Localized, Guided Propagation Modes in Photonic Crystals with Shear Discontinuities

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Photonic crystals consist of periodic arrays of dielectric media [1,2]. Electromagnetic waves propagate in photonic crystals as Bloch waves whose coupling gives rise to the band structure, which may include forbidden gaps where the waves cannot propagate. Certain defects can lead to the coupling of energy to confined, localized states in the vicinity of the defect. We propose a new type of defect, consisting of a shear discontinuity in a photonic crystal lattice. Figure 1(a) shows a square lattice of circular dielectric columns with a shear discontinuity in the middle row. The circular dielectric columns in the middle line are cut in half. The shear shift is exactly half the lattice constant. Using FDTD, we simulated a band-limited pulse with its spectrum inside the band gap of the (unperturbed) photonic crystal being injected by the waveguide near the tip of the sheared slice. As Figure 1(a) shows, the entire pulse is well localized to the shear plane as it propagates in the crystal. The confined propagation mode occurs over a broadband spectrum. As Figure 1(c) shows, the coupling efficiency is almost 100% over a long wavelength range, provided that the shear shift is approximately half a lattice constant.

![Figure 1(a)](image1a.png)
![Figure 1(b)](image1b.png)
![Figure 1(c)](image1c.png)

Figure 1. The pulse propagates inside the sheared photonic crystals. The refractive index of basis media is 1.0; that of the circular dielectric columns is 3.0. The diameter of each column is 80nm and the lattice constant is 200nm. The duration of the pulse is 10fs and its center wavelength is 560nm: (a) half-lattice-constant shift; (b) quarter-lattice-constant shift (the confinement is turned off); (c) the spectrum of flux at the exit of the waveguide and in the sheared slice and the couple-in efficiency of (a)

REFERENCES:
