Second-order nonlinear scattering from photonic crystal microcavities

M. W. McCutcheon, J. F. Young, G. W. Rieger, D. Dalacu, S. Frédérick, P. J. Poole, and R. L. Williams,
Department of Physics and Astronomy, University of British Columbia, Ampel Building, Vancouver, Canada

We investigate second-order nonlinear processes in InP planar photonic crystal microcavities. Using a broad bandwidth, short-pulse excitation laser incident normal to the slab, we observe intra- and inter-mode nonlinear mixing from single and two-mode microcavities with Q factors of ~ 4000. We also demonstrate the nonlinear mixing of the resonant modes with a non-resonant, tunable source to generate tunable second-order radiation from the microcavities.

The polarization properties of the second-order radiation are analyzed by measuring the 2D spatial distribution of the far-field radiation with a cooled CCD detector, and comparing the resulting patterns with FDTD simulations. The radiation contains both non-resonant contributions from the laser-slab interaction, and resonant contributions arising from the modes. Although there is a relatively high surface-to-volume ratio in the photonic crystal microcavity, the data are consistent with simulations that use a bulk InP second-order tensor to describe the second-order polarization generated in the microcavity. As a result, the dominant second-order polarization generated by these TE-like modes consists of single or multiple dipoles oriented along an axis normal to the membrane surface. The complex second-order radiation patterns are the result of scattering from the air holes bounding the microcavity.