Fig. 2.1 Schematics of (a) 1-D PC (b) 2-D PC: rod-lattice and hole-lattices; and (c) 3-D PCs: woodpile and colloidal structures.
Fig. 2.3 Photonic band diagrams of (a) 1-D PC, (b) 2-D square PC, and (c) 2-D triangular PC. The gray area in (a) represents the 1BZ of the 1-D PC. The dark gray area in (c) represents the PBG of the TE lightwave in the 2-D triangular PC.
Fig. 2.4 (a) Square lattice of air-holes in a high-index material. Magnetic ($\mathbf{H}$)-field distribution at $M$-point ($k=\pi/a$, $\pi/a$) of (b) the first band (the lowest frequency band) and (c) the second band.
Fig. 2.5 (a) E-field concentrated in a high-index ($n_2$) region tends to be of a relatively low frequency due to the relatively long optical path length ($n_2L$) imposed. (b) E-field concentrated in low-index ($n_1$) region tends to be of a relatively high frequency due to the relatively short optical path length ($n_1L$).
Fig. 2.6 (a) Dispersion surface of a square lattice of air holes. (b) EFCs of the first band (lower) and the second band of the square lattice (upper). (c) Dispersion surface of a triangular lattice of air holes. (d) EFCs of the first band (lower) and the second band of the triangular lattice (upper).
Fig. 2.7 Band diagrams of a 2-D PC slab of (a) square lattice of air holes, and (b) a triangular lattice of air holes. The gray areas represent the radiation modes in the silica claddings.
Fig. 2.8 (a) PBG-guided modes which are confined by Bragg-reflection in PC waveguides. (b) Index-guided modes which are confined by the effective index contrast between the PC \((n_{\text{eff}})\) and the line-defect waveguide \((n_{\text{defect}})\). It can be treated as a conventional slab waveguide.
Fig. 2.9 k-space representation of the group velocities ($v_{gA}$, $v_{gB}$) and the wavevector ($\mathbf{k}_A$, $\mathbf{k}_B$) at the same frequency at point A and B in (a) an isotropic medium (air) and (b) a triangular PC.
Fig. 2.11 Schematics of the supercell used in (a) single defect and (b) line-defect introduced in PCs. The dashed lines enclosed individual supercell.
Fig. 2.12. Projected band diagram of a triangular PC lattice with defect waveguide plotted along ΓK direction. The gray areas represent the continuum PC band projected onto ΓK direction. The solid lines represent the defect waveguide modes. The inset shows the schematic of the line-defect structure.
Fig. 3.6 FDTD-simulation layout of a 1-D PCEM. A Gaussian pulse with $1/e^2$ temporal width of 20-fs and with a rectangular profile (with the width larger than the simulation window in $z$-direction) is launched at $P(z=2a)$. Time monitors A and B (black vertical bars) detect the transmitted and reflected waves from the 1-D PCEM. PMLs are used at the boundaries of the simulation window in the $z$-direction (See the shaded areas). Periodic boundaries conditions are applied in the $x$-direction.
Fig. 3.7 Schematic of the 1-D PCEM used in the supercell approach of the 1-D PWE method. The center region (in darker color) bounded by the dashed lines
Fig. 3.12 Dispersion relations of the 1-D PCEMs with $N = 3$ (dash-dotted line), $N = 9$ (dotted line) and $N = 21$ (solid line). The dispersion of the infinite 1-D PC (thin solid line) is also plotted for comparison. The inset is the zoom-in view of the portion near the band-edge.
Fig. 3. Normalized intensity plots of the resonance mode E-field distributions of (a) mode A, (c) mode B, (e) mode A, (g) mode B (see Fig. 3.8(b)). Their corresponding H-field distributions are plotted in (b), (d), (f) and (h), respectively. The dotted lines represent the index profile of the 1-D PCEM (N = 7).
Fig. 4.1 Schematics of (a) a square PCEM and (b) a hexagonal PCEM. The dotted arrows represent the lightwave orbits.
