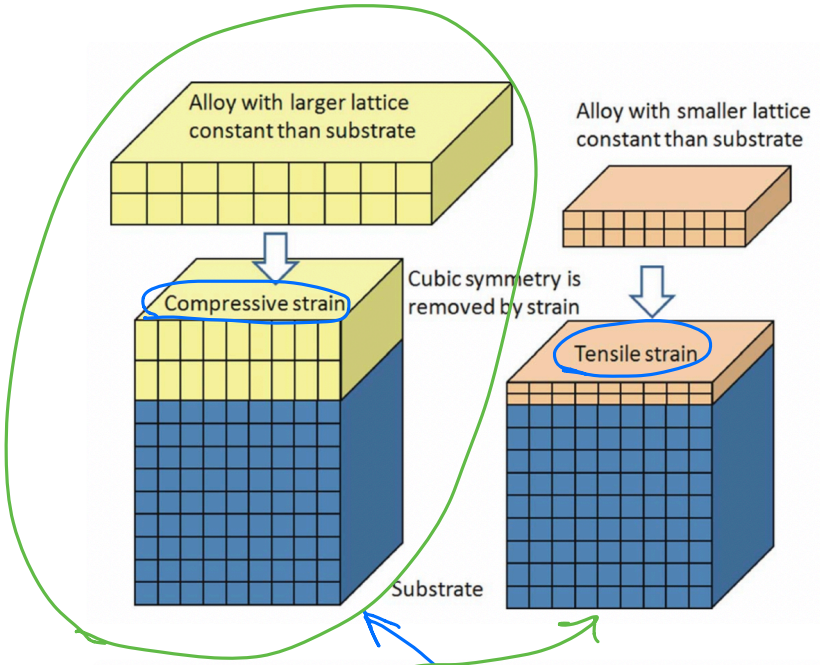
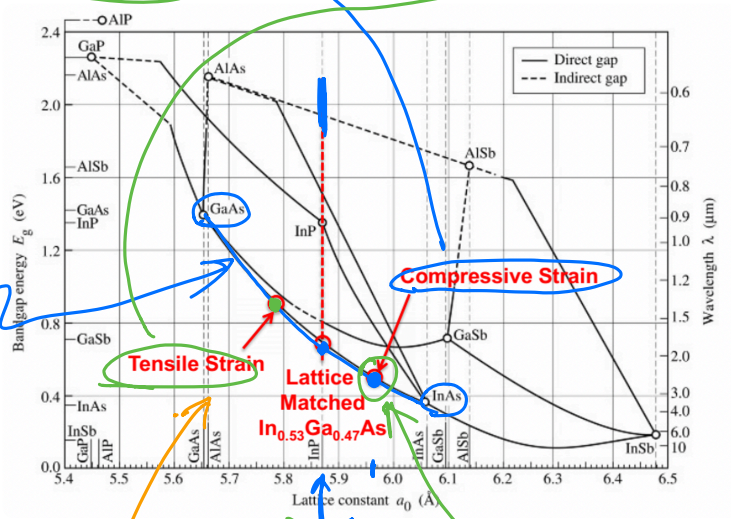
Strained Quantum Well Lasers (Cont'd)





