

## Improved Small-Signal Characteristics of Infrared 850 nm Top-Emitting Vertical-Cavity Lasers

**Authors :** Ahmad Al-Omari, Osama Khreis, Ahmad M. K. Dagamseh, Abdullah Ababneh, Kevin Lear

**Abstract :** High-speed infrared vertical-cavity surface-emitting laser diodes (VCSELs) with Cu-plated heat sinks were fabricated and tested. VCSELs with 10 mm aperture diameter and 4 mm of electroplated copper demonstrated a -3dB modulation bandwidth ( $f_{-3dB}$ ) of 14 GHz and a resonance frequency ( $f_R$ ) of 9.5 GHz at a bias current density ( $J_{bias}$ ) of only 4.3 kA/cm<sup>2</sup>, which corresponds to an improved  $f_{-3dB}^2/J_{bias}$  ratio of 44 GHz<sup>2</sup>/kA/cm<sup>2</sup>. At higher and lower bias current densities, the  $f_{-3dB}^2/J_{bias}$  ratio decreased to about 30 GHz<sup>2</sup>/kA/cm<sup>2</sup> and 18 GHz<sup>2</sup>/kA/cm<sup>2</sup>, respectively. Examination of the analogue modulation response demonstrated that the presented VCSELs displayed a steady  $f_{-3dB}/f_R$  ratio of 1.41±10% over the whole range of the bias current (1.3 I<sub>th</sub> to 6.2 I<sub>th</sub>). The devices also demonstrated a maximum modulation bandwidth ( $f_{-3dB max}$ ) of more than 16 GHz at a bias current less than the industrial bias current standard for reliability by 25%.

**Keywords :** current density, high-speed VCSELs, modulation bandwidth, small-signal characteristics, thermal impedance, vertical-cavity surface-emitting lasers

**Conference Title :** ICNED 2017 : International Conference on Nanoelectronics Engineering and Devices

**Conference Location :** Istanbul, Türkiye

**Conference Dates :** December 21-22, 2017