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# Vertically Coupled III-V/Silicon Single Mode Laser with a Hybrid Grating Structure

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**Abstract :** Silicon photonics has gained much interest and extensive research for a promising aspect for fabricating compact, high-speed and low-cost photonic devices compatible with complementary metal-oxide-semiconductor (CMOS) process. Despite the remarkable progress made on the development of silicon photonics, high-performance, cost-effective, and reliable silicon laser sources are still missing. In this work, we present a 1550 nm III-V/silicon laser design with stable single-mode lasing property and robust and high-efficiency vertical coupling. The InP cavity consists of two uniform Bragg grating sections at sides for mode selection and feedback, as well as a central second-order grating for surface emission. A grating coupler is etched on the SOI waveguide by which the light coupling between the parallel III-V and SOI is reached vertically rather than by evanescent wave coupling. Laser characteristic is simulated and optimized by the traveling-wave model (TWM) and a Green's function analysis as well as a 2D finite difference time domain (FDTD) method for the coupling process. The simulation results show that single-mode lasing with SMSR better than 48dB is achievable, and the threshold current is less than 15mA with a slope efficiency of around 0.13W/A. The coupling efficiency is larger than 42% and possesses a high tolerance with less than 10% reduction for 10 um horizontal or 15 um vertical dislocation. The design can be realized by standard flip-chip bonding techniques without co-fabrication of III-V and silicon or precise alignment.

**Keywords :** III-V/silicon integration, silicon photonics, single mode laser, vertical coupling
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