Fig. 4.3 FDTD simulation layouts of (a) a square PCEM ($n = 3.5$) and (b) a hexagonal PCEM ($n = 3.5$). Period $a = 0.465 \, \mu m$ and radius $r = 0.3 \, a$. For square PCEM, sidewall length $L_s = (Na + m_s)$, where $m_s = 0.4a$ is the margin width. For hexagonal PCEM, sidewall-to-sidewall distance $L_s = N(\sqrt{3}/2)a + 2r + m_s$, $m_s = 0.105 \mu m$ is the margin width. $d = 1.5 \, \mu m$ is the distance between the PMLs and the PCEMs sidewalls in both the $x$- and $y$-direction. $N$ is number of rows in $x$-direction ($y$-direction) for square lattice and in $y$-direction ($y$-direction) for triangular lattice.
Fig. 4.4 (a) TE-polarized resonances field intensity spectra of a square PCEM (N = 7) calculated by nine time monitors. The top arrows indicate the 9 sets of resonance modes. I, II and III are the three highest-frequency sets of resonances. (b) The positions of the 9 time monitors inside the square PCEM. (c) First band of the TE-polarized band diagram of a 2-D square PC lattice of air-hole in silicon (n = 3.5). The dash-dotted lines in (a) and (c) represent the band-edge frequency at M-point of the first band.
Fig. 4.6 FDTD-simulated resonance mode magnetic $H$-field patterns in a square PCEM ($N = 7$): (a) mode $A_{77}^1$; (b) and (c) modes $B_{77}^1$ and $B_{77}^2$; (c), (d) and (e) mode $C_{77}^1$, $C_{77}^2$ and $C_{77}^3$. 
Fig. 4.8 (a) TE-polarized resonance field intensity spectra of a hexagonal PCEM (N = 7) calculated by 5 time monitors. The top arrows indicate the 7 resonance modes in the PCEM. I, II, and III are the three highest-frequency sets of resonances. (b) The positions of the 5 time monitors inside the hexagonal PCEM. (c) First band of the TE-polarized band diagram of a 2-D triangular PC lattice of hole in silicon (n = 3.5). The dash-dotted lines in (a) and (c) represent the band-edge frequency at K-point of the first band.
Fig. 4.10 FDTD-simulated resonance mode field patterns in a hexagonal PCEM (N = 7): (a) mode $A_1^N$; (b) $A_2^N$; (c), (d) modes $B_2^N$; (d) mode $C^N$. 
Fig. 4.13 (a) TE-polarized (E-field in-plane) dispersion diagram calculated by the supercell approach of 2-D square PCEMs. The PCEM resonance modes are highlighted in the figure. The light-gray curves represent the radiation modes. The inset shows the resonance mode field patterns calculated at M-point. Zoom-in view of the resonance modes are shown in (b) mode $A^{t7}$ (closed squares); (c) $B^{s7}$ (closed circles) and $B^{t7}$ (open circles); (d) $C^{s7}$ and (e) $C^{s7}$ (closed triangles) and $C^{t7}$ (open triangles).
Fig. 4.14 (a) TE-polarized ($E$-field in-plane) dispersion diagram calculated by supercell approach of 2-D hexagonal PCEMs ($N=7$). The PCEM resonance modes are highlighted in the figure. The light-gray curves represent the radiation modes. The inset shows the resonance mode field patterns calculated at K-point. Zoom-in view of the resonance modes are shown in (b) mode $A_1^{N7}$ (closed squares); (c) $A_2^{N7}$ (opened squares); (d) $B_1^{N7}$ (closed circles) and $B_2^{N7}$ (open circles); (e) $C_1^{N7}$ (closed triangles) and $C_2^{N7}$ (opened triangles) and (f) $D_1^{N7}$ (closed rhombuses) and $D_2^{N7}$ (opened rhombuses).