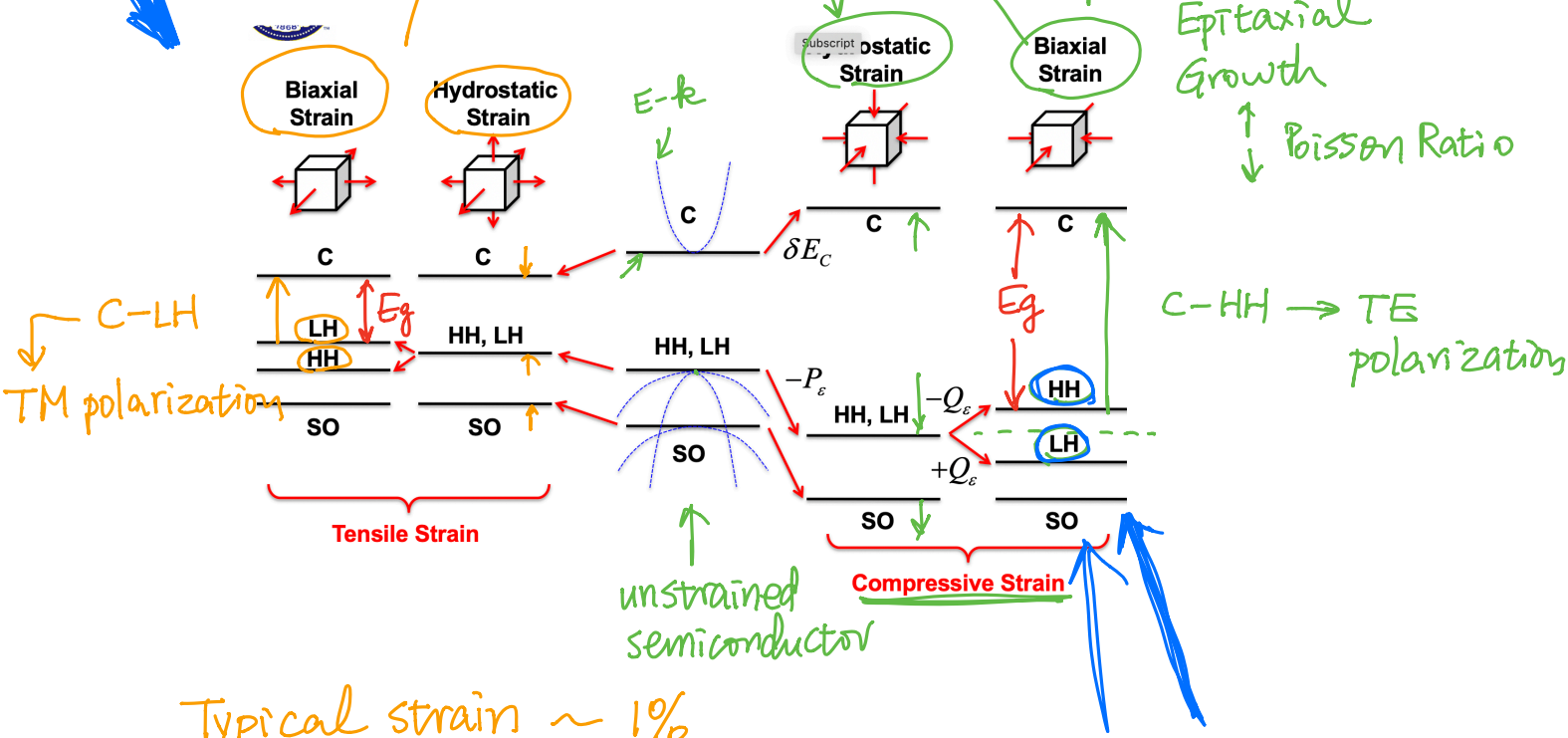
$In_xGa_{1-x}As$

InP

Band Edges

Experimental Epitaxial Growth

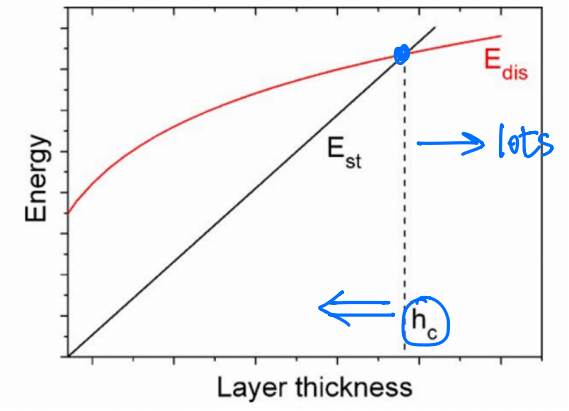
Poisson Ratio



C-LH → TM polarization

C-HH → TE polarization

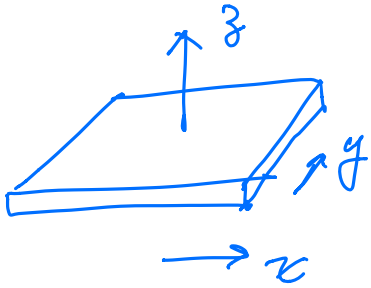
Typical strain ~ 1%



→ lots of dislocation

