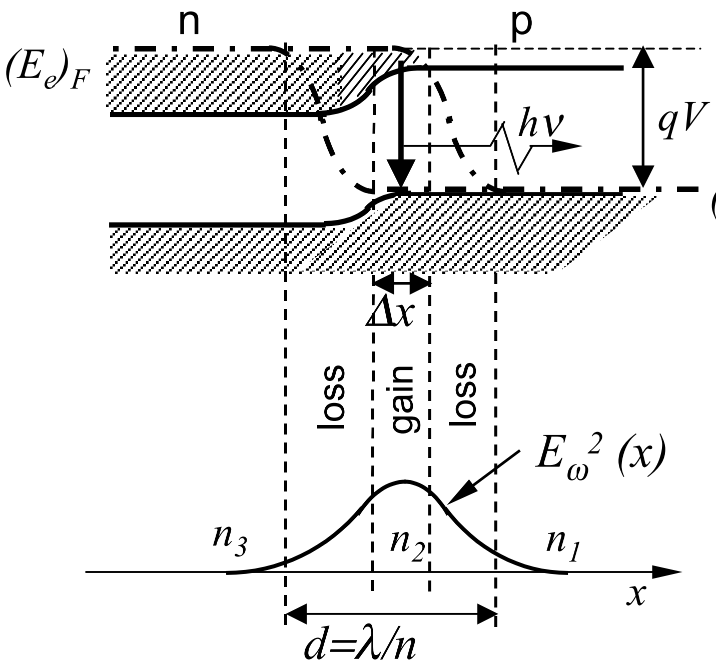
Disadvantages of homolasers

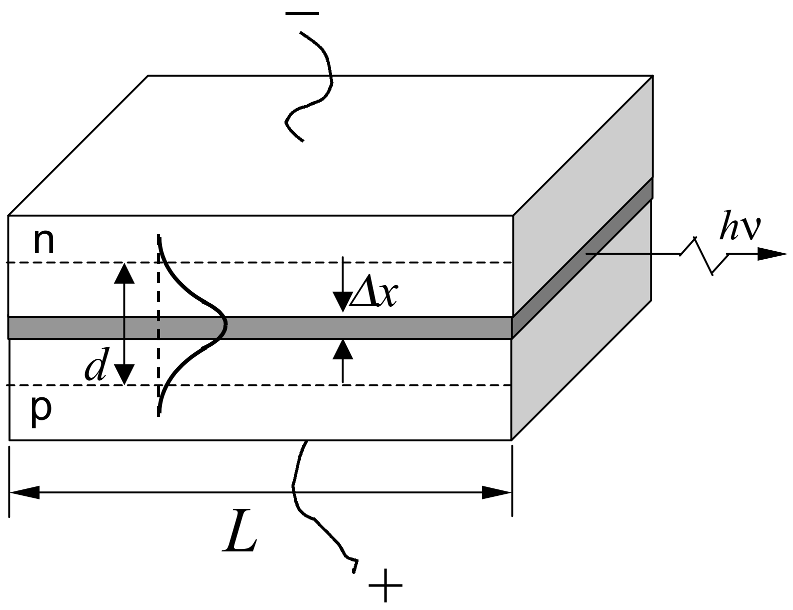


$n_2 > n_1 , n_3$

$\Gamma = \Delta x / d$

Forward biased p-n homojunction

Δx – region of light amplification ($G > 0$)

