

## PHOTONIC CRYSTAL DEVICES AND APPLICATIONS

### 1. Electromagnetism in Mixed Dielectric Media

Introduction-Photonic crystals, The Macroscopic Maxwell Equations, Electromagnetism as an Eigenvalue Problem, General Properties of the Harmonic Modes, Electromagnetic Energy and the Variational Principle, Magnetic vs. Electric Fields, The Effect of Small Perturbations, Scaling Properties of the Maxwell Equations, Discrete vs. Continuous Frequency Ranges.

### 2. Symmetries and Solid-State Electromagnetism

Using Symmetries to Classify Electromagnetic Modes, Continuous Translational Symmetry, Index guiding, Discrete Translational Symmetry, Photonic Band Structures, Rotational Symmetry and the Irreducible Brillouin Zone, Mirror Symmetry and the Separation of Modes, Time-Reversal Invariance, Bloch-Wave Propagation Velocity.

### 3. The Multilayer Film: Types of photonic crystals

A One-Dimensional Photonic Crystal: The Multilayer Film, The Physical Origin of Photonic Band Gaps, The Size of the Band Gap, Evanescent Modes in Photonic Band Gaps. Two-Dimensional Photonic Crystals: Two-Dimensional Bloch States, A Square Lattice of Dielectric Columns, A Square Lattice of Dielectric Veins-A Complete Band Gap for All Polarizations. Three-Dimensional Photonic Crystals: Three-Dimensional Lattices, Crystals with Complete Band Gaps, Spheres in a diamond lattice, Yablonovite.

### 4. Photonic -Waveguides, Crystal Slabs and Crystal Fibers

Wave guides: A Two-Dimensional Model, Periodic Dielectric Waveguides in Three Dimensions, Symmetry and Polarization, Point Defects in Periodic Dielectric Waveguides, Quality Factors of Lossy Cavities. Crystal Slabs: Rod and Hole Slabs, Polarization and Slab, Reduced-radius rods, Removed holes, Substrates, dispersion, and loss-Point Defects in Slabs. Crystal Fibers: Mechanisms of Confinement, Index-Guiding Photonic-Crystal Fibers, Endlessly single-mode fibers.

### 5. Designing Photonic Crystals for Applications

A Mirror, a Waveguide, and a Cavity, Designing a mirror, Designing a waveguide, Designing a cavity, A Narrow-Band Filter, Temporal Coupled, Mode Theory, The temporal coupled, mode equations, The filter transmission, A Waveguide Bend, A Waveguide Splitter, A Three-Dimensional Filter with Losses, Resonant Absorption and Radiation, Nonlinear Filters and Bistability.

#### References:

1. John D. Joannopoulos, Steven G. Johnson, Joshua N. Winn, Robert D. Meade, -Photonic Crystals-Molding the Flow of Light, Second Edition, Princeton University Press, 2008.
2. Jia-Ming Liu- Photonic Devices, Cambridge University Press, 2005.

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