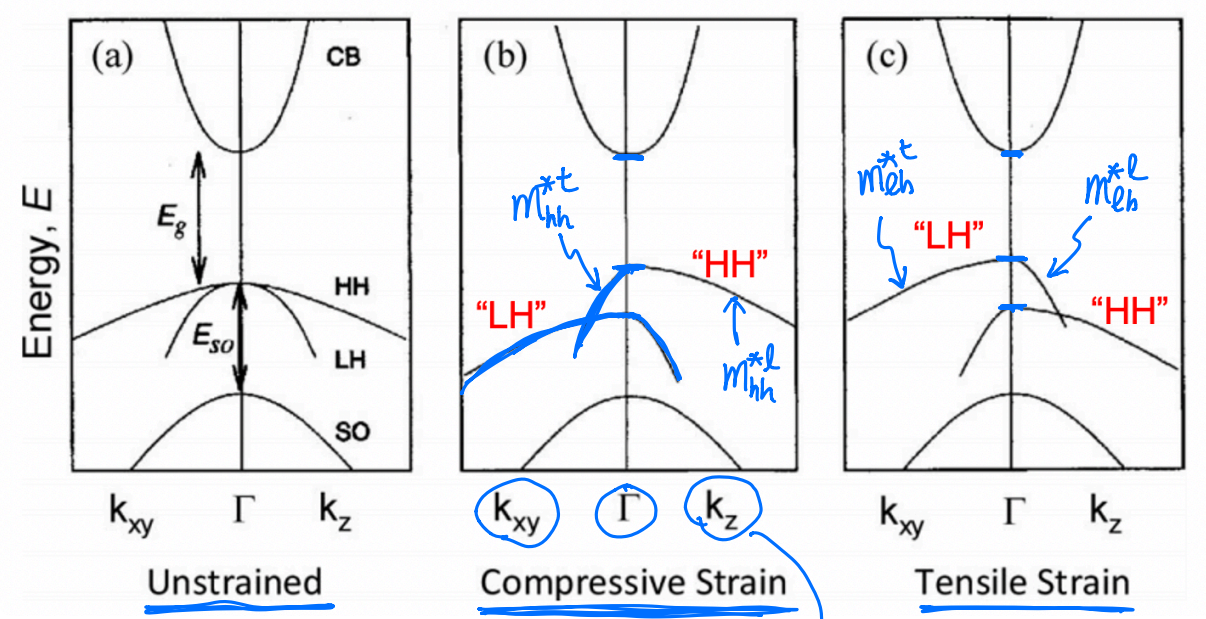
$h_c \sim 10$ to 20 nm

⟹ Quantum Well



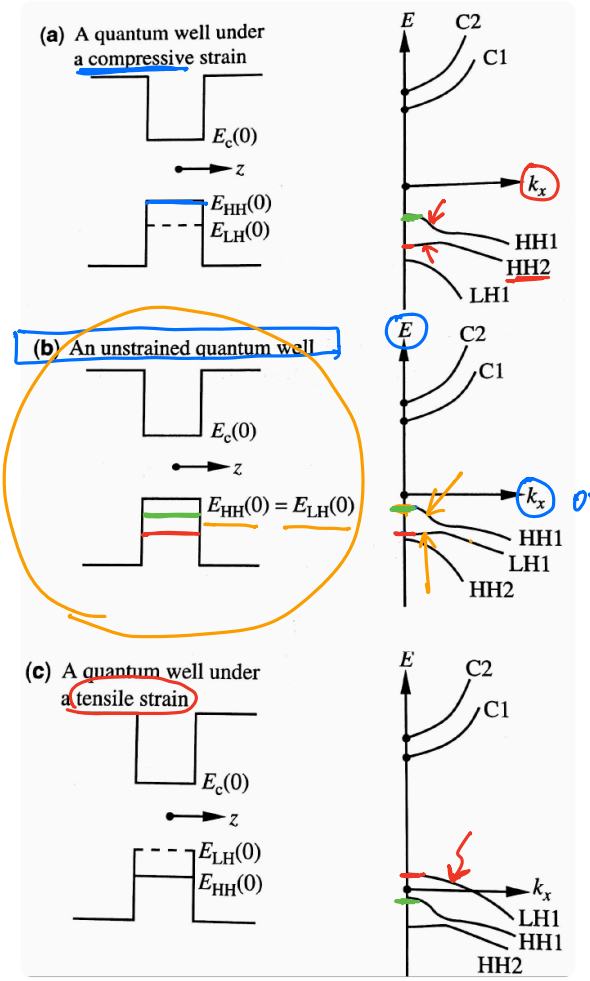
Strained QW: since early 90's

E-k for "bulk" material



longitudinal

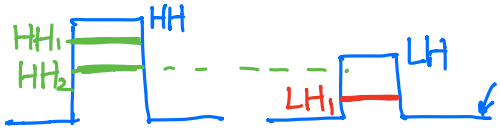
E-k for Strained QW



or k_y

Potential Well Landscape is different for HH and LH

Why?



Earlier

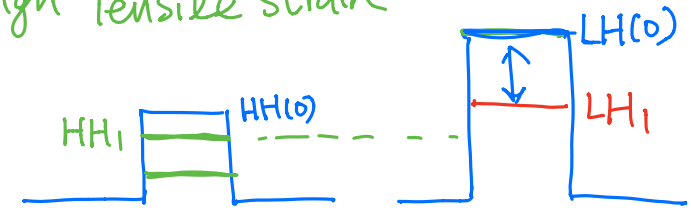
$$E = \frac{\hbar^2}{2m_h^*}\left(k_x^2 + k_y^2 + \left(\frac{\pi}{L_z}\right)^2\right)$$

$$E = \frac{\hbar^2}{2m_{hh}^{*t}}(k_x^2 + k_y^2) + \frac{\hbar^2}{2m_{hh}^{*z}}\left(\frac{\pi}{L_z}\right)^2$$

