High power CW output from low confinement asymmetric structure diode laser
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structure leads to minimised mond heatsinks using In as away from the active region. We use a 0.22 µm thick AlGaAs waveguide and the optical trap layer are separated by a 0.1 µm etching. Uncoated devices were mounted p-down on Cu and diamond heatsinks using In as a solder. The wavelength of the emitted radiation is \( \lambda = 970\text{nm} \) 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 270–400 A/cm². The internal efficiency is >90% and the value of the internal absorption coefficient is very low, -1 cm⁻¹ as deduced from the differential efficiency dependence on device length. The value of the external differential efficiency is 70%. The series resistance is \(-2.0 \times 10^4 \) Ω cm, 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°, FWHMA.

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 270–400 A/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 (\( \Gamma = 7.7 \times 10^3 \)) for each of the two 6nm quantum wells. The corresponding spot size is \( d_\text{eff} = 0.78\mu m \). 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 AlGaAs '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, \( \sim 1\text{cm}^{-1} \), 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 power per stripe width before catastrophic optical damage (COD) for uncoated devices is as high as 36mW/µm, which is 2.5 times higher than those reported for uncoated conventional structures [4]. Even better results should be obtained from mirror coated devices.

The \( T_r \) parameter, which describes the temperature sensitivity of the threshold current, is 175K.

Conclusion: The results presented here clearly demonstrate the possibility of obtaining high power output from diode lasers using low loss, low confinement, asymmetric structures as predicted in [1–3]. This Letter describes also a new semiconductor InGaAs/AlGaAs DQW laser structure for high power CW operation, which uses a separate 'optical trap' layer on the n-side of the active region to meet the requirement for low confinement factor, down to \( 7.7 \times 10^3 \) per QW. The structure shows very low values
for the absorption coefficient, i.e. $\alpha = 1$ cm$^{-1}$, and a high COD output power level, i.e. 36mW/um for uncoated devices, which represents an improvement by a factor of 2.5 times when compared with conventional structures. The threshold current density is $\simeq 270 - 400$ A/cm$^2$ for 1-3mm long laser diodes.

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References


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. 1 shows our proposed configuration for the integrated external cavity laser. The groove in the silica waveguide is filled with silicone [5]. The TO coefficient of silicone is opposite to that of the LD. This matches the coefficient of the longitudinal mode to that of the silica waveguide when the silicone length is optimised. The mode hopping temperature interval is

\[ T = \frac{1}{2(n_{LD}L_{LD} + n_pL_p + n_sL_s)} \left| \frac{1}{m - m_s} \right| \] (1)

The TO coefficient of the longitudinal mode of the integrated external cavity laser is

\[ m = \frac{m_L(n_{LD}L_{LD} + n_pL_p + n_sL_s)}{n_{LD}L_{LD} + n_pL_p + n_sL_s} \] (2)

Here, $m_L$, $m_p$, and $m_s$ are the TO coefficients of the Bragg wavelength of the grating in the silica waveguide; SS-LD and silicone, respectively, and $n_{LD}$, $n_p$, and $n_s$ are their respective refractive indices. The length of the silica waveguide, SS-LD and the silicone-filled groove are $L_{LD}$, $L_p$, and $L_s$ respectively. We can estimate the required silicone groove length using these equations.

Experiment: We etched the silica glass to fabricate a large number of narrow grooves to eliminate insertion loss. There were 15 grooves with a total length of 210μm, and a total loss of less than 1dB.