High power CW output from low confinement asymmetric structure diode laser

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structure leads to minimised losses, which are essential for low confinement laser diodes.

The limitation of the optical field extension in the p-side of the structure leads to minimized series resistance and free-carrier losses, which are essential for low confinement laser diodes. A low absorption coefficient, \( \approx 1 \text{cm}^{-1} \), is an important requirement for low confinement laser diode structures. The diffusion constant, \( \mu_{\text{D}} \), is an important parameter, which describes the temperature sensitivity of the threshold current density, \( J_T \).

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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 2.5 Gbit/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

\[ T = \frac{c}{2(\beta n_{pL_D} n_{ld} + \beta p L_P + n_s L_S)} \left| \frac{1}{m} - \frac{1}{m_s} \right| \]  

Here, \( m, m_s, \) and \( m_p \) are the TO coefficients of the Bragg wavelengths of the grating in the silica waveguide; SS-LD and silicone, respectively, and \( n_s, n_p, \) and \( n_{ld} \) are their respective refractive indices. The length of the silica waveguide, SS-LD and the silicone-filled groove are \( L_s, L_d, \) and \( L_r, \) respectively. We can estimate the required silicone groove length using these equations.

Fig. 2 shows the output power against current. The threshold current is 15 mA and the optical power is 1 mW at an injection current of 60 mA. 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...