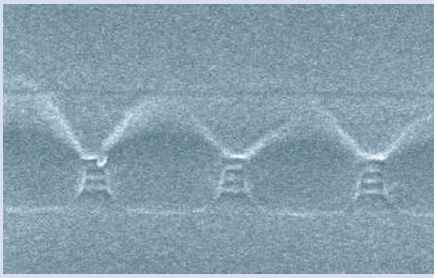
Two-section design provides bistability

Photon. Tech. Lett. **19,** 804–806 (2007)

Optical bistability is important for applications in optical communications and photonic switching. Now lasers with bistable wavelength operation and a very high contrast between modes look feasible, thanks to research carried out by groups in Boulder, USA, led by Mingming Feng. Unlike previous studies that focus on polarization and power stability, Feng and colleagues demonstrate wavelength bistability using a two-section mode-locked laser diode based on self-assembled quantum dots. Their quantum-dot laser has a configuration that is similar to those reported previously, but features a two-section ridge waveguide that can be electrically pumped and reverse-biased simultaneously. By varying the reverse-bias voltage on the absorber, the researchers observe hysteresis and bistability in the lasing wavelength. When optimized, lasing occurs bistably at 1,173 nm and 1,166 nm with a largest switchable wavelength range of 7.7 nm. Two stable outputs with almost identical optical power and pulsewidth and a power–contrast ratio of over 30 dB are achieved. With a switching time of 120 ps, this device is potentially useful for applications that require wavelength switching on a picosecond timescale.

Quantum-wire laser beats the heat

Jpn J. Appl. Phys. **46,** L411–L413 (2007)



To make transmitter modules as cost effective as possible, it is advantageous if they are temperature insensitive, so that the need for a thermoelectric cooler is avoided. Yoshifumi Nishimoto and co-workers from Japan have proposed a design of distributed-feedback (DFB) configuration that allegedly offers a much-improved resilience to changes in temperature.

The device in question is a GaInAsP/InP DFB laser that contains multiple strain-compensated quantum-wire active regions. The 37-nm-wide quantum wires are separated by 247.5 nm. The researchers show that by applying 30–40 nm of detuning, such that the gain peak wavelength of the quantum-wire active regions matches the Bragg wavelength at about 80 °C, stable single-mode operation lasing at 1,587.4 nm, with a constant threshold current and slope efficiency, can be obtained over a wide temperature range (20–80 °C). A submode-suppression ratio of 42 dB at a bias current of 1.2 times the threshold is also achieved. The team observes characteristic temperatures of 95 K and 243 K for the threshold current density and differential quantum efficiency, respectively, which are both higher than those in DFB lasers without detuning. They are confident that a further increase in the characteristic temperature can be realized by increasing the volume of the active region as well as increasing the amount of detuning.

Quantum-cascade efficiency boost

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Terahertz quantum-cascade lasers (QCLs) are semiconductor lasers with emission that is generated from intersubband transitions of a repeated stack of semiconductor superlattices. The development of QCLs with a high electrical-to-optical power-conversion efficiency, also known as wall-plug efficiency, is imperative for applications such as imaging, spectroscopy and chemical sensing. However, so far, the reported efficiency is typically low (no more than 2%). Now, thanks to an idea proposed by Miriam Vitiello and co-workers from Italy and France, this efficiency can be nearly tripled. Their scheme involves high-power QCLs consisting of GaAs/$Al_{0.15}Ga_{0.85}As$ heterostructures. By analysing the local lattice temperature at different electrical power levels, with the aid of microprobe photoluminescence, they observed a peak optical power of 100 mW at an emission frequency of 2.83 THz and a temperature of 4 K. The measured wall-plug efficiency was as high as 5.5% in continuous-wave mode at 40 K. A slope efficiency of 0.41 W A^{-1} was estimated.

Dual-wavelength at multiwatt powers

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For applications such as wavelength multiplexing, frequency down-conversion, two-wavelength interferometry and terahertz-frequency generation, a semiconductor source that emits two powerful coaxial laser beams at different wavelengths is highly desired. Now, a US–German collaboration has come up with a simple and efficient method for making a vertical-external-cavity surface-emitting laser (VECSEL) that is up to the task. The device offers not only dual-wavelength operation but also emission that is both linearly polarized and at the multiwatt power level. The VECSEL developed by Li Fan and colleagues relies on an intracavity tilted Fabry–Pérot etalon and a Brewster window, which are placed between the laser chip and a strongly reflecting flat mirror. By tilting the etalon, the researchers equalize the spectral intensity of each colour as well as optimizing the total output power. Side-mode suppression of over 30 dB with a spectral spacing of 2.1 nm is achieved.

Low-noise quantum-dot lasers

Opt. Express **15,** 5388–5393 (2007)

Semiconductor quantum-dot lasers are attractive because of their potential for very fast dynamics. Now Amir Capua and co-workers from Israel and Germany have studied in detail the impact of nonlinear gain compression on the small signal modulation response and relative-intensity noise (RIN) of a GaAs/InGaAs QD laser emitting near 1,300 nm. Their laser is made up of 15 layers of quantum dots separated by 33-nm GaAs barriers. The wide barriers are needed to increase the nonlinear gain compression coefficient. The researchers show a very flat modulation response with a 3-dB bandwidth of about 6.5 GHz at an optical power of 20 mW. They observe that ultralow RIN can be obtained at high optical powers. At a power of 27 mW, very low RIN, from –158 to –160 dB Hz^{-1}, at frequencies of up to 10 GHz is achieved. With such a RIN, the researchers envisage that their lasers could substitute commercial solid-state lasers for advanced analog fibre-optics transmission systems.