Photonic Crystals: Molding the Flow of Light

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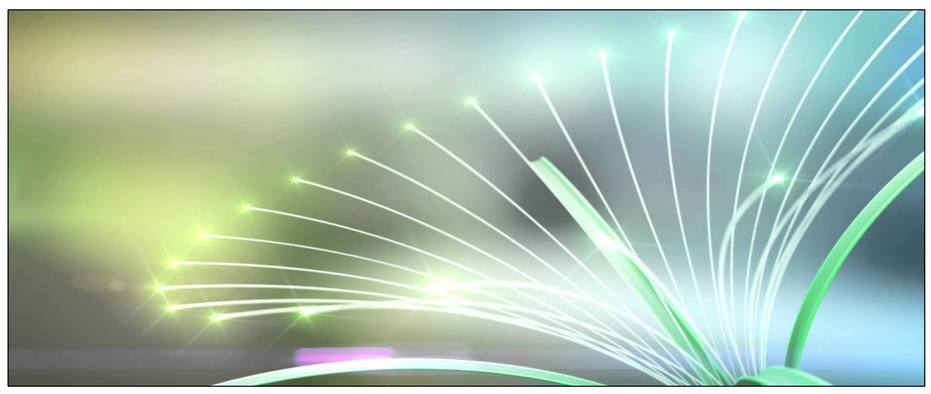
Dawn of the Ultrafast Communication Era

Information Carrier: ✗ Electrons ✓ Photons (Light)



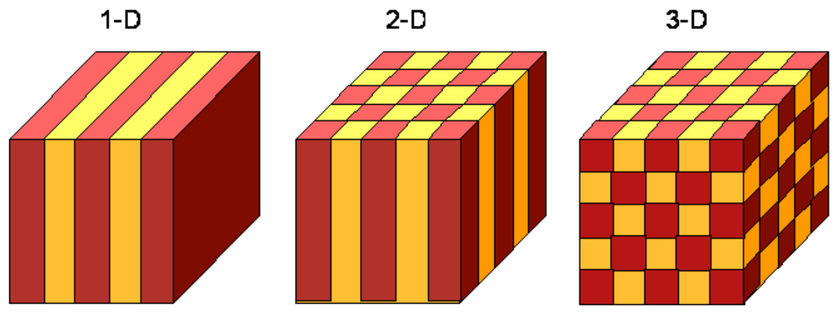
Advantages of lights over electrons:

- Speed: Photons in dielectric materials > Electrons in metallic wire
- Bandwidth: Dielectric materials > Metals
- Minimum Energy loss

Semiconductor crystals → Affect → Properties of Electrons

Photonic crystals → Affect → Properties of Photons

Photonic Crystals



- Bandgap due to a periodicity in the materials dielectric properties.
- Mechanism of total internal reflection.

