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Temperature-Stable High-Speed Vertical-Cavity Surface-Emitting Lasers with Strong Carrier Confinement

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Abstract : Higher speed short-wavelength vertical-cavity surface-emitting lasers (VCSELs) working at high temperature are required for future optical interconnects. In this work, the high-speed 850 nm VCSELs are designed, fabricated and characterized. The temperature dependent static and dynamic performance of devices are investigated by using current-power-voltage and small signal modulation measurements. Temperature-stable high-speed properties are obtained by employing highly strained multiple quantum wells and short cavity length of half wavelength. The temperature dependent photon lifetimes and carrier radiative times are determined from damping factor and resonance frequency obtained by fitting the intrinsic optical bandwidth with the two-pole transfer function. In addition, an analytical theoretical model including the strain effect is development based on model-solid theory. The calculation results indicate that the better high temperature performance of VCSELs can be attributed to the strong confinement of holes in the quantum wells leading to enhancement of the carrier transit time.

Keywords : vertical cavity surface emitting lasers, high speed modulation, optical interconnects, semiconductor lasers
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