Long-wavelength quantum dot lasers: from promising to unbeatable

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Recently, edge-emitting GaAs-based QD lasers operating near 1.3 µm (up to 1.38 µm) have been reported with properties close or superior to those for the best quantum well devices on InP substrates. Maximum output power of 3 W cw at 20 ^{o}C heat sink temperature has been realized.

For applications in telecom, however, vertical cavity surface emitting lasers (VCSELs) are preferable. The advantages of a good beam quality, a possibility of on-chip integration and wavelength tunability, lower operation currents, temperature stability of the wavelength, low cost, planar technology, *etc.* make the VCSEL sector of the market the most quickly growing.

Until recently cost-effective all-epitaxial, single growth run, 1.3 µm GaAs-based VCSELs with competitive parameters were not available. Now, due to the development of the epitaxial and defect reduction techniques, InAs QDs have been proven suitable for GaAs -based VCSELs operating at 1.3 µm. The devices include intracavity contacts, selectively oxidized Al(Ga)O apertures and fully oxidized Al(Ga)O-GaAs distributed Bragg reflectors with the stop-band as wide as 600 nm. These devices have particularly great potential for wavelength-tunable 1.3 µm VCSEL applications.

Continuous wave output power of 0.7 mW, enough for practical applications, has been realized. Extended cw operation lifetimes at 35 ^{o}C heat sink temperature are demonstrated. Maximum differential efficiency is about 40% and the maximum wall-plug efficiency is about 15%. Addition of nitrogen allows to realize QDs emitting in the 1.5-1.6 µm range or to realize 1.3 µm QDs with a smaller average strain in the system.

Review of QD growth approaches in MBE and MOCVD, optical and lasing properties of long wavelength QDs will be given.