Fig. 4.15 Projection of the FDTD-simulated resonance mode-field patterns of the 2-D square PCEM (N = 7) onto the five IRREPs of the C_{4v} point group (From first column to the fifth column: A_l, A_2, B_{1}, B_{2} and E). (a) mode A^{\nu}; (b), (c) modes B^{\nu}_{1} and B^{\nu}_{2}; (d), (e) and (f) mode C^{\nu}_{1}, C^{\nu}_{2} and C^{\nu}_{3}.
Fig. 4.16 Projection of the resonance modes patterns of 2-D hexagonal PCEM ($N = 7$) obtained from the FDTD simulation onto the five IRREPs of the $C_{6v}$ point group (From first column to the fifth column: $A_1$, $A_2$, $B_1$, $B_2$, $E_1$ and $E_2$). (a) mode $A_1^{A_1}$, (b) $A_1^{A_2}$, (c) mode $B_1^{A_1}$, (d) mode $B_1^{B_1}$, and $B_1^{B_2}$, (e) mode $B_2^{B_2}$, (f) mode $E_1^{E_1}$, $E_1^{E_2}$, (g), (h) mode $D_2^{E_1}$. 
Fig. 4.17 (a) Reciprocal space of square PC. \( k_M \) are the k-vector component at M-points in 1BZ (gray region), \( i = 1,2,3,4 \). Note that \( k_M^1 = -k_M^2 \) and \( k_M^2 = k_M^4 \). (b) Reciprocal space of triangular PC. \( k_K \) are the k-vector component at K-points in 1BZ (gray region), \( i = 1,2,3,4 \). Note that \( k_K^1 = -k_K^2 \), \( k_K^2 = -k_K^3 \) and \( k_K^3 = k_K^4 \).
Fig. 4.18 The approximate forms of the square PCEM resonance mode field patterns calculated by Eq. 4.6-4.7. (a) mode (1,1); (b), (c) mode (2,1) and (1,2); (d) mode (2,2); (e), (f) mode (3,1) and (1,3).
Fig. 4.19 Projection of (a) mode (3.1) and (b) mode (1.3) onto the five IRREPs of the $C_{4v}$ point group. The projected IRREPs $A_1$ and $B_1$ in (a) and (b) are almost identical to mode $C_{2}^3$ and $C_{2}^1$, implying they are degenerate modes of mode (3.1) or (1.3).
Fig. 4.20  Calculated mode field patterns of (a) $H_{n1}$ and (b) $H_{n2}$ (Eq. 4.11 and 4.12). The mode field pattern is almost identical to mode $A_n^{p/2}$ and $A_n^{p/1}$.
Fig. 4.21 (a)-(i) Fourier transforms of the square PCEM (N = 7) resonance modes overlaid with the first band EFCs of the square PC (r/μ = 0.3; n = 3.5). The transformed resonance modes are labeled in the figure. Right column (b), (d), (f), (h), (j) and (l) are the zoom-in view of the left column (a), (c), (e), (g), (i) and (k). The frequency contour intervals of the EFCs on the left and right are displayed as Δω/ω = 0.01 and Δω/ω = 0.005, respectively. The dashed line enclosed the BZ of the EFCs. The dotted arrows and the bolded-solid arrows represent the k-vectors (pointing at the peak of the Fourier components) and the corresponding group velocities νg = v(ω(k)) of the resonance modes. The thin-solid arrows represent νg in the EFCs.
Fig. 4.22 Schematic of constructing the four-bounce orbit in PCEMs in reciprocal space for (a) mode A^{0}_{1} and (b) mode C^{+}_{2}. The solid circles represent the EFCs of air at (a) mode A^{0}_{1} frequency $a/\lambda=0.215$ and (b) mode C^{+}_{2} frequency $a/\lambda=0.19$. (c) $k$-conservation for $k_{sd}$ and $k_{sa}$. (d) TIR condition at the interface between PCEM and oxide-air region.
