Nanophotonic Modeling Lecture 4.22: Summary & Conclusions for Unit 4

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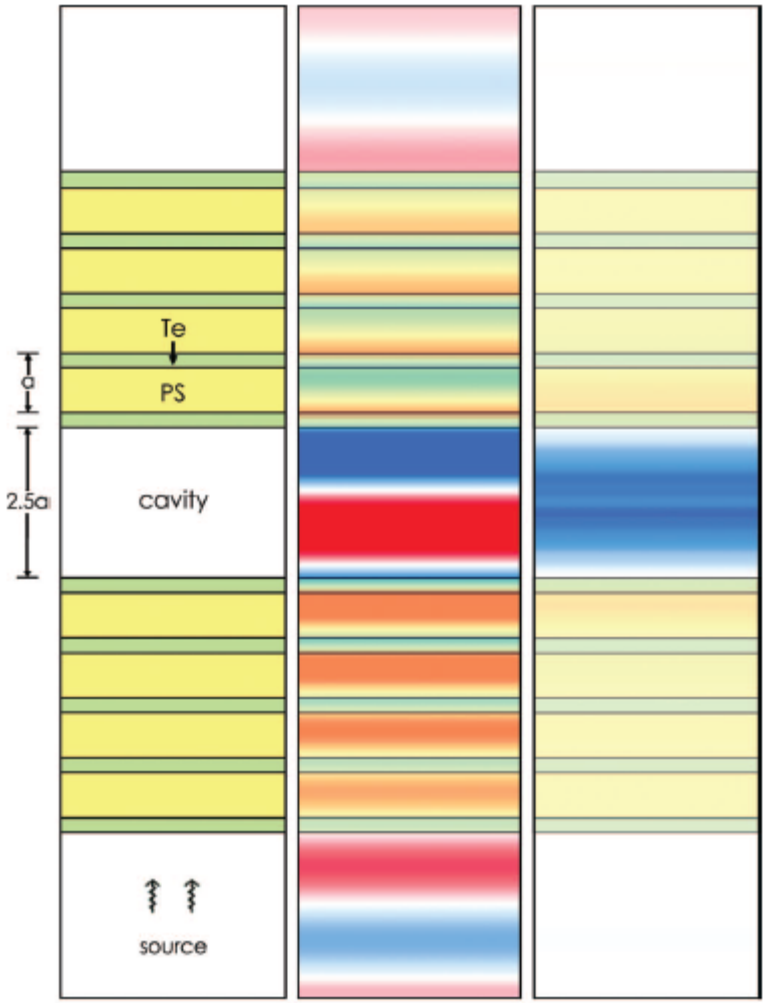
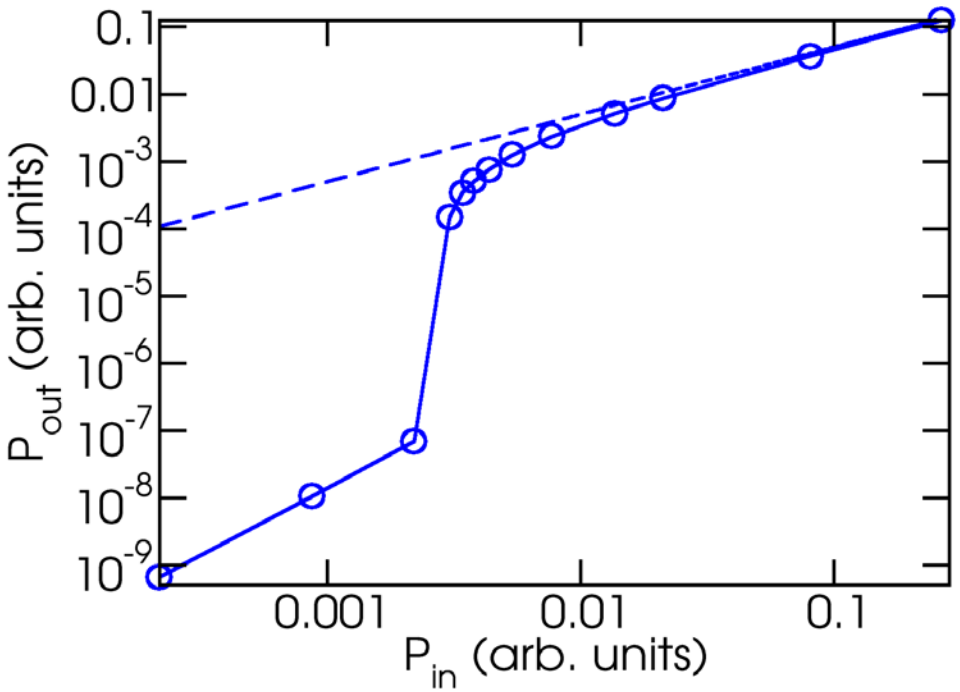
Photonic Cavity Lasing





