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Research Paper PHYSICS

Shapes of Rods Affect the Eigenmode in Photonic Crystal Fiber

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ABSTRACT

The rods formed in PCF are not exact cylinders rather ellipse rods which shows that the defect eigen frequency is controlled by the cross section area of rods. The control by the cross section area of rods provides a better way to modify the distribution of electromagnetic fields in photonic crystal and keeps the eigen frequency unchanged.

KEYWORDS Photonic Crystal; Eigenmode; Rod Shape.

1. Introduction

Photonic Crystal Fibers (PCF) is now a proven technology that is competing with conventional fibers in many applications. The emergence of localized defect modes in the gap frequency region when a disorder is introduced to the periodic dielectric structure is one of the most important properties of photonic crystals. There are usually two types of two dimension (2D) structure which are adopted in PFC[3], triangular lattice and square lattice of dielectric cylinders. In order to form a defect, one or more cylinders are moved from a regular lattice structure.

The localized defect mode will appear around the defect which is called an eigenmode. The relations between the eigenmode or bandgaps and the structure parameters are studied extensively [2].

However the dielectric rods fabricated with recent technology in PCF are not exact cylinders

The shapes of rods affect the eigenmode in PCF

The 2D photonic crystals in the form of triangular lattice and square lattice of circular dielectric cylinders have complete bandgaps for TM modes. A localized eigen-mode will form around a defect as shown in **Figure 1**.

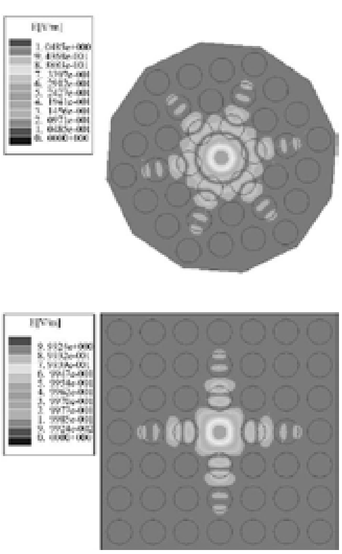

Figure 1. (a) Triangular lattice, (b) Square lattice

The relations between the eigenfrequency and the ra-dius of dielectric cylinders in a small region have been calculated numerically with Finite Element Method [4] and are shown in **Figure 2**.

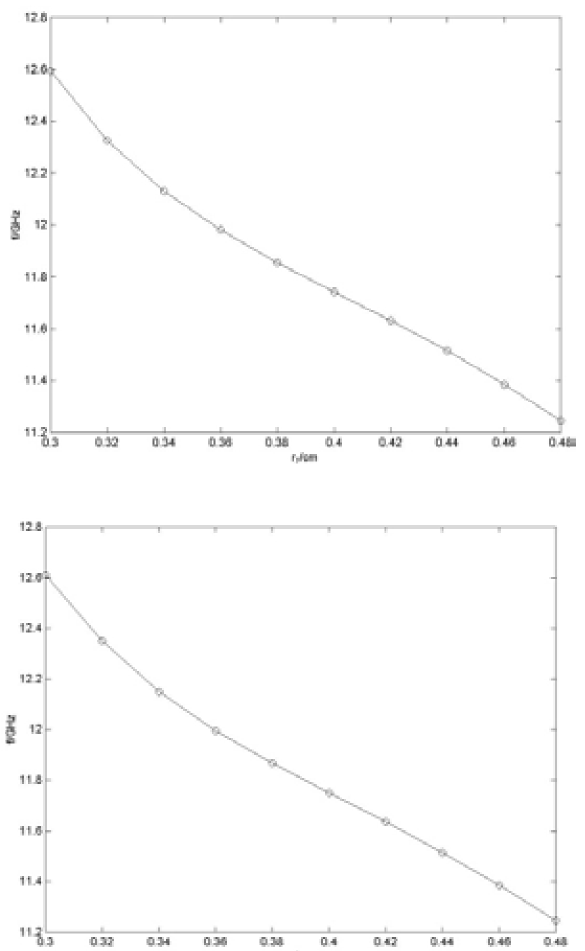

Figure:2. The relations between the eigen frequencies and the minor axis radii of ellipse rods. (a) The minor axis of ellipse rods is along the vertical direction; (b) The minor axis of ellipse rods is along the horizontal direction.