Fig. 4.23 (a)-(l) Fourier transform of the hexagonal PCEM ($N = 7$) resonance modes overlaid with the first band EFCs of triangular FC ($r/a = 0.3; n = 3.5$). The transformed resonance modes are labeled in the figure. Right column (b), (d), (f), (h), (j), (l) and (o) are the zoom-in view of the left column (a), (c), (e), (g), (i), (k), (m) and (o). The frequency contour intervals of the EFCs $\Delta a/2\lambda = 0.01$. The dashed line enclosed the 1BZ of the EFCs. The dotted arrows and the bolded solid arrows represent the $k$-vectors (pointing at the peak of the Fourier components) and the corresponding group velocities $v_g = \nabla \alpha(k)$ of the resonance modes. The thin solid arrows represent $v_g$ in the EFCs.

Fig. 4.24 Schematic of constructing the three-bounce orbit in hexagonal PCEMs in reciprocal space. The inset shows the $k$-conservation of the tangential $k$-components.
Fig. 5.1 Different schemes of light coupling to PCEMs: (a) Direct illumination; (b) Photoluminescence from the PCEMs with embedded in active materials; (c) evanescent-coupling between the waveguide and the PCEMs.
Fig. 5.2 FDTD simulation layout of the waveguide-coupled semi-infinite PC structures \((n = 3.5)\). Period \(a = 0.465 \mu m\); \(r = 0.3a\); truncated PC width \(W = 11a + 0.5w\); margin \(m = 0.4a\); gap \(g = 0.2 \mu m\) and \(d = 3a\). The length of the structure is 100a. The inset shows the details of the triangular and square PC.
Fig. 5.3 The unit-cell (supercell) of the waveguide-coupled semi-infinite square (upper) and triangular (lower) PC. $W = 11a + 0.5m$ for square lattice whereas $W = 6.5(\sqrt{3}a + r) + m$ for triangular lattice. The addition air region $d = 3a$. Other structural parameters are identical to that shown in Fig. 5.2.
Fig. 5.4 TE-polarized projected band structures of the waveguide-coupled semi-infinite square PC along ΓX-direction (left) and the corresponding FDTD-simulated TE-polarized transmission spectra (right). (a) $w = 0.275 \mu m$; (b) $w = 0.325 \mu m$; (c) $w = 0.375 \mu m$. The light-gray and the dark-gray region represent the leaky modes and the PC bulk modes projected onto ΓX-direction, respectively. The grey-dotted and black-dotted curves represent the defect modes (near the PC truncated surface) and the waveguide modes.
Fig. 5.5 The field distribution of the coupled lightwave from the waveguide (upper) at (a) $a/\lambda=0.205$ and (b) $a/\lambda=0.18$. The region enclosed by the dashed lines is magnified (lower).
Fig. 5.6 (upper) FC of the field distributions of the lightwave at (a) $a/\lambda = 0.205$ and (b) $a/\lambda = 0.18$. (lower) Dispersion curve of the waveguide of width $w = 0.375$ μm (solid line). The black dots represent the k-vector components at (c) $a/\lambda = 0.205$ and (b) $a/\lambda = 0.18$. The dashed arrows show the phase-matching conditions between the waveguide mode and the coupled-PC modes, i.e., $k_x$ component is conserved. The waveguide dispersion of $w = 0.275$ μm (dashed line) and $w = 0.325$ μm (dotted line) are plotted for comparison.
Fig. 5.7 (a) The coupled-PC mode (thick black line) on the square PC EFCs. They are obtained by mapping the waveguide mode \((w = 0.375 \, \mu m)\) on them based on the fact that \(k_x\)-components between two is conserved (see (b)). The gray disks represent the dominant Fourier components of the PCEM resonance modes. (Fig. 4.22)
Fig. 5.8 (a) TE-polarized projected band structures of waveguide-coupled semi-infinite triangular PC along ΓK-direction for $w = 0.3 \, \mu m$ (closed circles); $w = 0.35 \, \mu m$ (triangles); $w = 0.4 \, \mu m$ (opened circles). The light-gray and the dark-gray region represent the leaky modes and the PC bulk modes projected onto ΓK-direction, respectively. The gray-dotted curves represent the defect modes (near the PC truncated surface) and the waveguide modes. The FDTD-simulated TE-polarized transmission spectra are shown in (b) $w = 0.3 \, \mu m$; (c) $w = 0.35 \, \mu m$; (d) $w = 0.4 \, \mu m$. 