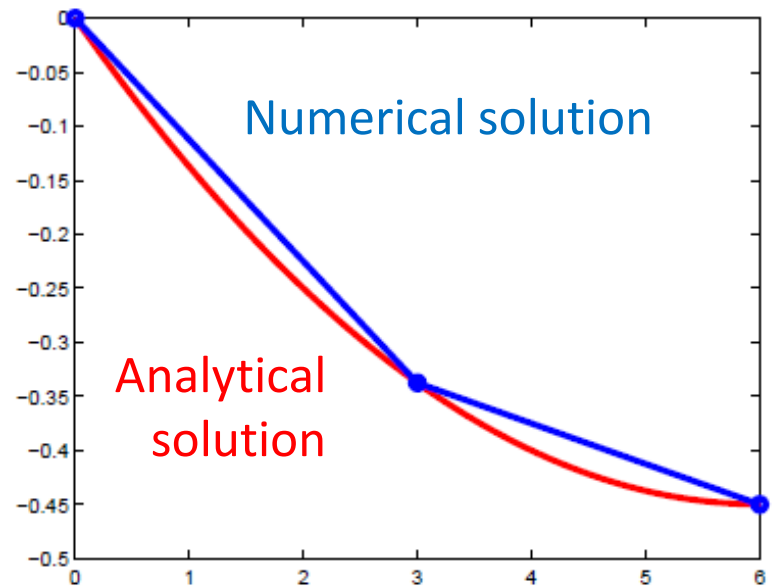
Finite Element Method

- In general, we want to apply Galerkin method with trial functions η_j:

$$\int_0^L dx\, \eta_j(x) r_B(x,t) = 0$$

- Analogy: stuff balloon into box, with each trial function as a single 'finger'
- FAESOR Modeling Toolbox:

http://hogwarts.ucsd.edu/~pkrysl/faesor/faesor_publish.html



Thermal Transport Mechanisms

- Convection: heat transfer by surface contact with gas or fluid molecules

$$Q = h(T_1 - T_2)$$

- Conduction: volumetric heat transfer by propagation of phonons

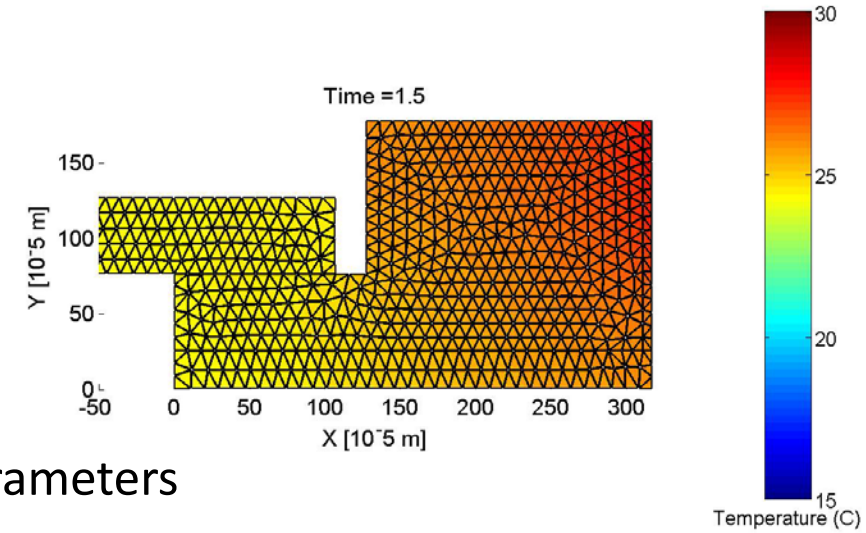
$$\frac{\partial u}{\partial t} - Q = \alpha \nabla^2 u$$

- Radiative thermal transfer: emission of thermal photons from source to receiver

$$\frac{dQ}{d\lambda} = \frac{2\pi h c^2 \, \epsilon(\lambda)}{\lambda^5 [e^{hc/\lambda kT} - 1]}$$