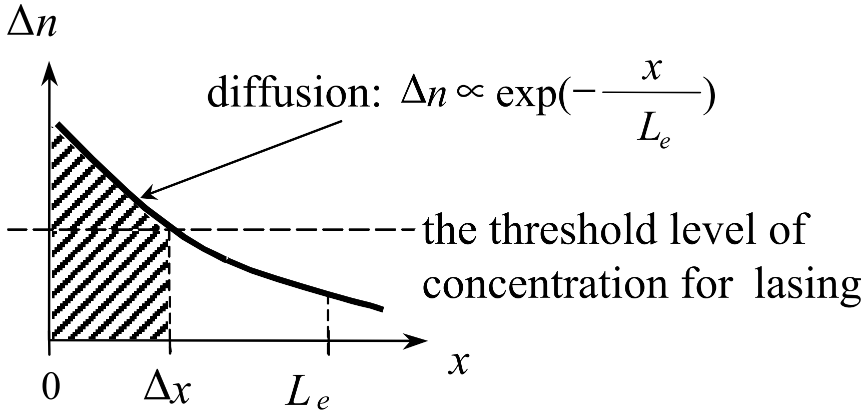


$n_2 \approx 3.5$

$\Delta n = n_2 - n_1 \approx n_3 - n_1 \approx 5 \cdot 10^{-3}$

1. Poor optical confinement

Disadvantages of homolasers



2. Poor electron confinement

Carriers in regions with $x > \Delta x$ do not contribute into lasing

$g = \Gamma \cdot G \propto n$, $\Gamma \cdot G = \alpha_{\text{loss}}$

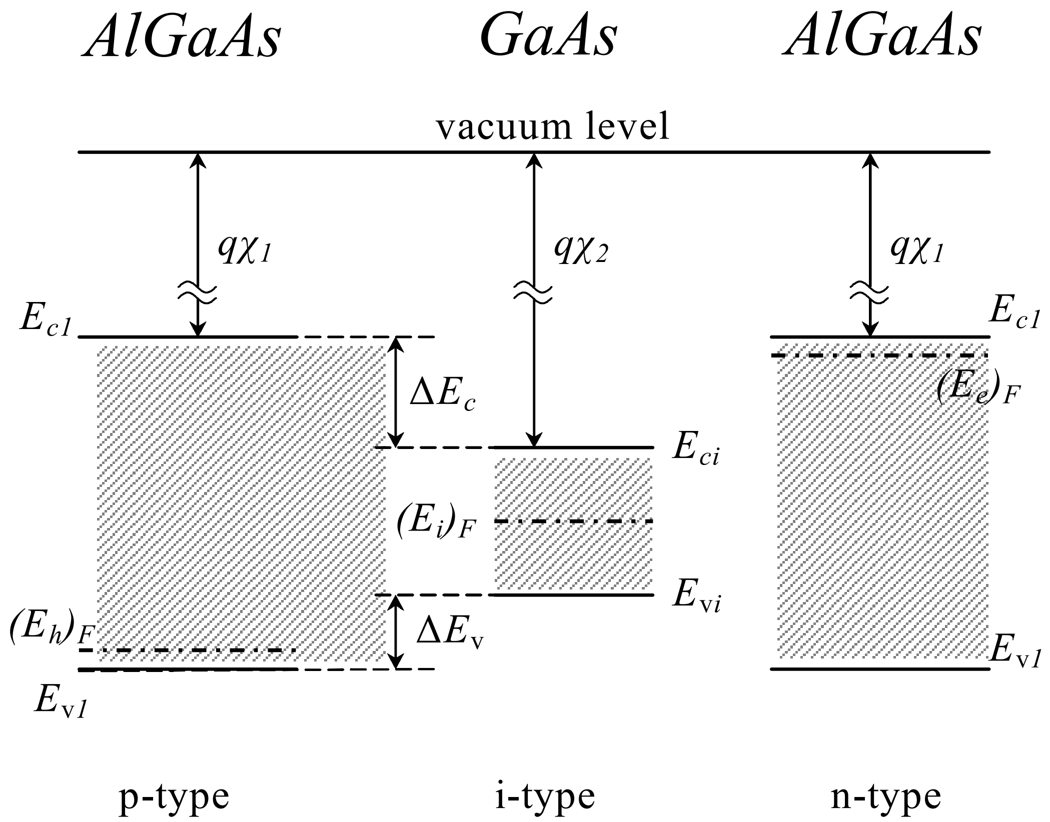
3. Double injection

Only injection of one type of carriers is useful, for example, electrons in p-region, in this case, injection of holes is parasitic effect.