Fig. 5.9 The field distribution of the coupled lightwave from the waveguide (upper) at $a/\lambda = 0.19$. The region enclosed by the dashed lines is magnified (lower).
Fig. 5.10  (a) (upper) FT of the field distributions of the lightwave at $a/\lambda =0.18$ (lower) overlaid with the triangular PC EFCs. The black dots represent the $k$-vector components of the waveguide dispersion curve of $w = 0.4 \mu m$ (solid line) at $a/\lambda =0.18$. The dashed arrow shows the phase-matching conditions between waveguide and coupled-PC modes. The waveguide dispersion of $w = 0.35 \mu m$ (dashed line) and $w = 0.3 \mu m$ (dashed-dotted line) are plotted for comparison. (b) The coupled-PC mode (thick black line) on the triangular PC EFCs (upper). They are obtained by mapping the waveguide mode ($w = 0.35 \mu m$) (dashed curve in lower plot) on them based on the fact that $L_\perp$-components between two is conserved. The gray disks represent the dominant Fourier components of the PCEM resonance modes (Fig. 4.23).
Fig. 5.11 FDTD-simulation layout of waveguide-coupled 2-D (a) square PCEM and (b) hexagonal PCEM. The detail structural parameters are as same as those depicted in Fig. 4.27. The length of the waveguide is $3L_0$ in (a) and $3L_4$ in (b). $d = 1.5 \text{ \textmu m}$ in both cases. Forward and backward propagating waves are detected at the port 1 and 2.
Fig. 5.13 FDTD-simulated steady-state square PCEM (N=7) resonance mode field evolutions (H-field) from an arbitrary time instant $t = t_0$ (leftmost) to $t = t_0 + T/2$ (rightmost), where $T$ is the period (oscillation frequency). Each snapshot is taken at $T/6$-interval. The resonance modes are (a) mode $A^0$, (b) $B^0$, (c) $C^0$, (d) $C^0_2$ and (e) $C^0_3$. 
Fig. 5.16 FDTD-simulated steady-state hexagonal PCEM (N=7) resonance mode field evolutions from an arbitrary time instant $t = t_0$ (leftmost) to $t = t_0 + T/2$ (rightmost), where $T$ is the period. Each snapshot is taken at $T/6$-interval. The resonance modes are (a) mode $A^{57}$, (b) $B^{57}$, (c) $C^{57}$. 
Fig. 5.22 (a) Transmission spectra of waveguide-coupled \( w = 0.375 \mu \text{m} \) square PCEM \( (N=\infty) \) as a function of the index change in silicon \( (n = 3.5+\Delta n) \). (b) Transmission spectra of waveguide-coupled \( w = 0.4 \mu \text{m} \) hexagonal PCEM \( (N=7) \) as a function of the index change in silicon \( (n = 3.5+\Delta n) \). (c) Sensitivity of the resonance wavelength shift to the refractive index change in silicon in square PCEM (open circles) and hexagonal (closed circles).
Fig. 6.1 Ray-orbit schematics of surface-wave resonance lightwaves in (a) 2-D square PCEM and (b) hexagonal PCEMs. The enlarged portions represent the truncated-PC waveguide structures in (a) square and (b) triangular PC.
Fig. 6.2 (a) Schematic of the PBG-guided modes confinement mechanism in TPC-waveguides along the PC-air interface; TIR at the air-dielectric interface; Bragg-reflections on the dielectric-PC interface. The size of the arrows represents the lightwave amplitudes. (b) Schematic of the index-guided modes confinement mechanism. The dark gray region indicates the effective waveguide core sandwiched by air and PC bulk as an effective-index medium (n_{eq}). (c) Sketch of dispersion diagram of the PBG-guided and index-guided modes in TPC waveguides.
