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A Short Note on Photonic Crystals

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Description

A photonic crystal is an optical nanostructure with a periodic shift in refractive index. This has an effect on light propagation in the same way that natural crystal structure causes X-ray diffraction and semiconductor atomic lattices (crystal structure) influence electron conductivity. Photonic crystals are found in nature as structural coloring and animal reflectors, and they have the potential to be beneficial in a variety of applications when intentionally manufactured.

One, two, or three-dimensional photonic crystals can be made. Thin film layers put on top of each other can be used to create one-dimensional photonic crystals. Photolithography or drilling holes in an appropriate substrate can be used to create two-dimensional ones. Drilling at various angles, stacking numerous 2-D layers on top of each other, direct laser writing, or, for example, inducing self-assembly of spheres in a matrix and dissolving the spheres are all fabrication methods for three-dimensional ones.

Photonic crystals can theoretically be used whenever light needs to be altered. Thin-film optics with lens coatings are one of the existing applications. Nonlinear devices and unusual wavelengths are guided by two-dimensional photonic-crystal fibers. Three-dimensional crystals could be employed in optical computers in the future. Photonic crystals in three dimensions could lead to more effective photovoltaic cells.

Despite the fact that the energy of light (and all electromagnetic radiation) is quantized in photons, photonic crystal analysis only requires classical physics. The term "photonic" refers to photonics, which is a modern term for the study of light (optics) and optical engineering. Indeed, Lord Rayleigh, an English physicist, experimented with periodic multi-layer dielectric stacks in 1887, demonstrating that they can induce a photonic band-gap in one dimension.

Periodic dielectric stacks, metallo dielectric, or even though the superconductor microstructures or nanostructures in the photonic crystals influence electromagnetic wave propagation in the same way that the periodic potential in a semiconductor crystal influences electron propagation, determining allowed and forbidden electronic energy bands. Photonic crystals have a regular pattern of high and low refractive index areas. Depending on their wavelength, light waves may or may not be allowed to flow through this structure. The ranges of wavelengths that can propagate in a given direction are known as bands, and the wavelengths that can propagate in that direction are known as modes. Photonic band gaps are wavelength bands that are not permitted. Inhibition of spontaneous emission, for example, It is one of the optical phenomena .

Low-loss wave guiding and high-reflecting omni directional mirrors similar to the band gaps of electrons in solids, the band gap of photonic crystals can be interpreted as the destructive interference of numerous reflections of light travelling in the crystal at each interface between layers of high and low refractive index regions.

For interference effects to occur, the periodicity of the photonic crystal structure must be about or greater than half the wavelength (in the medium) of the light waves. The wavelength of visible light varies between 400 nm (violet) and 700 nm (red), and the resulting wavelength inside a material is determined by dividing the wavelength by the average index of refraction. As a result, the repeated high and low dielectric constant zones must be produced at this scale. Thin-film deposition techniques are commonly used to achieve this in one dimension.

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