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An impact of a localization of an oxide aperture within a vertical-cavity surface-emitting diode laser (VCSEL) cavity on its lasing threshold

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Keywords

semiconductor laser, vertical-cavity surface-emitting diode laser (VCSEL), oxide-confined VCSELs, fundamental-mode operation

Abstract

In the present paper, an impact of localization of an oxide aperture within a vertical-cavity surface-emitting diode laser (VCSEL) on its threshold operation is analyzed. As expected, a shift of the aperture from the anti-node position of the standing optical wave within a VCSEL cavity to the node position is followed by a drastic change of the wave guiding mechanism from the index guiding to the gain guiding. Index-guided VCSELs have been found to exhibit much lower threshold currents, but any increase in their active-region diameters over a relatively low critical value is followed by excitation of higher-order modes. On the other hand, the fundamental-mode operation is achieved in gain-guided VCSELs with much larger active regions but at the expense of considerably higher lasing thresholds. Therefore, a new VCSEL design, *i.e.*, the separate confinement oxidation (SCO) VCSEL, is proposed. The SCO VCSELs are expected to combine advantages of both previous oxide-confined VCSELs, *i.e.*, low lasing thresholds of index-guided VCSELs with the fundamental-mode operation of gain-guided ones even in the case of large active regions.