Fig. 6.3 $k$-vector components ($k_x, k_y$) (middle) and their field distributions in the x- and y-directions (right) of the (a) PBG-guided modes and (b) index-guided modes.
Fig. 6.4 Schematics of the surface-modes in two different TPC-waveguides (triangular PC), according to the margin width $w_{\text{eff}}$: (a) donor-like waveguide when $w_{\text{eff}} > \lambda_\text{o} / 2n_{\text{eff}}$, (b) donor-like waveguide when $w_{\text{eff}} > \lambda_\text{o} / 2n_{\text{eff}}$, where $\lambda_\text{o}$ is the wavelength within the first bandgap; $n_{\text{eff}}$ and $n_{\text{eff}}$ are the effective indices of the waveguides in two different cases.
Fig. 6.5 Schematics of the TPC-waveguides using (a) square PC lattice and (b) triangular PC lattice. The dashed-line windows represent the unit-cell defined in PWE calculation. $m_s$ and $m_t$ are defined as the truncated PC margin width, i.e. the margin width, in square and triangular PC cases. $d = 3a$ is the additional air-region.
Fig. 6.6 Dispersion diagrams of the TPC-waveguides using square PC lattice for (a) $m_x = 0.4a$, (b) $m_x = 0.6a$ and (c) $m_x = 0.8a$. The black dotted curves represent the defect-guided modes ($D_1$, $D_2$, $A_1$, $A_2$ and $l_1$). The light-gray and dark-gray regions represent the leaky modes (radiate into the air) and the projected PC bands onto the ΓX-direction. The inset next to (c) shows the gap at $k_x \sim 0.8\pi/a$, originates from the anti-crossing of modes $l_1$ and $D_1$. 
Fig. 6.7 PWE-simulated time-averaged $H$-field distribution of (a) mode $D_1$ at $k_r=\pi/a$ for $m_r=0.4a$; (b) mode $D_2$ at $k_r=\pi/a$ for $m_r=0.8a$; (c) mode $I_1$ at $k_r=\pi/a$ for $m_r=0.8a$ and (d) mode $A_2$ at $k_r=\pi/a$ for $m_r=0.6a$. The cross-sectional distributions of each mode (across the dashed-dotted lines) are shown in (e), (f), (g) and (h).
Fig. 6.8 (a) Schematic of a 1-D Bragg-waveguide obtained by keeping only the first row of the air-holes adjacent to the margin in a TPC-waveguide. (b) Dispersion diagram of a conventional slab waveguide (bolded solid lines), showing the fundamental (C₀) and the first-order mode (C₁). The band-foldings (dotted lines) at IBZ (k=π/a) due to the introduction of a fictitious periodicity a and anti-crossing between band C₀ and C₁ occurs at point 2. If the slab waveguide is periodically perturbed by air-holes, the resultant schematic of a dispersion diagram is shown in (c).
Fig. 6.9 Supercell-calculated dispersion diagram of the 1-D Bragg-waveguide (opened circles) and TPC-waveguide (closed circles).
Fig. 6.10 Supercell-calculated dispersion diagrams of the TPC-waveguides using triangular PC lattice for (a) $m_3 = W - 0.9a$, (b) $m_3 = W - 0.5a$ and (c) $m_3 = W - 0.3a$. The black dotted curves represent the defect-guided modes ($A_1$, $A_2$ and $I_1$). The light-gray and dark-gray regions represent the leaky modes (radiate into the air) and the projected PC bands onto the ΓX-direction. The inset next to (c) shows the gap that is originated from the anti-crossing of mode $I_1$ and $A_2$. 
