Study for Semiconductor Planar Phonon Cavity

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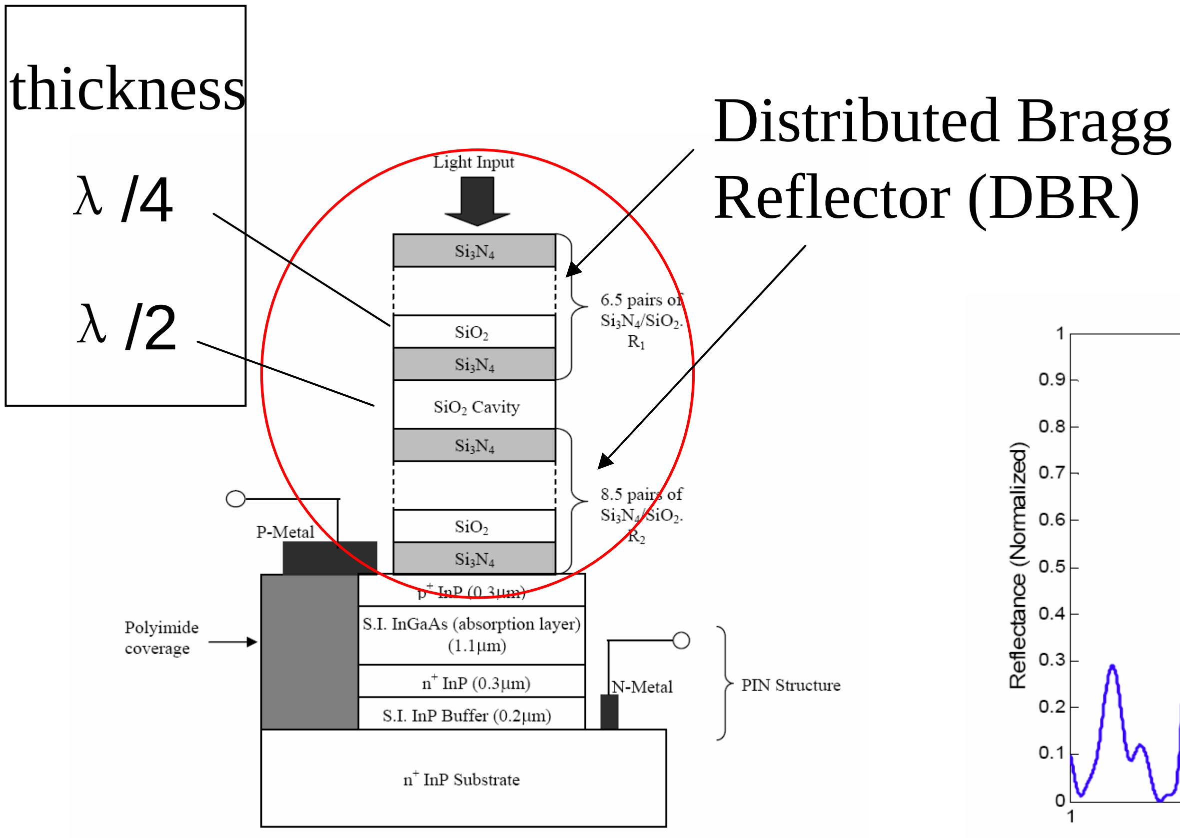
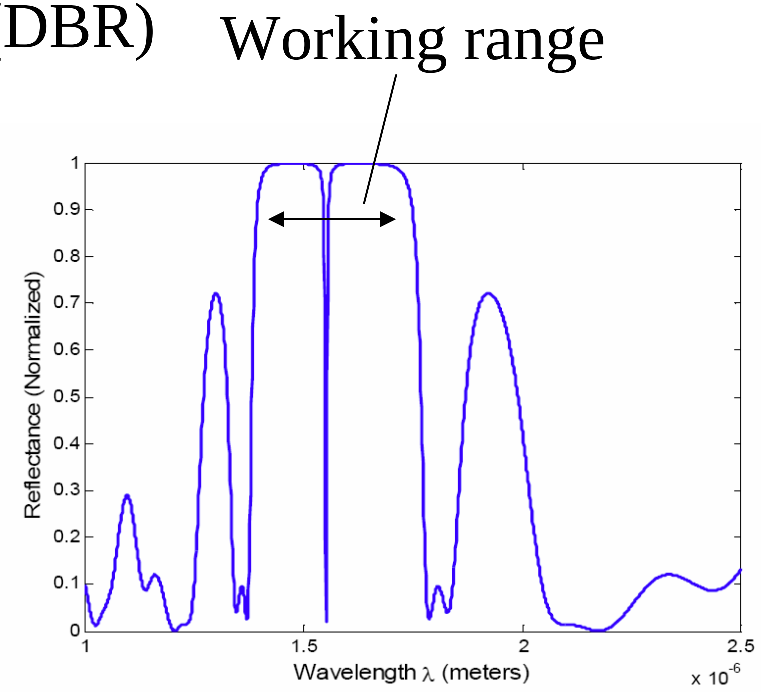
Optical Cavity for photons