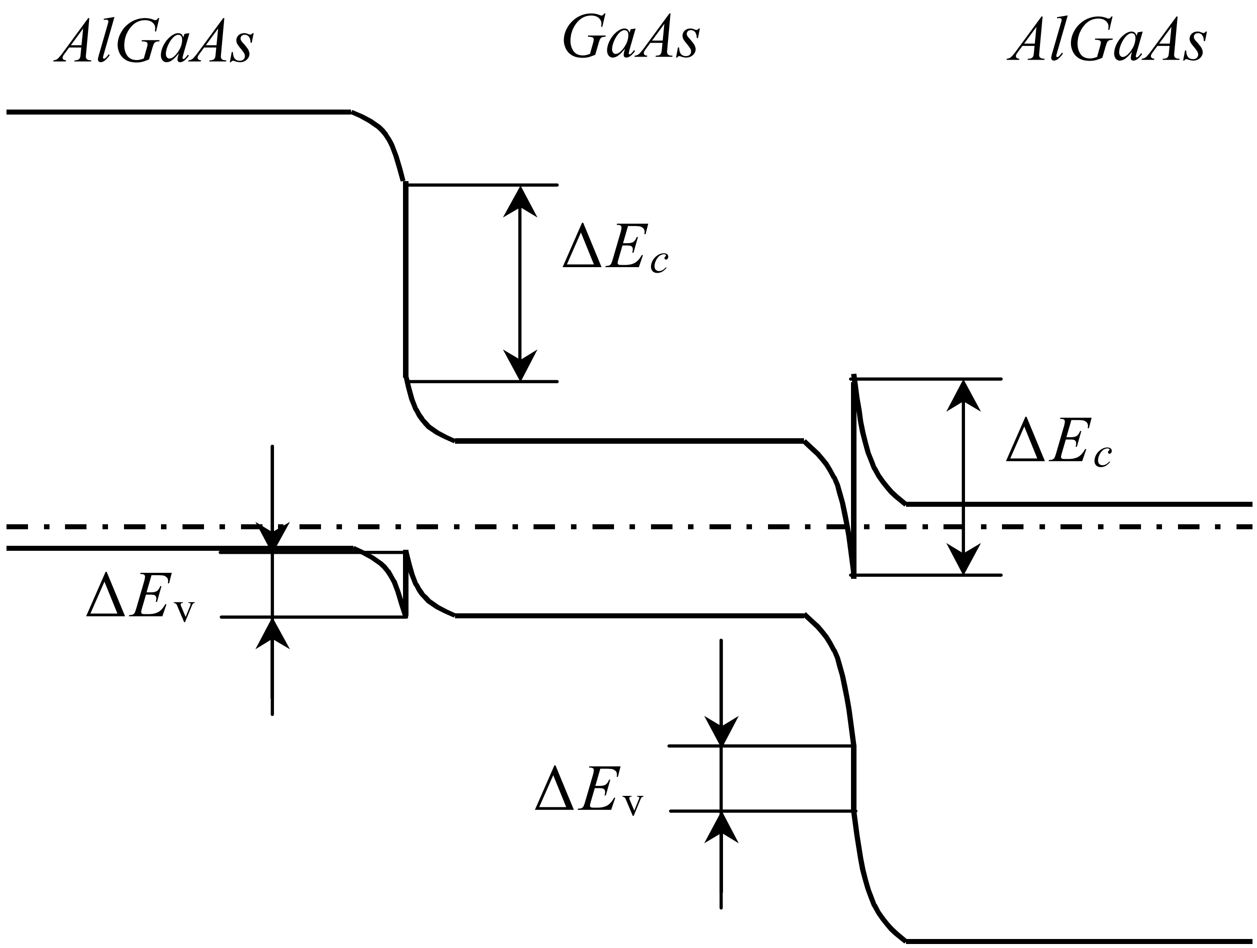
4. Strong doping

Heavy doping is necessary to get degenerate Fermi distribution of carriers. Heavy doping increases the losses in waveguide.