Fig. 6.11 H-field distribution of (a) mode A₁ at $k_x = \pi/a$ for $m_y = W - 0.9a$; (b) mode I₁ at $k_x = \pi/a$ for $m_y = W - 0.5a$; (c) mode A₂ at $k_x = \pi/a$ for $m_y = W - 0.5a$. The cross-sectional distributions of the each mode (cut through the dashed-dotted lines) are shown in (d), (e) and (f). Note that in (a), the mode A₁ at $k_x = \pi/a$ for $m_y = W - 0.5a$ is also plotted to compare with the mode A₁ for $m_y = W - 0.9a$. 

Fig. 6.12 Zoom-in of dispersion diagram of the TPC- waveguide using triangular PC for $m_0=W=0.5a$ (see Fig. 6.9(b)). The closed and opened circles represent the index-guided ($l_1$) and band-gap guided modes ($A_5$). The insets shows the time-averaged $|H|^2$ plots of the upper and lower bands at (from left to right) $k_x=0.64\pi/a, 0.72\pi/a, 0.82\pi/a, 0.92\pi/a$. 
Fig. 6.13  (a) Schematic of 1-D Bragg-waveguide obtained by keeping the first row of holes adjacent to the interface in a hybrid-Bragg waveguide.  (b) Dispersion diagram of the 1-D Bragg-waveguide (opened circles) and hybrid-Bragg waveguide using triangular PC(closed circles). Both waveguides have same margin width $m_0=W-0.5a$. 
Fig. 6.14 FDTD simulation layout of the waveguide-coupled TPC-waveguide with (a) square and (b) triangular PC structures ($n = 3.5$), i.e. hybrid-Bragg waveguides. Period $a = 0.465 \mu m$; $r = 0.3a$; margin $m = 0.4a$; gap $g = 0.2 \mu m$ and $d = 3a$. The length of the structure in the x-direction in both cases is $50a$. The insets detail the triangular and square PC. The unit-cell (supercell) of the waveguide-coupled TPC-Bragg waveguide using (c) square and (d) triangular PC in PWE calculation. The addition air region $d = 3a$. 
Fig. 6.15 Dispersion diagram of the slab waveguide-coupled (w=0.275μm) TPC-waveguide using square PC structures for (a) $m=0.4a$ and (c) $m=0.6a$. The black dotted curves represent the guided modes in this system. The light-gray and dark-gray regions represent the leaky modes and the bulk PC bands. The dashed lines and the solid lines represent the dispersion curves of the isolated slab waveguide and uncoupled TPC-waveguide surface modes, respectively. The FDTD-simulated transmission spectra for $m=0.4a$ and $m=0.6a$ are shown in (b) and (d).
Fig. 6.16 FDTD-simulated $H$-field distribution of the slab-waveguide ($w=0.275\mu m$) -coupled TFC-waveguide using square PC at (a) $m/\lambda = 0.255$ for $m=0.4a$ and (b) $m/\lambda = 0.274$ for $m=0.6a$. The dashed lines represent the launched position of the lightwave in the slab waveguides.
Fig. 6.17 Dispersion diagram of the slab waveguide-coupled ($w=0.3\mu m$) TPC-waveguide using square PC structures for (a) $m_{0}=W=0.5a$ and (c) $m_{0}=W=0.3a$. The black dotted curves represent the guided modes in this system. The light-gray and dark-gray regions represent the leaky modes and the bulk PC bands. The dotted lines and the solid lines represent the dispersion curves of the isolated slab waveguide and uncoupled TPC-waveguide surface modes, respectively. The FDTD-simulated transmission spectra for $m_{0}=W=0.5a$ and $m_{0}=W=0.3a$ are shown in (b) and (d).
Fig. 6.18 FDTD-simulated $H$-field distribution of the slab-waveguide ($w=0.3 \mu$m) -coupled TPC-waveguide using hexagonal PC at (a) $a/\lambda = 0.26$ for $m_0=W-0.5a$ and (b) $a/\lambda =0.23$ for $m_0=W-0.3a$. The dashed lines represent the launched position of the lightwave in the slab waveguides.
