

Slow light in coupled resonator optical waveguides possessing highly dispersive background media

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Ultra-slow light propagation has been shown in media exhibiting the highly dispersive phenomena called electromagnetically induced transparency (EIT) [1]. Additionally, propagation delays are possible in non-dispersive materials by using a coupled resonator optical waveguide (CROW) structure [2]. In this work, we describe a system which combines these two slow light platforms to enhance the functionality and performance of the CROW structure. The CROW system studied consists of a 2D square lattice photonic crystal (PhC) of high-dielectric rods embedded in an EIT background media. A single rod of the lattice was removed from a unit cell of the structure to create an infinite line of coupled resonator cavities. We used the finite-difference time-domain (FDTD) method to model the system and the Padé approximation with Baker's algorithm to calculate the mode resonance frequency and Q-factor of the structure. For the EIT regions, the FDTD algorithm used an exact, complex two-pole representation of the permittivity [3]. We found that tuning the CROW dispersion relationship can be achieved by adjusting the Rabi frequency of the EIT control field. As the strength of the control field decreased, the CROW band flattened, revealing a slow group velocity in the structure, and eventually zero group velocity at zero control field strength. Our results show that the CROW structure combined with highly dispersive media offers improvement in the reduction of group velocity in these structures.

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