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# Design and Analysis of Metamaterial Based Vertical Cavity Surface Emitting Laser

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**Abstract :** Distributed Bragg reflectors are used in vertical-cavity surface-emitting lasers (VCSELs) in order to achieve very high reflectivity. Use of metamaterial in place of distributed Bragg reflector can reduce the device size significantly. A silicon-based metamaterial near perfect reflector is designed to be used in place of distributed Bragg reflectors in VCSELs. Mie resonance in dielectric microparticles is exploited in order to design the metamaterial. A reflectivity of 98.31% is achieved using finite-difference time-domain method. An 808nm double intra-cavity contacted VCSEL structure with 1.5 λ cavity is proposed using this metamaterial near perfect reflector. The active region is designed to be composed of seven GaAs/AlGaAs quantum wells. Upon numerical investigation of the designed VCSEL structure, the threshold current is found to be 2.96 mA at an aperture of 40 square micrometers and the maximum output power is found to be 71 mW at a current of 141 mA. Miniaturization of conventional VCSELs is possible using this design.

**Keywords :** GaAs, LASER, metamaterial, VCSEL, vertical cavity surface emitting laser
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