Investigation the effect of shapes, size, and orientation of dielectric rods on the photonic band gap for various lattices in 2D anisotropic photonic crystals

The photonic band structures of two-dimensional anisotropic photonic crystals have studied by solving Maxwell's equations with use of the plane-wave expansion method.

Three distinct theoretical approaches are pursued: the calculation of photonic bands and density of states, and of modes in the gap associated with line and point defects; the calculation of optical properties like reflection, transmission and diffraction; numerical simulation of the propagation of electromagnetic waves in photonic crystals, including the effects of disorder.

We have calculated the photonic band structure for electromagnetic waves in a structure consisting of a periodic array of parallel dielectric rods of various cross sections, whose intersections with a perpendicular plane form a different shape of lattice.

We reveal that a maximum absolute band gap for these structures is achieved for an intermediate rotation angle of the rods. This angle depends on the radius of the rods and the refractive index of the background material.

It has recently been reported that the symmetry reduction of atom configuration by introducing two-point basis set in simple 2D lattices can remarkably increase absolute band gaps. Owning to different refractive indices for electromagnetic waves with E and H polarization, the band gaps for the two polarization modes can be freely adjusted and matched to overlap optimally. The anisotropy in atom dielectricity can break the degeneracy of photonic bands and remarkably increase absolute band gaps. We prefer to choose the extraordinary axis of uniaxial crystal parallel to the extension direction of rods with a positive anisotropy.

We considered three type of lattice (triangular, square, and Hexagonal) with anisotropic tellurium rods in air background with different geometric shapes (oval, circle, square, hexagon and rectangle).

The numerical results show that the overlap photonic band gap (PBG) between the TM and TE gaps (polarization-independent PBG) is the largest for a triangular lattice of oval rods with 0°orientation.The overlap PBG for a square lattice of rectangular rod with 150° orientation is the next largest.

An important result is that compared to isotropic photonic crystals, which maximum photonic band gap is achieved by selecting a rod of the same symmetry with lattice; this inference is not true in the case of anisotropic crystals.