

the variable space to make an accurate least squares fit of the duty cycle to match the data shown in Figs. 5 and 6. The coupling constant of the grating (κ) can then be found in terms of the simulation parameters as:

$$\kappa = \left(\frac{n_{\text{grating}}}{\bar{n}_{\text{Bragg}}} \right)^2 \frac{2}{\lambda} \sin(\pi \cdot DC) \cdot \Gamma \cdot (n_{\text{core}} - n_{\text{clad}}) \quad (6)$$

where Γ is the fraction of the power of the mode within the alternating wide and narrow grating regions defined by the Si_3N_4 core geometry as illustrated in Fig. 7. The sinusoidal factor is included to account for the duty cycle's influence on the grating coupling constant. Here a duty cycle of either 0 or 1 (meaning a grating where there is no width difference along its entire length) produces a coupling constant of 0, as expected of a straight waveguide. A duty cycle of 0.5 would produce the maximum value of κ for the particular width difference chosen.

4. Conclusions

We have demonstrated for the first time sidewall gratings in an ultra-low-loss Si_3N_4 planar waveguide platform. It is possible to make use of such structures for a variety of different applications, including the realization of extremely narrow linewidth mirrors. By changing the width difference between the periodic grating sections on only a single lithographic layer we can achieve coupling constants that range from 13 cm^{-1} to 310 cm^{-1} , and with careful apodization of duty cycles we can align the grating passband to match a single Bragg wavelength. The waveguide loss over the range of 1540 to 1570 nm is below 5.5 dB/m. Other interesting grating transfer functions, such as tailored spectral windows, can be achieved through use of an apodized width difference profile.

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