Photodetector for single wavelength

Spectra of Reflection

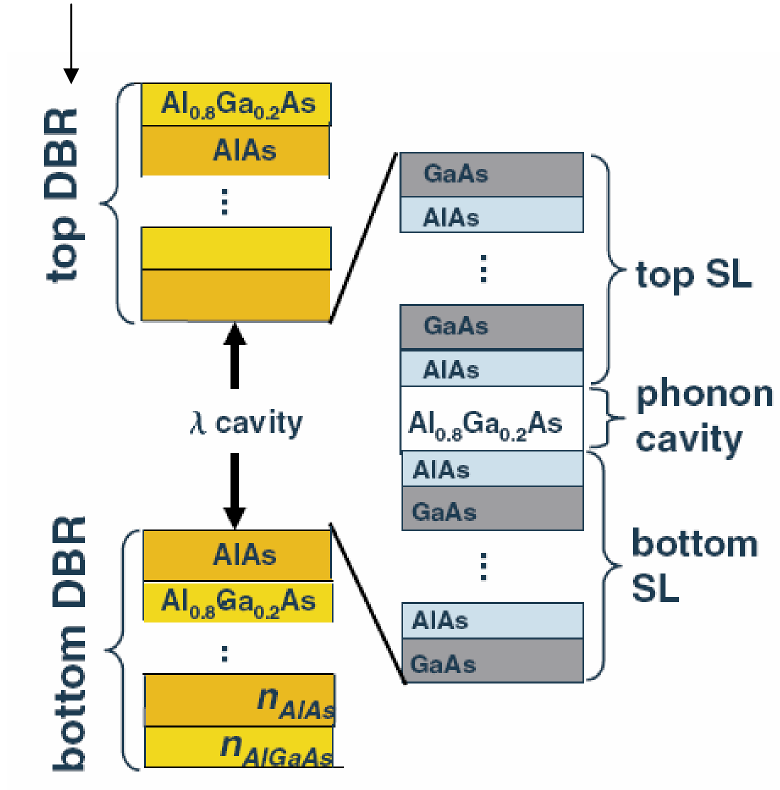
* S. Vichnesh, etc, Proceeding of Optics and Photonics, 2006

