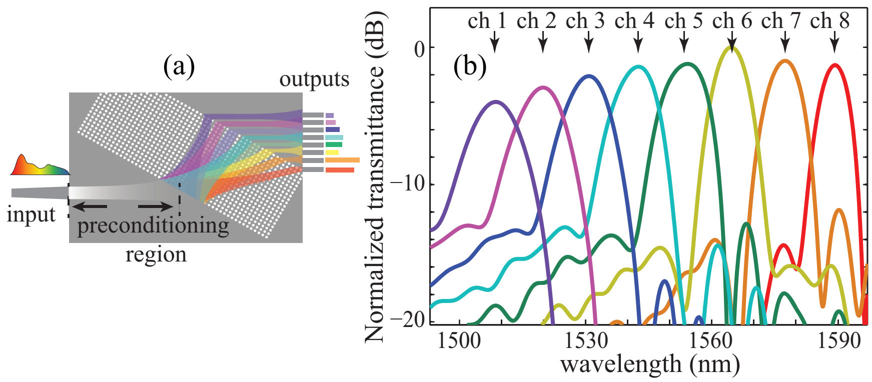

Fig. 4. (a) Schematic diagram of a flat-band superprism spectrometer; (b) Spectral transmission of the 8 channels that are evenly spaced over the working bandwidth.

widened to an exit-width of 3.72 μm in order to reduce the angular spatial frequency components of the input beam. The preconditioning region is designed to be 140 μm long and has opposite sign in the second-order diffraction coefficient [17] as compared to that in the PhC region. As a result, the beam first diverges in the preconditioning region and then re-focuses as it propagates within the PhC region. The total PhC area is approximately 135 by 42 μm^2. The spacing between neighboring output waveguides is approximately 3.5 μm. The output signals are coupled into 8 single-mode waveguides. Figure 4(b) shows the normalized spectral transmittance of the 8 channels. As predicted by the design, this device shows a quite flat spectral response over its designed working bandwidth, and the number of channels it can support is approximately doubled as compared to previous designs [10–13]. The peak transmission varies by approximately 4 dB over the eight channels, and the spectral response slightly widens from channel 8 to channel 1. Such non-uniformity in transmission and the crosstalk between the channels are primarily caused by the aberrations, e.g., spherical and coma, of the spectrometer geometry that involves a rectangular PhC region. These aberrations can be potentially reduced by optimizing the shape and local lattice geometries of the PhC region [18]. The on-chip loss of the spectrometer is simulated to be approximated 11-15 dB, which is mainly caused by the undesired reflection at the slab-PhC interfaces. Such reflections can be mitigated by adiabatically optimizing the PhC structures at the vicinity of the slab-PhC interfaces [19, 20].

Conclusion

In this work, we have proposed a new figure of merit, namely the angular-group-dispersion–bandwidth-product to quantify the spectroscopic performance of a PhC superprism structure. Using this FOM, we have performed optimization of a parallelogram-lattice PhC structure for building a superprism spectrometer. We have shown that a flat angular group dispersion can be achieved for a wide range of working bandwidths. Furthermore, the performance of an 8-channel spectrometer with 10 nm channel spacing at the center wavelength of 1550 nm has been determined using numerical simulation. Our method provides a systematic procedure to design flat-band on-chip miniaturized spectrometers and demultiplexers based on photonic crystals, and can be extended straightforwardly to other dispersive mechanisms.

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