High power CW output from low confinement asymmetric structure diode laser


High power continuous wave output from diode lasers using low loss, low confinement, asymmetric structures is demonstrated. An asymmetric structure with an optical trap layer was grown by metal organic vapour phase epitaxy. Gain guided 50μm wide stripe 1-3mm long diode lasers were studied. 1.8W of continuous wave optical power per uncoated facet was obtained at an injection current of 4.7A (36mW/μm). The threshold current density is 270-400A/cm².

Introduction: High optical power from diode lasers can be obtained using structures designed to realise a low confinement factor in the active region [1-3], about three times smaller than in usual GRIN symmetric structures. An asymmetric design meets this requirement more easily and avoids the limitations related to the thickness of the confinement layers.

This Letter reports results obtained using diode lasers having a low confinement InGaAs/AlGaAs double quantum well (DQW) asymmetric structure with an optical trap layer, grown by metal organic vapour phase epitaxy.

Structure: As the DQW asymmetric InGaAs/AlGaAs structure with optical trap layer was designed for high power continuous wave (CW) operation, the confinement factor is low (Γ = 7.7 × 10⁻⁴) for each of the two 6nm quantum wells. The corresponding spot size is dꜣ = 0.78μm. The quantum wells are bordered by graded layers with a composition index varying from 0.20 to 0.60. The waveguide and the optical trap layer are separated by a 0.1μm thick layer with A1 content x = 0.60. To lower the confinement factor of the structure by shifting the maximum of the optical field away from the active region, we use a 0.22μm thick Al₀.₇Ga₀.₃As 'optical trap' layer on the n-side, as shown in Fig. 1.

The limitation of the optical field extension in the p-side of the structure leads to minimised series resistance and free-carrier losses, which are essential for low confinement laser diodes. A low absorption coefficient, ~1cm⁻¹, which is an important requirement for low confinement laser diode structures [1-3], was obtained using low doped layers.

Experimental results: Gain-guided, 1-3mm long diode lasers were studied. The 50μm wide stripe was defined by shallow 0.2μm wet etching. Uncoated devices were mounted p-down on Cu and diamond heatsinks using In as a solder. The wavelength of the emitted radiation is λ = 970nm at 20°C for a driving current of 4A.

The CW measurement results for the most important parameters (output optical power, voltage and power conversion efficiency) against direct driving current are presented in Fig. 2. The threshold current density for CW operation is 270-400A/cm². The internal efficiency is ~90% and the value of the internal absorption coefficient is very low, ~1cm⁻¹ as deduced from the differential efficiency dependence on device length. The value of the external differential efficiency is 70%. The series resistance is ~2.0 × 10⁵ Ω cm², which is comparable to values reported for the usual GaAs/AlGaAs QW GRIN symmetric structures. The transversal emitted laser beam far field distribution is 25°, FWHA.
for the absorption coefficient, i.e. $\alpha = 1\ cm^{-1}$, and a high COD output power level, i.e. $36\ mW/\mu m$ for uncoated devices, which represents an improvement by a factor of 2.5 times when compared with conventional structures. The threshold current density is ~270–400A/cm$^2$ for 1–3mm long laser diodes.

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References


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Hybrid integrated external cavity laser without temperature dependent mode hopping


The authors propose a new integrated external cavity laser which eliminates temperature dependent mode hopping by employing silicone between the LD and the grating. Operation without mode hopping is experimentally confirmed from 18 to 34°C.

Introduction: External cavity lasers [1] composed of a UV written waveguide grating and an LD are promising light sources for WDM systems because their oscillation wavelength is stabilised to the Bragg wavelength of the grating and is less dependent on temperature than that of conventional DFB LDs.

We have fabricated integrated external cavity lasers in which an LD chip is integrated with a grating written in a silica waveguide [2, 3] and we have also confirmed 2.5Gbit/s direct modulation [4]. However, our lasers have mode hopping every several °C [2] caused by the difference between the thermo-optic (TO) coefficients of the LD and the silica waveguide.

In this Letter, we propose a new integrated external cavity laser which eliminates temperature dependent mode hopping, and we report on its oscillation characteristics.

Construction: In a conventional integrated external cavity laser [2], the oscillation wavelength is determined by the longitudinal mode of the external cavity which is nearest to the Bragg wavelength of the grating. As the temperature increases, the wavelength shifts of the longitudinal mode and those of the Bragg wavelength diverge. As a result, another longitudinal mode becomes the nearest to the Bragg wavelength of the grating and the selected longitudinal mode hops. That is, temperature dependent mode hopping is caused by the difference between the TO coefficients of the longitudinal mode and the Bragg wavelength. To eliminate mode hopping, the TO coefficient of the longitudinal mode must coincide with that of the Bragg wavelength.

Fig. 2 shows the output power against current. The threshold current is 15mA and the optical power is 1mW at an injection current of 60mA. There is no mode hopping with changes in current. Fig. 3 shows the dependence of the oscillation wavelength on temperature. The conventional integrated external cavity laser shows mode hopping every 6.5°C but in our proposed configuration...