Finite-size Periodic Stacks of Anisotropic Layers: Field Enhancement Effects and Sensitivity Analysis

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Periodic materials composed of two misaligned anisotropic dielectric layers and one isotropic layer produce band edges on the dispersion diagram and can support slow wave propagation at frequencies near those band edges. The band edge can be classified according to the functional behavior of $\omega(k)$ near the band edge frequency, which is essentially determined by geometrical and material parameters. Recently, a *degenerate band edge* (DBE) photonic crystal (PhC) [A. Fitotin and I. Vitebskiy, *Phys. Rev. E*, **72**, 036619, 2005], viz. with a quartic dispersion relation near the band edge, was proposed to further slow down wave propagation compared to a regular band edge (RBE), the latter having a quadratic dispersion relation. To increase the transmittance properties of the DBE PhC (and fully take advantages of slow wave propagation), *finite-size* periodic stacks must be employed to generate (narrow-band) Fabry-Perot resonances. These resonances yield close to unit transmittance. However, the response of both DBE and RBE PhC strongly depends on the incident wave polarization. More recently, Figotin and Vitebskiy proposed a polarization-independent photonic crystal, referred to as a *split band edge* (SBE) PhC, which has a dispersion relation given by the superposition of a quartic term and an opposite signed quadratic term [A. Fitotin and I. Vitebskiy, *ArXiv*, 0705.3495, 2007].

In this work, we numerically analyze Fabry-Perot resonance-assisted SBE PhCs by focusing on the field enhancement effects and on a sensitivity analysis of the response versus geometrical and material perturbations. In addition, we investigate the response under different incident wave polarizations. Note that the consideration of these perturbations breaks the periodicity of the problem and makes the analysis by standard analytical techniques not directly applicable.

This analysis is based upon a newly developed unconditionally stable finite-difference time-domain (FDTD) algorithm that employs a complex envelope representation for the fields and can incorporate lossy anisotropic dielectrics in the formulation. This algorithm is two order of magnitude faster than conventional FDTD for the analysis of the same problem, essentially allowing for a sensitivity analysis to become feasible. (Acknowledgments: This work was supported in part by AFOSR, NSF, and OSC).