Numerical Investigation of Vertical Cavity Lasers With High-Contrast Gratings Using the Fourier Modal Method

We explore the use of a modal expansion technique, Fourier modal method (FMM), for investigating the optical properties of vertical cavities employing high-contrast gratings (HCGs). Three techniques for determining the resonance frequency and quality factor (Q-factor) of a cavity mode are compared, and the computational uncertainties in the resonance frequency and Q-factor calculations are analyzed. Moreover, a method for reducing a three-dimensional (3D) simulation to lower-dimensional simulations is suggested, which allows for very fast and approximate analysis of a 3D structure. By using the implemented FMM, the scattering losses of several HCG-based vertical cavities with inplane heterostructures which have promising prospects for fundamental physics studies and on-chip laser applications, are investigated. This type of parametric study of 3D structures would be numerically very demanding using spatial discretization techniques.

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