Beam shaping and manipulation in photonic crystal structures

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Photonic crystals (PCs) are well known materials mostly due to their band gap properties. Additionally is has been shown, both theoretically and experimentally, that PCs support the propagation of surface waves, provided that they are properly terminated. This termination consists of a corrugated outer periodic layer which may differ in shape and/or lattice constant from the bulk material. Introducing a line defect acting as a waveguide in a bulk photonic crystal structure and properly designing the corrugated layer enables the excitation of the surface states within the band gap. The surface layer alone leads to reduced transmission efficiency along the waveguide axis; nevertheless an additional grating like layer may facilitate the coupling of the surface waves to outgoing propagating waves [1]. The surface energy radiation results in enhanced transmission and directionality of the beam. The key feature of this configuration is the grating layer which under specific conditions, leads to constructive interference of the diffracted waves and beaming. This work investigates and demonstrates how the proper design of the grating layer allows for selective interference and provides control over the beam shape and emission angle. Apart from the PCs, it has been discovered that even a single dielectric layer can support surface states, whereas a surface and grating bilayer may couple the surface states to outgoing propagating waves. Here we also demonstrate both experimentally and theoretically, that such a bilayer dielectric structure allows for the collimation and enhanced transmission of a Gaussian incident beam, while a system of multiple cascading bilayers can sustain the beam for large propagation distances.

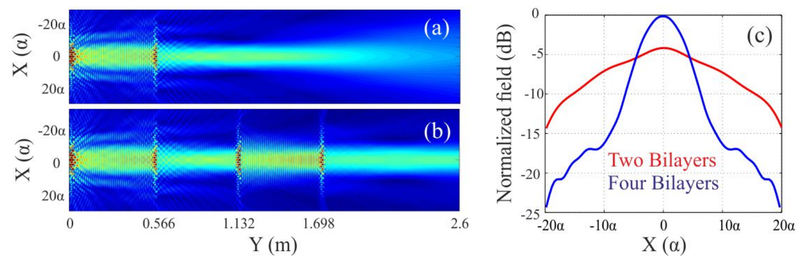

Figure 1: Field strength of (a) two bilayer and (b) four bilayer structure. (c) x cross section field distribution for two and four bilayers at a propagation distance of 100λ.

References [1]

R. Moussa, B. Wang, G. Tuttle, T. Koschny, and C. M. Soukoulis, "Effect of beaming and enhanced transmission in photonic crystals", Phys. Rev. B **76**, 235417 (2007).

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