The effect of short-range order on the transmission property of 12-fold quasiperiodic photonic crystals

Yiquan Wang

Institute of Lightwave Technology, Beijing Jiaotong University,

Beijing 100044, China

Tel: 86-10-51683834, E-mail: wyq@telecom.njtu.edu.cn

Photonic band-gap material, since proposed by Yablonovitch and John, has attracted considerable attention. Great deal of theoretical and experimental effort has been devoted to study the properties of the material. Owing to the symmetry, the property of periodic photonic materials is very clear. The long-range translational and oriental order resulted from the periodicity of the photonic crystals plays an important role. Compared with periodic photonic crystals, only long-range oriental order exists in quasiperiodic photonic crystals. Dose the long-range order resulted from quasiperiodicity have the same effect on the transmission properties of QPC as those in periodic photonic ones? Periodic photonic crystals can be considered constructed with basic cell or some kinds of supercells. Similarly, QPCs[1, 2] are also can be considered in the same way. Recently, we study the property of modified 12-fold quasiperiodic photonic crystals in which the supercells are arranged in various ways. The result shows that although the order of rotational symmetry, namely the oriental order, is reduced by arranging the supercells periodically, the transmission propertied remain almost unchanged.

The 12-fold QPC mentioned in ref. 1 is built up with dielectric cylinders placed on the vertices of random square-triangle tiling system. It can be considered constructed with supercells shown in Fig. 1. In the QPC, these supercells are arranged quasiperiodically. With the same supercell, two different crystals where the supercells are arranged in square and triangle periodic fashions are constructed and their transmission spectra show that the location and the width of the gaps are all identical with those of QPC shown in ref.1. Furthermore, the absulote gaps shown in the band gap structure display that the modified QPCs are also isotropic. It indicated that the order of rotational symmetry resulted from quasiperiodicty have little relation with the transmission property of the QPC.

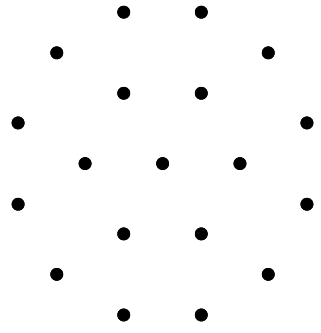

Fig. 1 Supercell of QPCs

In order to identify which factor determines the properties of QPCs, transmittance of the supercell is calculated. The result shows that the gaps of the supercell are superposed with those of any kind of QPC. Therefore we can conclude that the local properties result in the isotropiy in the QPCs.

1. Zoorob ME, Charlton MDB, Parker GJ, Baumberg JJ, Netti MC, Complete photonic bandgaps in 12-fold symmetric quasicrystals, Nature, **404** (2000): 740-743
2. Zhang XD, Zhang ZQ, Chan CT, Absolute photonic band gaps in 12-fold symmetric photonic quasicrystals, Phys. Rev. B **63** (2001): 081105