The Eigen frequency of the localized defect mode decreases roughly linearly with the increase of the radius. As the rods fabricated in 2D photonic crystals are not exact cylinders, the shape of rods will affect the bandgaps [5] and the defect eigen modes. The ellipse rods are taken to simulate the rods with ir-regular shapes for studying the eigen modes.

As for the triangular lattice structure shown in figure 1(a), if the radius of cylinders becomes smaller in horizontal or vertical direction in a small range, i.e. the ellipse rods take the place of cylinders

In order to make sure of this conclusion let the minor axis has different directions in a triangular lattice structure as shown in figure 3. The eigen frequency[1] almost keeps unchanged and the symmetry of the distribution of the electric field in this structure is disturbed[6]. A natural explanation to the common eigen frequency is that they have a common cross section area of rods. The cross section area of these ellipse rods is

$$S_1 = \pi r_x r_y = 3.14 \times 0.38 \times 0.48 = 0.573 \ \text{cm}^2$$

In **Figure 2(a)** when the eigenfrequency is 11.8611 GHz, the corresponding radius of cylinders equals 0.429 cm. The cross section area of these cylinders is

$$S_2 = \pi r^2 = 3.14 \times 0.429^2 = 0.578 \ \text{cm}^2$$

It is almost same to the cross section area of ellipse rods.

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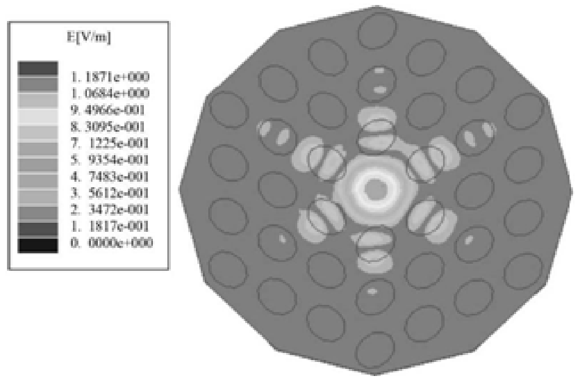

Figure:3. The distribution of electric field in 2D triangular lattice photonic crystal, the minor axis of ellipse rods has different directions. The eigen frequency is 11.8611 GHz.

3. Conclusion

The eigen frequency of defect eigen modes formed in 2D defect photonic crystals is controlled by the cross section area of rods and the distribution of electro- magnetic field around the defect is affected by the cross section shape of rods.

REFERENCES

[1] Cai X. H, W. H. Zheng, X. T. Ma, G. Ren and J. B. Xia, "Photonic Band Structures of Two-Dimensional Photonic Crystals with Deformed Lattices," Chinese Physics, Vol. 14, No. 12, 2005, p. 2507. | [2] Sakoda.K, "Optical Properties of Photonic Crystals," Springer, New York, 2004, p. 125 || [3] Cai X. H, W. H. Zheng, X. T. Ma, G. Ren and J. B. Xia, "Photonic Band Structures of Two-Dimensional Photonic Crystals with Deformed Lattices," Chinese Physics, Vol. 14, No. 12, 2005, p. 2507. || [4] Xiao. G. H, et al., "Influences of Structure Parameters of Triangular Lattice Photonic with Defect on Eigen Mode," Acta Photonica Sinica, Vol. 37, No. 4, 2006, p. 725. || [5] Xiao. G.H, et al., "The Influences of the Structure Pa-rameters of a Square Lattice Photonic Crystal with a De-fect in It on Its Defect Mode," Laser Journal, Vol. 28, No. 6, 2007, p. 27. || [6] Zhuang .F, L. Wu and S. L. He, "The Influences of the Structure Parameters of a Square Lattice Photonic Crystal with a Defect in It on Its Defect Mode," Chinese Physics, Vol. 11, No. 8, 2002, Article ID: 0834. |