Temperature Effects on the Power Characteristics of Vertical-Cavity Surface-Emitting Lasers (VCSELs)

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Abstract

A numerical analysis on temperature variation effects on the output power ($P_{out}$) characteristics of vertical-cavity surface-emitting lasers (VCSELs) is presented in this paper. While previous works in the literature mostly omitting the thermal effects. The effects have investigated according to the temperature dependence (TD) of the VCSEL parameters instead of the well-known Pankove empirical relationship. Also, unlike many previous studies, the thermal effects on the Auger process ($C$) were taken into account and were not neglected. Besides the temperature, the impact of laser cavity volume ($V_a$ i.e $D$, $L$, $d$), the injection current ($I_{inj}$), and the quality of mirror reflectivity ($R$) also have investigated. Results showed that the rate of decreasing the $P_{out}$ with the increase of the temperature has increased with the increase of the $D$ value compared with the $L$ or $d$ value. In contrast, results shown that the TD of the $C$ is affects the VCSEL performance and it is not correct to neglect its influence. Also, results showed that increasing the $I_{inj}$ value does not lead to a significant increase in the thermal effects on the $P_{out}$. On the other hand, increasing the $R$ value will lead to a significant reduction in the thermal effects and it may be dampening its behavior. Conversely, there is no significant effect when the increase in $R$ value is above 95%.

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