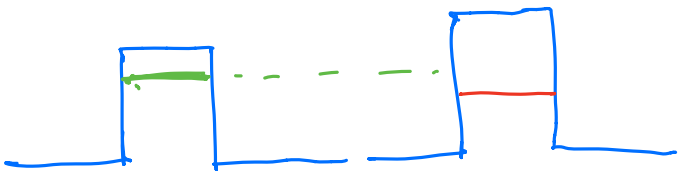
↑ Kinetic Energy

↑ Quantization Energy

High Tensile Strain

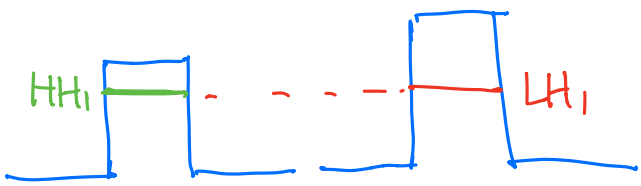


Low Tensile Strain

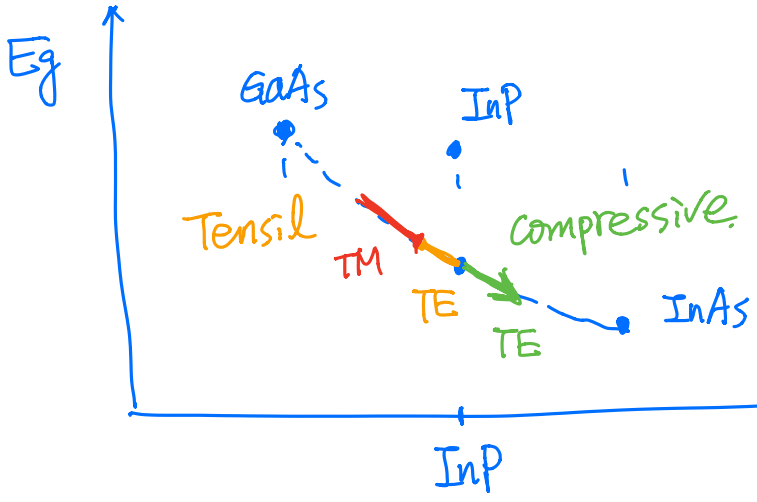


(One Value) Specific Tensile Strain

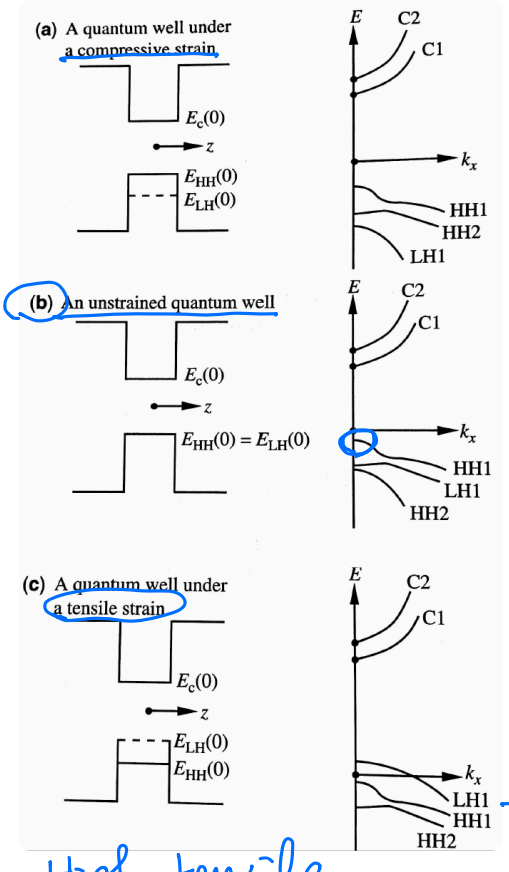
↳ SOA semiconductor optical amplifier



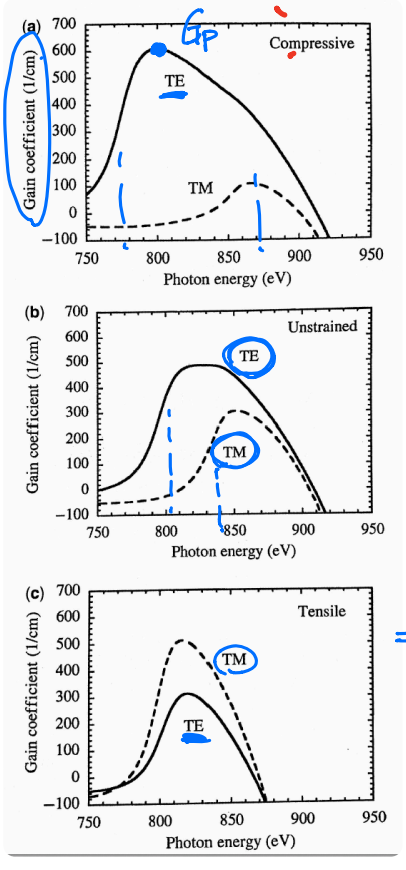
TE TM



$$\Rightarrow g(\hbar\omega) = C_0 |\hat{e}\cdot\vec{P}_{cv}|^2 \rho_{2D,r}(\hbar\omega)\cdot(f_c - f_v)$$



