High efficiency defect-based photonic-crystal-tapers designed by a genetic algorithm

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A method based on a genetic algorithm (GA) is used to design the optimum configuration of defects that when put within a photonic crystal (PhC) taper improve the coupling efficiency between dielectric and PhC waveguides [1]. One of the most popular GAs used in combination with multiple scattering theory is considered [2]. This approach optimises the whole configuration of defects simultaneously and, therefore, takes into account the correlation among the defects. Transmission efficiencies up to 94% have been predicted for a 3µm-wide dielectric waveguide into a single-line defect PhC waveguide. This result significantly improves the transmission efficiency of the same PhC taper without defects. On the other hand, the influence of the PhC-taper length on the coupling efficiency has also been analyzed. It is obtained that resonant modes can be excited when the length of the PhC-taper is increased thus degrading the coupling efficiency. However, these resonant modes can be avoided by carefully designing the PhC taper geometry.

[1] P. Sanchis, *et al* "Experimental demonstration of high coupling efficiency between wide ridge waveguides and single-mode photonic crystal waveguides", IEEE Photon. Tech. Lett., vol. 16, pp. 2272-2274, 2004.

[2] A. Håkanson, José Sánchez-Dehesa, and L. Sanchis "Inversed design of photonic crystal devices", to be published IEEE J. Sel. Areas in Commun, 2005.

Semi-analytic approach for coupling issues in photonic crystal structures

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A semi-analytic approach based on previously derived closed-form expressions for the transmission and reflection matrices between a dielectric waveguide and a semi-infinite photonic crystal (PhC) waveguide [1,2] is proposed for analyzing coupling issues in PhC structures. The proposed approach is based on an eigenmode expansion technique and introduces several advantages with respect to other conventional numerical methods such as a shorter computation time and the possibility to calculate parameters, such as the reflection into PhC structures, difficult to obtain with others methods. Two different examples are analyzed and results compared to finite-difference time-domain (FDTD) simulations to prove the usefulness of the proposed approach: (i) an especially designed two-defect configuration placed within a PhC taper to improve the coupling efficiency and (ii) a coupled-cavity waveguide (CCW) coupled to a single-line defect PhC waveguide by using an adiabatic taper.

[1] P. Sanchis, P. Bienstman, B. Luyssaert, R. Baets, and J. Marti, "Analysis of butt-coupling in photonic crystals", IEEE Journal of Quantum Electronics, vol. 40, pp. 550, 2004.

[2] P. Sanchis, J. Martí, B. Luyssaert, P. Dumon, P. Bienstman and R. Baets, "Analysis and design of efficient coupling in photonic crystal circuits", to be published in Optical and Quantum Electronics.