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Photon control by multi-periodic binary grating waveguides: A coupled-mode theory approach

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We present a coupled-mode theory (CMT) approach for the description of the modal behavior of planar waveguides with binary corrugations, created by the superposition of multiple binary gratings with varying pitches and fill factors. We present inter-modal coupling results for both, bound and radiating states.

Summary

In order to control the photon emission from thin-film devices, high-index layer structuring is frequently used to increase guided light outcoupling efficiency. Multi-periodic nanostructures, yielded by a logical disjunction of multiple binary gratings, have recently been proposed to achieve simultaneous control over multiple spectral resonance positions and relative intensities [1]. The experimental findings were theoretically backed up by a rigorous coupled-wave analysis (RCWA, [2]) approach, yielding the leaky modes' complex propagation constants and diffraction efficiencies. This approach, however, can only lead to quantitative results outside the device's band gaps, since only radiative propagation loss is calculated.n order to provide more physical and quantitative insight to grating-induced waveguide losses, we implemented a coupled-mode theory (CMT, [3]) approach for the semi-analytical treatment of the corrugated waveguides modal behavior. In this contribution, we present guided-to-guided as well as guided-to-radiation mode coupling in multi-periodic binary grating waveguides.

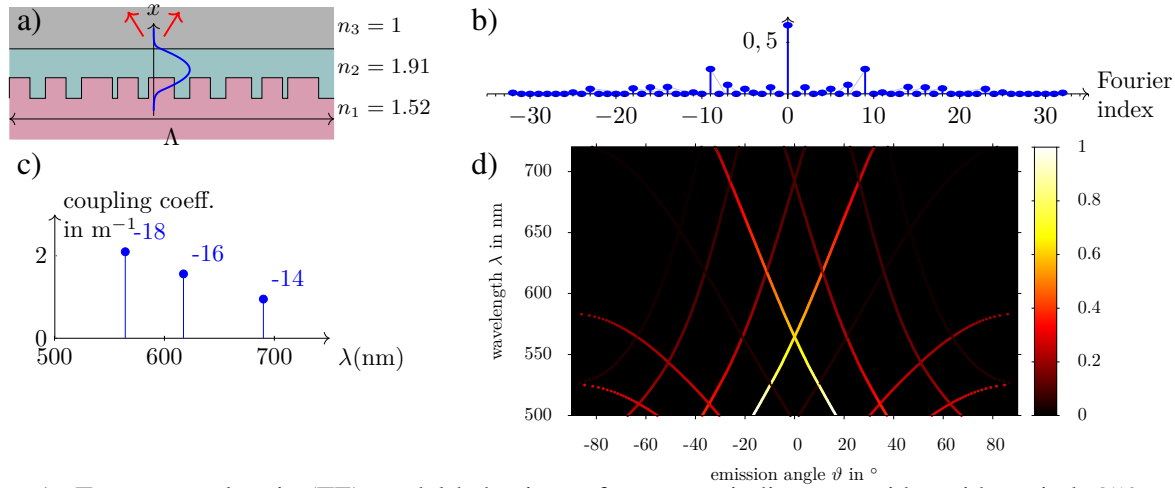

Figure 1: Transverse-electric (TE) modal behaviour of a two-periodic waveguide, with periods 350 nm *and* 450 nm*; a) geometry sketch and* TE_0 *mode profile, b) Fourier index moduli for the two-periodic grating, c)* TE_0 *to* TE_{-0} *mode-coupling coefficients, d) normalized* TE_0 *to radiation-mode coupling coefficients.*

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