High tensile strain



⇒ laser in TE

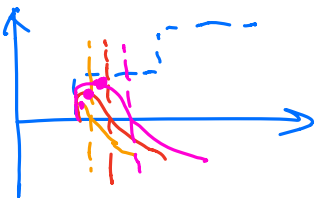
⇒ laser w/ TE

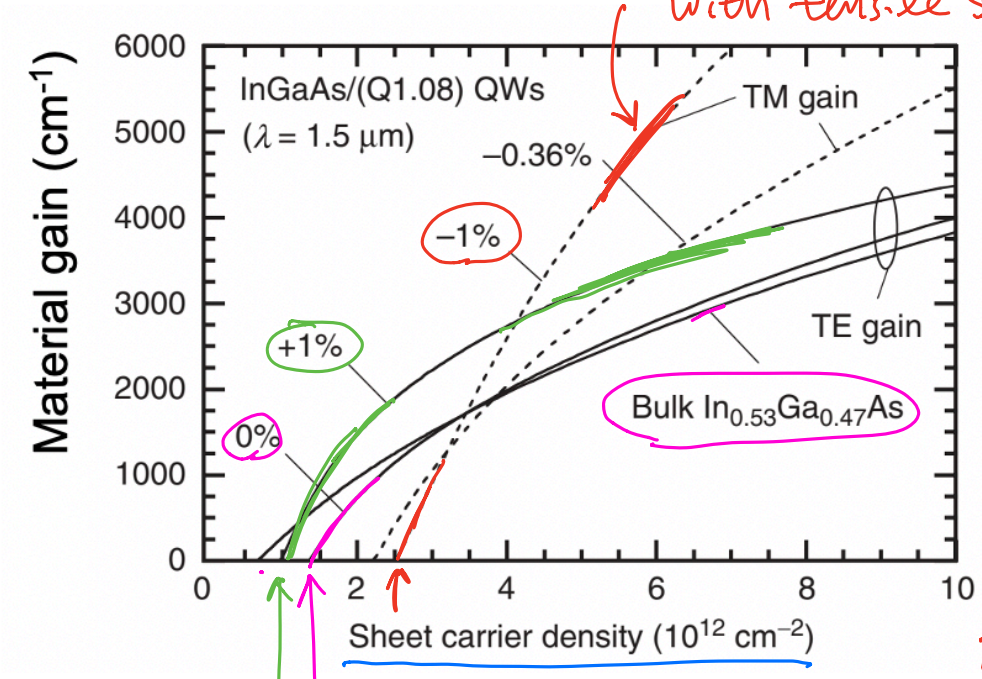
⇒ laser in TM

⇒ large TM, small TE in $\vec{P}_{cv}$

Gain Curve

Reach higher gain with tensile strain

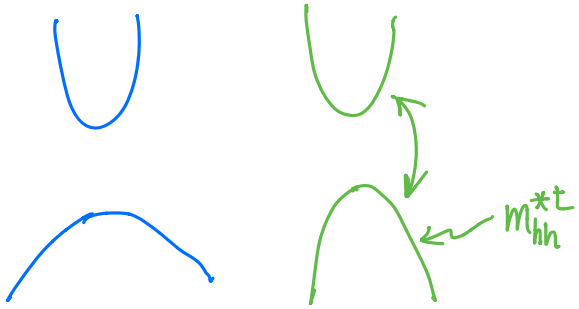




n_{tr} (-1%) ↑

n_{tr} : Transparency Carrier Conc.

n_{tr} reduces



Low threshold laser ⟷ Compressive strain

High gain ⟷ Tensile strain
e.g. SOA

Next Topic : Quantum Dots.