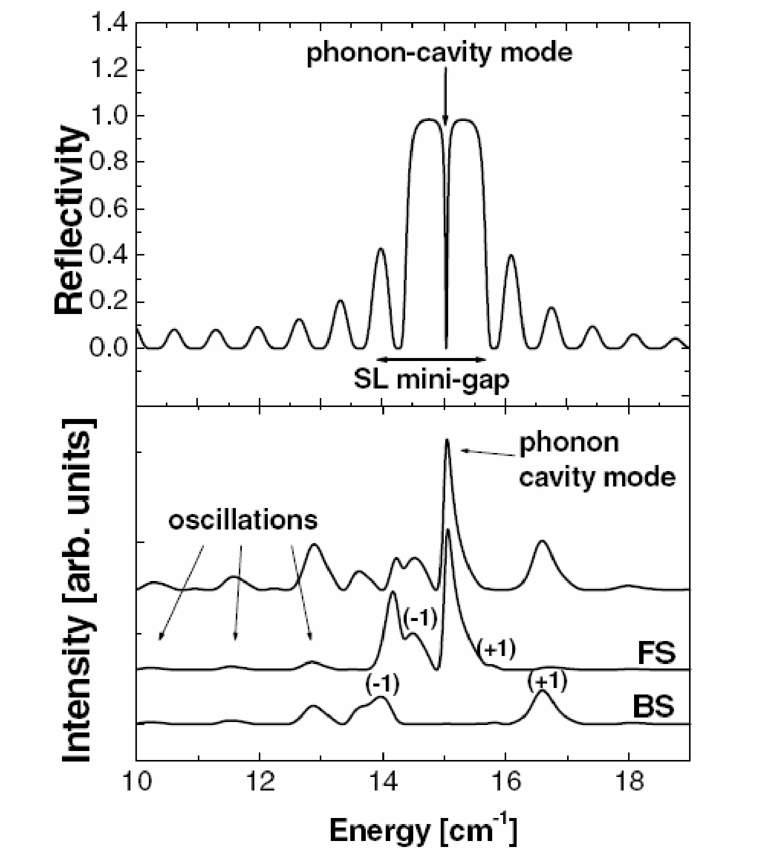
Acoustic Phonon Cavity

- Why to study acoustic phonon
  - energy dissipation and lattice heating
  - to create directional energy flow of lattice excitations in active electronic devices
- How similar with photon
  - They both are waves with certain wavelengths
  - They both can be reflected or transmitted
- What we can do
  - confine acoustic phonons as it is done in laser
  - or equivalently make filters for phonons

Example

Optical filter to enhance
photon-electron reaction





* M. Trigo, etc, PRL, Vol 89, 227402-1, 2002

Transfer Matrix for electron and Phonon

- Solution for Schrödinger Equation

$$\Psi_n(z) = A_n e^{ik_z^n z} + B_n e^{-ik_z^n z}$$

- Transfer Matrix

$$\begin{pmatrix} A_n \\ B_n \end{pmatrix} = \mathrm{M}_n \begin{pmatrix} A_{n+1} \\ B_{n+1} \end{pmatrix}$$

$$\begin{pmatrix} A_1 \\ B_1 \end{pmatrix} = \mathrm{M}_1 \mathrm{M}_2 \ldots \mathrm{M}_{N-1} \begin{pmatrix} A_N \\ B_N \end{pmatrix}$$

- Transmission part

$$T = \frac{k_z^N m_e^1}{k_z^1 m_e^N} \frac{|A_N|^2}{|A_1|^2}$$

Solution for phonons

$$U(z) = \sum A_n \hat{e}_n e^{i(k_z^n z - \omega t)}$$

$\hat{e}$ is the unit polarization vector

n is the index for modes

$$\begin{pmatrix} T_n \\ J_n \end{pmatrix} = \mathrm{M}_n \begin{pmatrix} I_{n+1} \\ R_{n+1} \end{pmatrix}$$

$$\begin{pmatrix} T_1 \\ J_1 \end{pmatrix} = \mathrm{M}_1 \mathrm{M}_2 \ldots \mathrm{M}_{N-1} \begin{pmatrix} I_N \\ R_N \end{pmatrix}$$

T & R are transmitted and reflected amplitude

I & J are the input amplitude from $-$ and $+\infty$

$$T = \ ?$$

To Do List

- Design an acoustic phonon cavity with AlGaN/GaN system with necessary simulation
- Grow above structure with MBE taking the advantage of accurate layer thickness control
- Use Raman scattering to find out the confined phonon-cavity mode