Photonic Band Gap of Two-dimensional Photonic Crystals with Broken Symmetry

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Abstract

In this study, we investigate how structural and rotational symmetries affect the E-polarization and H-polarization band structures in the two-dimensional photonic crystal. The plane-wave method is employed to calculate band structures and field patterns. The features of band structures have been reasonably explained with field pattern and scattering mechanisms. To understand how the regular shape and boundary of rods affect the formation of PBG in square lattice, the N-polygonal and corner-cutting structures are considered. The effects of N-polygonal rods on the E-polarization and H-polarization band structures have been examined. Our calculations also show that the band structures of polygonal rod approach the same to that of circular rod while N is large. We use band-structure viewpoint to examine the formed PBG in the corner-cutting structure. The reason why the complete PBG of octagonal dielectric rods with square lattice is closed can be understand.

Three deformed and two rotational structures are constructed to the formed PBG of hollow rods in the triangular lattice. The H-polarization band gaps are strongly affected by the interaction between the fields of the rods as the rods are deformed and affected by the reduction in the rotational symmetry as whole rods are rotated. Only the shapes of the rods affect the E-polarization band gaps as the rods are either deformed or rotated. Moreover, H-polarization modes determine the complete PBG width as the rods are rotated, whereas E-polarization modes determine the complete PBG width as the rods are deformed.