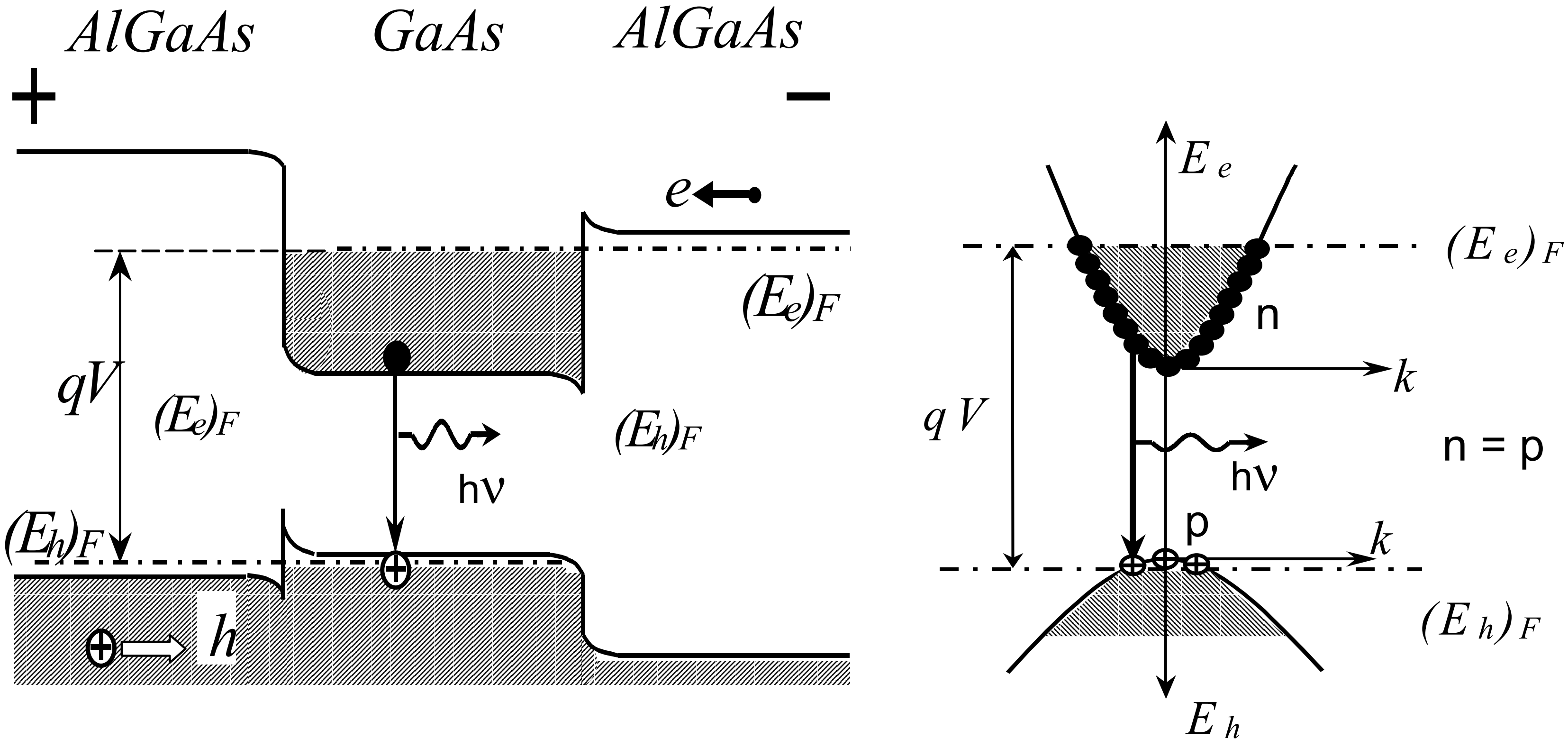
Band diagram of narrow gap i-type semiconductors, sandwiched between wide gap n- and p-type semiconductors before joining ($q\chi$ is electron affinity).



p-i-n heterojunction
Band discontinuities and band bending at equilibrium ($V = 0$).



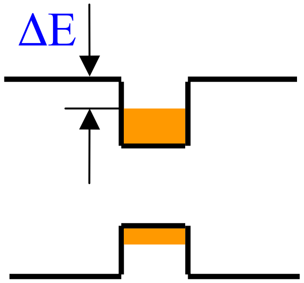
Emission of light from p-i-n heterojunction



Forward biased p-i-n double heterostructure (DH). Emission of photon. There is population inversion in the narrow gap semiconductor of DH, i.e. $f_e + f_h > 1$

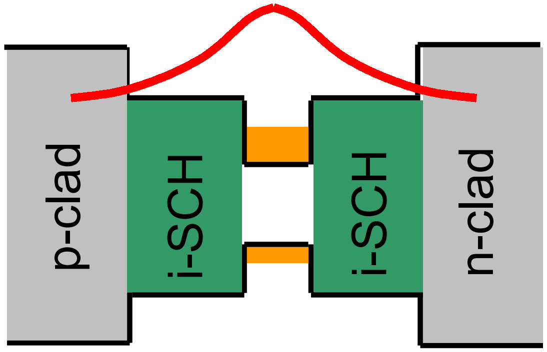
Advantages of heterolasers

1. Improved carrier confinement reduces threshold current and improves its thermal stability.



no need for high doping of the active region; no useless carriers outside the gain region, and a barrier preventing their thermal escape from gain region

2. Reduced optical loss and improved optical field stability by utilizing a separate confinement heterostructure



no doping in waveguide region and strong index guiding

3. Ability to modify dimensionality of gain media to increase gain and reduce threshold current – 2D (Q Well), 1D (Q Wire) and 0D (Q Dot).