A Dimensionality Reduction Technique for Scattering Problems in Photonics

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Optical scattering problems in guided wave photonics are addressed. We represent the unknown optical fields as superpositions of 1D slab modes bounded by PMLs. By applying a variational principle [1], the problems are reduced to lower dimensional systems of differential equations for the unknown coefficient functions, which are solved using the finite elements method. Dirichlet to Neumann maps allow influx to be prescribed and radiation to freely pass the computational window boundaries. Expansions with one or a few modes give a quick, effective index-like approximation [2]; more modes provide more accurate solutions [3]. We give examples for a series of 2-D configurations, where reliable reference data is available [4].

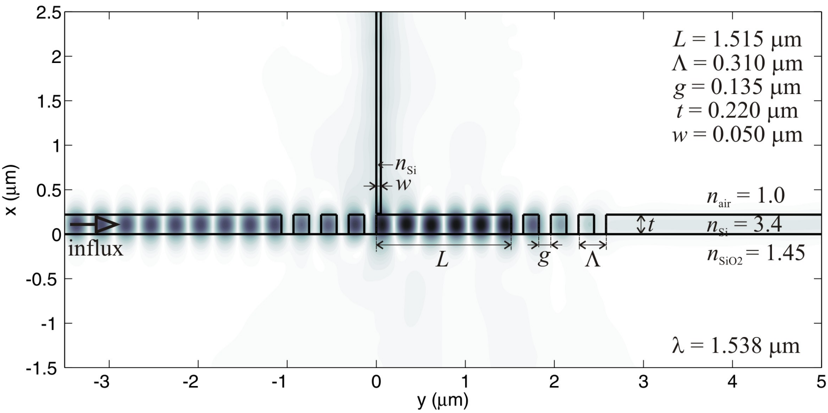

Figure 1. Field profile of the dominant electric field component $E_z(x, y)$ of a resonator, formed by a defect in a 2D waveguide grating, and perturbed by the presence of a thin silicon tip [5]. As influx from the left, the fundamental mode of the waveguide is prescribed. A superposition of sixty 1D vertical slab modes is used to reduce the 2D equation to a system of 1D problems in the horizontal direction.

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