Comments and Corrections

Corrections to “Analysis of First-Order Gratings in Silicon Photonic Waveguides”

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***Abstract*—We report errors in Table III of (Tan et al. 2022) that requires changing the text discussions in four places. These errors, due to using an incorrect thickness for the middle layer of a three-layer waveguide in an analytic formula (Huang et al., 2017), only applies to a single comparison of the analytic formula to other methods (slab effective index and Floquet Bloch) of calculating the grating coupling coefficient occurring in Table III. The corrected results show that the analytic formula has good agreement with both methods even for deep gratings.**

I. Comments and Corrections

The values of the coupling coefficient $\kappa_{\mathrm{pq}}^{\mathrm{rect}}$ in the third column of Table III in [1] are in error because the wrong thickness of the middle layer of a three-layer waveguide was used in an analytic formula [2]. Using the proper layer thickness, the agreement with a numerical “exact” calculation of the coupling coefficient (α_{peak}) is within 5% for the deepest grating considered compared to the previously reported 16%. The notation for the calculated coupling coefficients is also modified for clarity in the corrected sections. All changes that should be made to [1] because of the calculation error are listed below.

Correction I: The last line of the Abstract (*Coupling coefficients calculated using analytic formulas are shown to be accurate only for shallow grating depths*) should be deleted.

Correction II: Replace the following section that begins as the last paragraph of column 1 on page 5 and ends on page 6 (*The first-order modal coupling coefficient κ for any grating region in the waveguide (Fig. 1(a)–(c)) is the maximum value of α ($\kappa = \alpha_{peak}$).* Table III *shows a comparison of κ calculated by the analytic perturbation formula [30], [31], [32], [33] κ_{pq}^{rect} (column 3) and the slab effective index method $\kappa = \kappa_{rect}$*) with “The first-order modal coupling coefficient κ for any grating region in the waveguide (Fig. 1(a)–(c)) is the maximum value of α ($\kappa = \alpha_{\mathrm{peak}}$). Table III shows a comparison of κ calculated by the analytic perturbation formula [30], [31], [32], [33] $\kappa = \kappa_{\mathrm{pq}}^{\mathrm{rect}}$ (column 3) and the slab effective index method $\kappa = \kappa_{\mathrm{slab}}$ (column 5) for rectangular gratings.

Correction III: Replace the first paragraph under Fig. 7 (*The slab effective index method has excellent agreement (<2%) with the coupling coefficient κ calculated by Floquet Bloch at the first Bragg condition for even deep gratings, but because the analytic formulas are based on perturbation theories that only include the first term in a Taylor series expansion, the agreement is reasonable (<10%) only if the grating depth is less than ∼20% of the silicon photonic waveguide core thickness. Revision of the analytic formulas to include higher order terms in the derivation would increase the agreement with the exact coupling coefficient a $_{peak}$ for deeper grating depths.*) with “The slab effective index method (κ_{slab}) shows excellent agreement and the analytic formula ($\kappa_{\mathrm{pq}}^{\mathrm{rect}}$) shows good agreement with the coupling coefficient (α_{peak}) calculated by Floquet Bloch at the first Bragg condition for even deep gratings.”

Correction IV: Replace the first paragraph of III. Conclusions (*A simple thin-film analysis of first-order gratings in Si photonic waveguides provides highly accurate results for reflected and transmitted power spectra as long as the waveguide remains single mode and non-radiating. The differences in the coupling coefficients, reflectivities, and reflectivity spectral widths calculated by the slab effective index method, FDTD, EME and Floquet-Bloch methods are very small (e.g., ∼0.1% for first-order gratings on Si photonic waveguides.) However, commonly used analytic formulas for gratings only provide accurate values of coupling coefficients in silicon photonic waveguides for grating depths of less than ∼20% of the core thickness. Additionally, the Floquet Bloch, slab effective index and EME methods show near-exact agreement even for only one grating period, and the FDTD method has excellent agreement once the grating has more than 5 grating periods (Fig. 2(d))* with “A simple thin-film analysis of first-order gratings in Si photonic waveguides provides accurate results for TE_0 to TE_0 coupling for reflected and transmitted power as long as the waveguide remains single mode and non-radiating. The differences in reflectivities and spectral widths calculated using the slab effective index, analytical formula, FDTD, EME and Floquet-Bloch methods are small, especially for moderate grating depths. With the exception of the FDTD approach, all methods show good agreement for the reflectivity of a rectangular grating with only one grating period. The FDTD approach shows good agreement with all approaches for gratings that contain more than 5 periods (Fig. 2(d)).”

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TABLE III
COUPLING COEFFICIENTS CALCULATED BY THE ANALYTIC PERTURBATION (κ_{pq}^{rect}), SLAB EFFECTIVE INDEX (κ_{SLAB}) AND FLOQUET BLOCH (α_{PEAK}) METHODS FOR SI PHOTONIC WAVEGUIDES WITHOUT COVER LAYERS FOR 0.001, 0.005, 0.010, 0.050 AND 0.1 MICRON RECTANGULAR GRATING DEPTHS

Grating Depth (μm)	α_{peak} (μm^{-1})	κ_{pq}^{rect} (μm^{-1})	Difference (%) $\frac{\kappa_{pq}^{rect} - \alpha_{peak}}{\alpha_{peak}}$ *100	κ_{slab} (μm^{-1})	Difference (%) $\frac{\kappa_{slab} - \alpha_{peak}}{\alpha_{peak}}$ *100
0.001	0.004249	0.004253	-0.09414	0.004249	0.00000
0.005	0.021569	0.021444	0.57954	0.021565	0.01855
0.010	0.043973	0.043957	0.03639	0.043972	0.00227
0.025	0.116638	0.116363	0.23577	0.116572	0.05659
0.050	0.259132	0.256316	1.08670	0.258192	0.36275
0.100	0.654963	0.624384	4.66881	0.641023	2.12836

Correction V: Table III and the caption for Table III should be replaced with the caption and Table III above.

REFERENCES

[1] H. Tan et al., "Analysis of first-order gratings in silicon photonic waveguides," *IEEE Photon. J.*, vol. 14, no. 6, Dec. 2022, Art. no. 6659110, doi: 10.1109/JPHOT.2022.3211456.

[2] J. Huang, K. Liu, J. K. Butler, N.-H. Sun, and G. A. Evans, "First-order grating coupling coefficients in asymmetric three-layer waveguides for transverse electric modes," *IEEE/OSA J. Lightw. Technol.*, vol. 35, no. 11, pp. 2200–2210, Jun. 2017.