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An impact of the electrical pumping scheme on some VCSEL performance characteristics

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Abstract

A comprehensive theoretical model of an operation of vertical-cavity surface-emitting diode lasers (VCSELs) is used to compare anticipated room-temperature (RT) continuous-wave (CW) performance of three modern VCSEL designs: the MESA VCSEL with the upper ring contact on the upper *p*-side DBR structure and the bottom broad-area contact as well as the single and the double intra-cavity contacted VCSELs. The MESA VCSEL has been found to demonstrate the best mode selectivity because its desired single fundamental mode operation is expected even for the largest 20-μm diameter devices. However its RT CW lasing thresholds are by about 30% higher than those for both intra-cavity contacted VCSELs because of increasing free-carrier absorption and heat generation. Therefore large-size MESA VCSELs cannot operate at higher temperatures and/or for higher operation currents. On the contrary, although both intra-cavity contacted VCSELs ensure single-fundamental-mode operation for smaller devices only, they seem to operate properly also at higher temperatures and operation currents. Therefore, with an exception of some special applications, intra-cavity contacted VCSELs currently seem to be the best VCSEL designs.