Fig. 6.19 FDTD simulation layout of the waveguide-coupled a 2-D (a) square PCEM and (b) triangular PCEM for studying the defect-guided resonances. The solid line in the waveguide represents the light source position. Port 1 and 2 detect the transmitted and the reflected field, respectively. The structural parameters are referred to Fig. 6.14.
Fig. 6.21 Magnetic-field distribution of the coupled defect-guided resonances in square PCEM for (a)-(c) $m_a=0.4a$ and (d)-(e) $m_a=0.6a$. 
Fig. 6.23 Four selected magnetic field distribution of the defected-guided resonance modes ($A_\nu$ for $m_0=W-0.3a$ and $B_\nu$ for $m_0=W-0.5a$) in waveguide-coupled hexagonal PCEMs. The subscript $\nu$ represents the mode order of the resonances.
Fig. 7.1 Schematics of the waveguide-coupled PCEM (a) channel add-drop filter configuration (first design), and (b) notch-filter configuration (second design).
Fig. 7.3 SEM images of the fabricated PCEMs patterned by i-line photolithography. (a) square PCEM (N = 14) with designed $r = 0.275 \mu m$ and $a = 1.05 \mu m$. (b) square PCEM (N = 6) with $r = 0.275 \mu m$ and $a = 1.05 \mu m$. (c) square PCEM (N = 6) with $r = 0.25 \mu m$ and $a = 0.85 \mu m$. (d) Zoom-in views of (a). (e) and (f) show the cross-sectional profile of the waveguide at output facet.
Fig. 7.5 SEM images of the fabricated PCEMs (with designed $r = 0.175\mu m$ and $a = 0.55\mu m$) patterned by e-beam lithography. (a) square PCEM ($N = 22$). (b) hexagonal PCEMs ($N = 23$). The inset shows the waveguide profile at the input facet. (c) and (d) shows the zoom-in views of the coupling region of the square and hexagonal PCEMs.
Fig. 7.6 Bird's-eyes-view of the (a) square PCEM and (b) hexagonal PCEM of the second designs (using e-beam lithography). (c) Bird's-eyes-view of the square PCEMs of the first design (using photolithography).
Fig. 7.7 (a) TE-polarized (E-field // wafer plane) band diagram of a Si PC slab with square lattice of air holes. Gray region represents leaky modes. (b) Ray-diagram of the leaky modes in the Si PC slab. $\theta_1$ and $\theta_2$ are the incident (reflected) angle at air-Si and Si-SiO$_2$ interface. $\theta_{cr}$ ($\theta_{br}$) is the critical angle between air and Si (Si and SiO$_2$).
Fig. 7.8 Experimental set-up of the reflection measurement of the SOI PCEM devices on SOI sample. The gray-dashed line setup indicates the laser beam incident angle tuning.
Fig. 7.9 (a) Near-IR image of the incident laser beam (incident angle $\theta = 70^\circ$) on the SOI sample. The bright area corresponds to the incident light spot while the small bright spot on the left is the light scattered out of the PCEMs. (b) Schematic of the image in (a). (c) Horizontal line scan across the bright spot on the left in (a).
Fig. 7.10 Typical reflection spectra of three square PCEM devices with designed lattice constant $a = 0.9\mu m$, $0.95\mu m$ and $1.05\mu m$. Each spectrum is shifted apart relative to each other for clarity. The air-hole radii are fixed at $r = 0.275\mu m$. The arrows indicate apparent red-shifts as $a$ increases. The insets show the SEM images of two of the PCEM with designed $a = 0.9\mu m$ and $1.05\mu m$. 
Fig. 8.1 (a) Top-view optical micrograph of a typical photonic crystal fiber (PCF) (from Crystal Fibre A/S). Proposed experimental setup for characterizing the PCFs by using (b) Gaussian beam side-coupling with elastic scattering spectra measurement and (c) tapered fiber coupling technique with transmission spectra measurement.
Fig. A.1 Symmetry operations for (a) a 2-D square PCEM and (b) a 2-D hexagonal PCEM.