PHYSICS DEPARTMENT COLLOQUIUM

"Photonic Band Gap Materials: Semiconductors of Light"

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The 20th century has been the Age of Artificial Materials. One material that stands out in this regard is the semiconductor of electricity. The electronics revolution of the 20th century was made possible by the ability of semiconductors to microscopically mould the flow of electrons. Along this line of technological progress, many scientists around the world have suggested that the 21st century will be the Age of Photonics in which artificial materials are synthesized to microscopically mould the flow of laser light.

Photonic Band Gap (PBG) materials are periodic dielectrics that enable engineering of the most fundamental properties of electromagnetic waves. These properties include the laws of refraction, diffraction, and emission of light from atoms. This opens a new frontier in integrated optics as well as the basic science of radiation-matter interactions. Unlike electronic semiconductors, PBG materials execute their novel functions through selective trapping or "localization of light" using engineered defects within the dielectric lattice. This is of direct practical importance for all-optical communications and information processing. Unlike electronic micro-circuitry, optical wave-guides in a PBG micro-chip can simultaneously conduct hundreds of wavelength channels of information in a three-dimensional circuit path.

I review the history of the field of PBG materials and recent approaches to micro-fabrication of these crystals. I discuss how the unusual properties of PBG materials provide a foundation for novel practical applications ranging from clinical medicine to information technology.

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