FEM Modeling Steps: Thermal Conduction

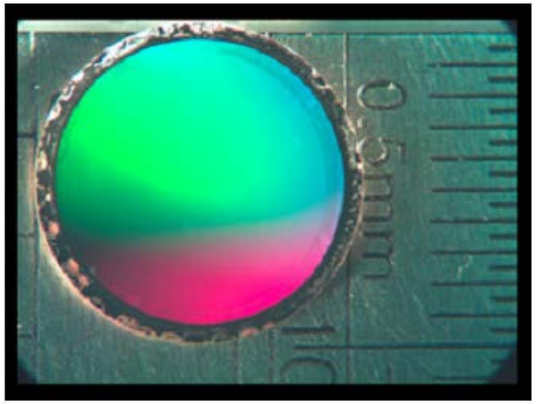
$$c_v \frac{\partial T}{\partial t} - \nabla \cdot [\kappa (\nabla T)^T] - Q = 0$$

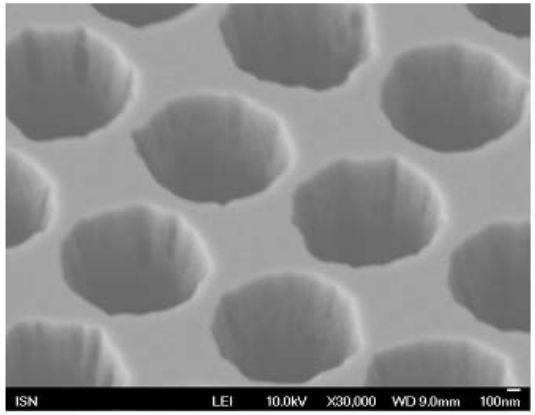


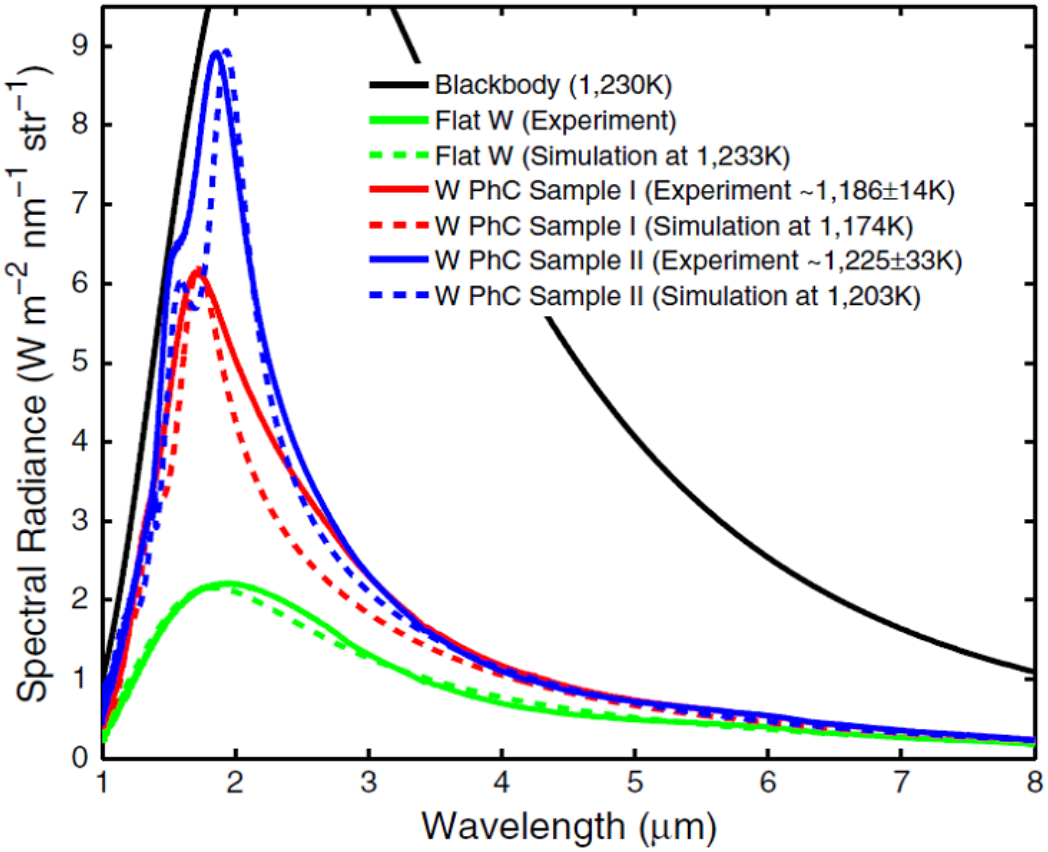
1) Define material constants and system parameters
2) Define geometry and initiate targe2_mesher
3) Create material objects (blocks of cells)
4) Apply initial conditions and generate system matrices
5) Solve for heat field and iterate over time

