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References


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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 x 10⁴) for each of the two 6nm quantum wells. The corresponding spot size is d₀ = 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 Al₆Ga₄As '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 x 10⁴ Ω cm⁻¹, which is comparable to values reported for the usual GaAs/AlGaAs GRIN symmetric structures. The transversal emitted laser beam far field distribution is 25°, FWHA.

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 x 10² A/QW. The structure shows very low values for the optical field extension in the p-side of the structure.
for the absorption coefficient, i.e. $\alpha = 1$ cm$^{-1}$, and a high COD output power level, i.e. 36nW/µm for uncoated devices, which represents an improvement by a factor of 2.5 times when compared with conventional structures. The threshold current density is $\approx 270 - 400$ A/cm$^2$ for 1-3 mm long laser diodes.

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