Photonic Band Gap

A particular range of frequencies are restricted to pass through

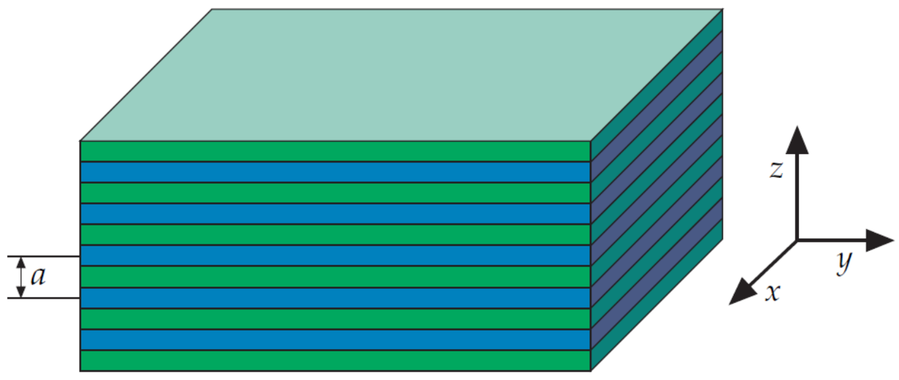


Fig: Multilayer film: A 1D Photonic Crystal

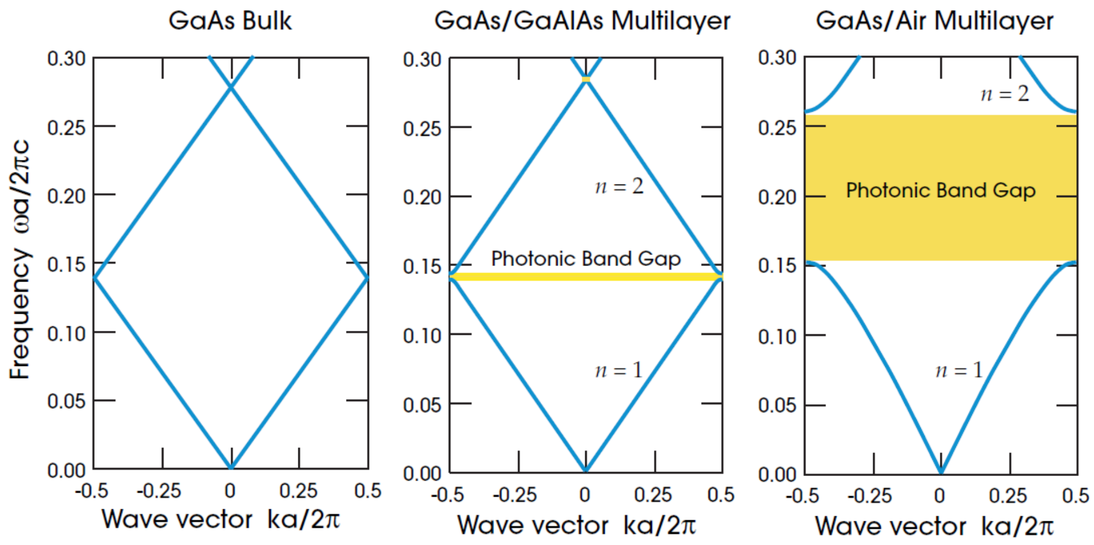


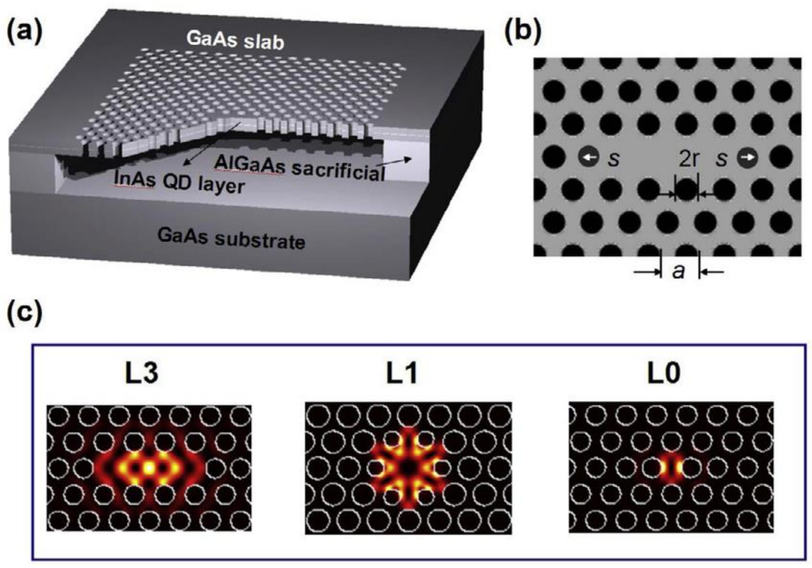
Fig: 3 different multilayer films; each layer has width 0.5a

Left: Every layer has same dielectric constant ε = 13
Center: Layers alternate between ε of 13 & 12
Right: Layers alternate between ε of 13 & 1

Bandgap increases with contrast in ε

Ref: John *et al.* "Photonic Crystals" Princeton University Press, 2008

Photonic Crystals: Play with Defects

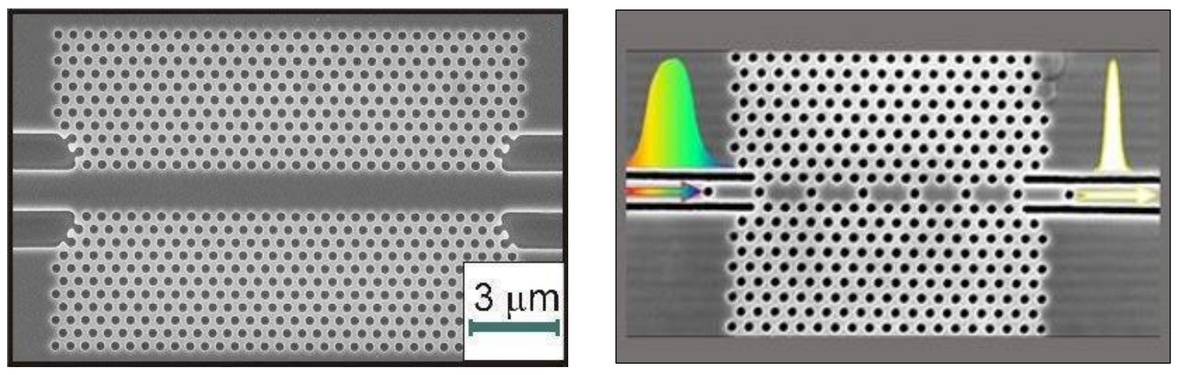


Cavity controlled light emissions

In plane electric field energy densities: L3 (3 missing holes, shifted end holes), L1 (1 missing holes, shifted & shrunk neighbor holes), L0 (no missing holes, only 2 shifted holes)

Ref: Uday *et al.* Nanotechnology 21 (2010), 065202

Photonic Crystals (GaAs) as Waveguides



Only the light that resonates on the point defects can pass

Most Important Challenge: Design & Fabrication

Current fabrication techniques:

- Electron Beam Lithography
- X-Ray Lithography

* This poster is a part of the coursework "GCE 6103: October 2017" under supervision of Dr. M. Hasanuzzaman