Photonic Band Gap Materials: Light Trapping Crystals

IEEE Photonics Society Distinguished Lecture
By Dr. Sajeev John
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CREOL Room 102

Abstract

Photonic Band Gap (PBG) materials are artificial, periodic, dielectrics that enable engineering of the most fundamental properties of electromagnetic waves. These include the laws of refraction, diffraction, and spontaneous emission of light. Unlike traditional semiconductors that rely on the propagation of electrons through an atomic lattice, PBG materials execute their novel functions through selective trapping or "localization of light". This is a fundamentally new and largely unexplored property of Maxwell's equations. This is also of practical importance for all optical communications, information processing, efficient lighting, and solar energy trapping. Three dimensional (3D) PBG materials offer a unique opportunity to simultaneously (i) synthesize micron-scale 3D circuits of light that do not suffer from diffractive losses and (ii) engineer the electromagnetic vacuum density of states in this 3D optical micro-chip. This combined capability opens a new frontier in integrated optics as well as the basic science of radiation-matter interactions. I review recent approaches to micro-fabrication of photonic crystals with a large 3D PBG centered near 1.5 microns. These include direct laser-writing techniques, holographic lithography, and a newly invented optical phase mask lithography technique. I discuss consequences of PBG materials in classical and quantum electrodynamics.

Biography

Sajeev John is a "University Professor" at the University of Toronto and Government of Canada Research Chair holder. He received his Ph.D. in physics at Harvard University in 1984, on the theory of classical wave localization. From 1986-1989 he was an assistant professor of physics at Princeton University, where he co-invented (1987) the concept of photonic band gap materials. In the fall of 1989 he joined the senior physics faculty at the University of Toronto. Professor John is the winner of numerous awards, including the IEEE LEOS International Quantum Electronics Award in 2007 and the 2008 IEEE Nanotechnology Pioneer Award. Prof. John has been awarded the Guggenheim Fellowship (USA), the Humboldt Senior Scientist Award (Germany) and the C.V. Raman Chair Professorship of the Indian Academy of Sciences. Prof. John is a Fellow of the American Physical Society, the Optical Society of America, the Royal Society of Canada, and a member of the Max-Planck Society of Germany.

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