A vectorial solver for the reflection of semi-confined waves at slab waveguide discontinuities for non-perpendicular incidence

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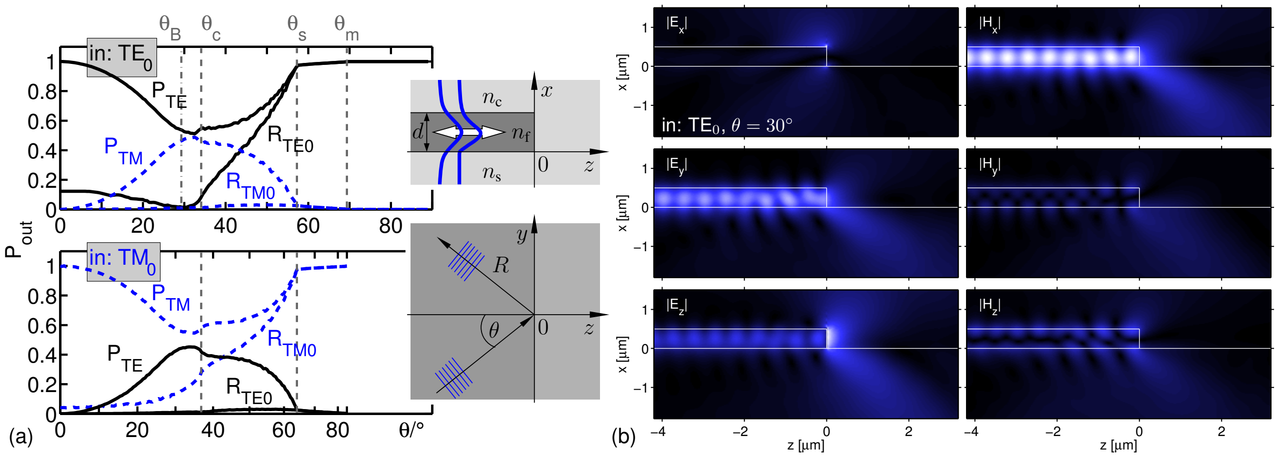
The non-normal incidence of thin-film guided, in-plane unguided optical waves on straight, possibly composite slab waveguide facets is considered. The quasi-analytical, vectorial solutions permit to inspect polarization properties of reflected and refracted guided waves, radiative losses, and full field details near the facet.

Non-normal light incidence on a slab waveguide discontinuity

The effects of a straight transition between regions with different layering, or of a core facet, on thin-film guided, in-plane unguided light forms the basis for a series of classical integrated optical components. While scalar TE / TM Helmholtz equations apply for perpendicular incidence, for non-normal incidence one is led to a vectorial problem [1] that is formally identical to that for the modes of 3-D channel waveguides. Here, however, it needs to be solved as a parametrized, inhomogeneous system on a 2-D computational window with transparent-influx boundary conditions.

Vectorial, quasi-analytical solutions by quadridirectional eigenmode propagation (QUEP)

As a step beyond the scalar approximation [1] and an older bidirectional approach [2], we report on a dedicated vectorial solver for — in principle — arbitrary rectangular cross section geometries, based on simultaneous expansions into slab modes along *two* orthogonal coordinate axes (QUEP, [3]). A review of general aspects (solver specifics, power balance, reciprocity, characteristic angles), will be followed by a discussion of solutions for different configurations, including the example below.



Reflection of semi-guided plane waves at a thin film facet. (a): reflected / outgoing power carried by the TE_0 / TM_0 modes (R_{TE0}, R_{TM0}) and by all TE / TM waves (P_{TE}, P_{TM}) for TE_0- (top) or TM_0-excitation (bottom), versus incidence angle θ; critical angles θ_c, θ_s, θ_m for power being carried away by "cover", "substrate", and TM -fields; quasi-Brewster angle $\tan\theta_B = n_c/n_{\text{eff,TE0}}$. (b): e.m. components (absolute values) for TE_0-excitation at $\theta = 30°$. Parameters: $n_s : n_f : n_c = 1.5 : 2.0 : 1.0$, $d = 0.5\,\mu$m, vacuum wavelength $\lambda = 1.55\,\mu$m.

References

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