Optical Simulation of Oxide-Confined Vertical Cavity Surface Emitting Lasers

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The optical properties of oxide-confined vertical cavity surface emitting lasers have recently become a subject of great interest, as the threshold current for such devices has already been pushed to record low values and potentially may drop further. Of interest, then, is an optical simulator which may compare various designs and be useful in determining which oxide configurations are most desirable. We have developed a full-vector cylindrical mode solver based on a novel gain eigenvalue equation. This simulator uses the analytic tensor Green's function of the planar VCSEL cavity to treat scattering loss, diffraction loss, and the open VCSEL boundary with a great deal of accuracy. A relatively small, dense matrix is assembled which describes the interactions between the gain and oxide regions. Once the matrix has been assembled, a wide variety of designs may be quickly analyzed merely by multiplying the matrix by a vector and diagonalizing. The output from the simulator includes the mode field patterns, the gain required to lase, and the lasing frequency for as many modes of the VCSEL as are required. Thus, it is a useful interactive tool for determining the lowest threshold designs, as well as determining which designs are best for single-mode operation. The mode solver will be reviewed, and various oxide confined VCSEL designs of current interest will be compared and contrasted to suggest likely design improvements.

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