\tau_r} + \frac{1}{\tau_{nr}}$.
 - Please show that η_{IQE} and the bandwidth f_c product is equal to $\eta_{IQE}f_c = \frac{1}{2\pi\tau_r}$. How do you interpret this result?
 - Consider an LED in which the radiative and nonradiative lifetimes are approximately 10 ns and 50 ns, respectively. What are the η_{IQE} and the possible bandwidth f_c ? What happens if defects cause nonradiative lifetime to be 25 ns?
- Consider a particular green LED. The emission wavelength is 528 nm. At an LED current of 350 mA, the forward voltage is 3.4 V. The emitted luminous flux is 92 lm. Please find the power conversion efficiency, external quantum efficiency, luminous efficacy, and the emitted optical power.
 - A particular 870 nm IR LED for use in optical links and instrumentation has a GaAs chip. The nonradiative lifetime of the material is about 100 ns and the radiative lifetime is about 25 ns. At a forward current of 30 mA, the voltage across it is 1.35 V, and the emitted optical power is 6.5 mW. Please calculate the internal quantum efficiency, power conversion efficiency, external quantum efficiency, and estimate the light extraction efficiency.
- Please find a commercial product for each of the lighting device shown below. List the brand, the name of the device, and the luminous efficacy.

(1)



(2)



(3)



(4)



(5)



5. (a) Please compare the features of LED and OLED in their optical properties. (b) Please find the current display technologies that use LED and OLED for TV displays.