* http://hogwarts.ucsd.edu/~pkrysl/faesor/

Selective Thermal Radiation Enabled by 2D Photonic Crystals

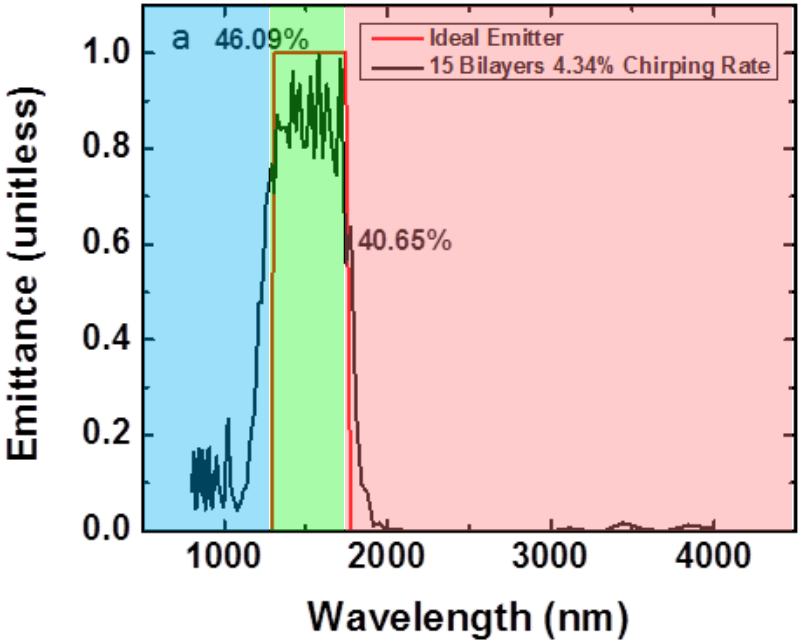


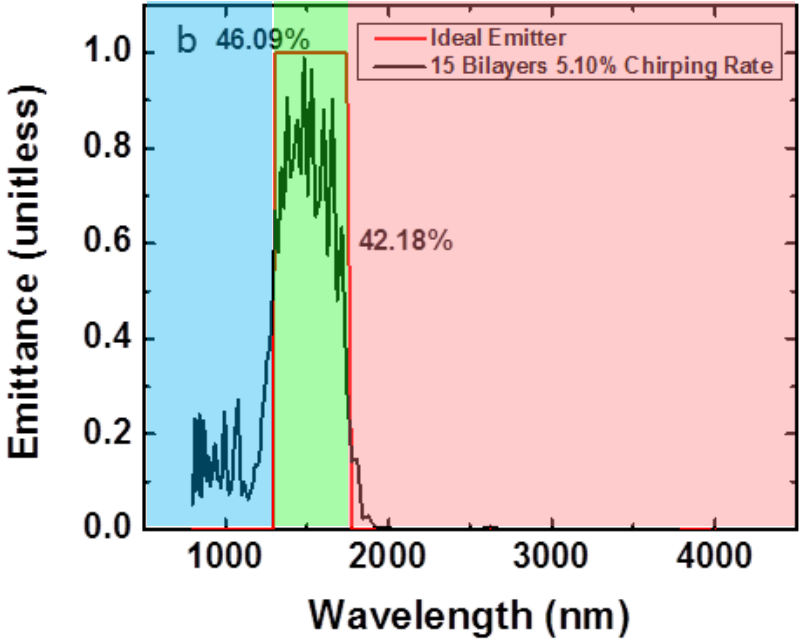




Y.X. Yeng et al., *PNAS* **109**, 2280 (2012)

Optimizing Thermal Emission with Integrated Filters





Integrated Filter Structure	Conversion Efficiency	Total Efficiency Gap	Parasitic Emission	Insufficient Emission	Short-wavelength Emission
15-Bilayer 4.34% Chirped	40.56%	5.44%	3.77%	0.77%	0.90%
15-Bilayer 5.10% Chirped	42.18%	3.91%	1.48%	1.69%	0.74%

Z. Zhou *et al.*, *SPIE J. Nanophoton.* (2016).