Nanophotonic Modeling
Lecture 4.3: Photonic Crystal Lasers

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Frequency Conversion

1D Fabry-Perot cavity made from quarter-wave stacks of high-contrast dielectrics:

• Takes in optical pump at high frequencies (0.4 c/a)
• Releases it at low frequency (0.2 c/a)

Effects of Absorber Material


Broadband optical pump distributed throughout structure

Stimulated emission more strongly localized to the F-P cavity
Gain Coefficient

Photon flux increase:

\[ \phi(z) + d\phi(z) \]

\[ d\phi = N W_i \, dz \]

\[ \frac{d\phi(z)}{dz} = \gamma(\nu) \phi(z) \]

Where gain coefficient:

\[ \gamma(\nu) = N \sigma(\nu) = N \frac{\lambda^2}{8\pi t_{sp}} g(\nu) \]

Optical Intensity:

\[ I(z) = h \nu \phi(z) \]

\[ I(z) = I(0) \exp[\gamma(\nu) \, z] \]
2D Photonic Crystal Lasers

Defect row in a rod-like 2D photonic crystal laser cavity

Π-like photonic crystal defect mode
2D Photonic Crystal Cavity

• Defect mode yields 100% transmission in cold cavity
• Transmission enhanced substantially by gain medium