AlGaInAs-InP C-Band Tunable DS-DBR Laser for Semi-Cooled Operation at 55°C

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Abstract

Digital supermode (DS) DBR lasers utilising an AlGaInAs based active region are demonstrated for full C-band operation (100 by 50GHz spaced channels) at 55°C for semi-cooled applications.

Introduction

Elevated temperature operation of opto-electronic devices is highly desirable to reduce cooling requirements and thereby decrease overall power consumption. This is particularly pertinent for pluggable and small form-factor applications where the power dissipation density within the overall system is high. The target here is semi-cooled operation at 55°C which is around the optimum point for minimising the electrical power required for temperature control over case temperature.

The design and performance of a digital supermode distributed Bragg reflector (DS-DBR) laser based on GaInAsP-InP for complete wavelength coverage over C-band has been reported previously [1]. Here, we describe the results from a DS-DBR with AlGaInAs based active regions on InP. This material system is well known to yield improved high temperature performance and structures have been investigated for operation around both the 1.3µm [2,3] and 1.55µm [4] telecoms wavelength bands. The AlGaInAs material system provides a more favourable conduction-band offset which improves electron confinement at elevated temperatures. The DS-DBR laser, however, requires selected area regrowth which can be problematic for highly reactive Al-containing materials due to oxidation at the surface.

Device Design

The optical gain providing regions of this DS-DBR laser comprise a graded-index separate confinement heterostructure (GRINSCH) AlGaInAs geometry containing four compressively strained quantum wells. During etch and regrowth processing, the etch stage was optimised for this material system and particular attention was given to ensuring that the etched surface was clean prior to the regrowth stage for the tuning sections. The design details of the tuning sections were as reported in *ref.* 1.

Results

The wavelength tuning maps obtained from these devices at 25°C and 55°C are plotted against front and rear grating current settings in figures 1 and 2 respectively.

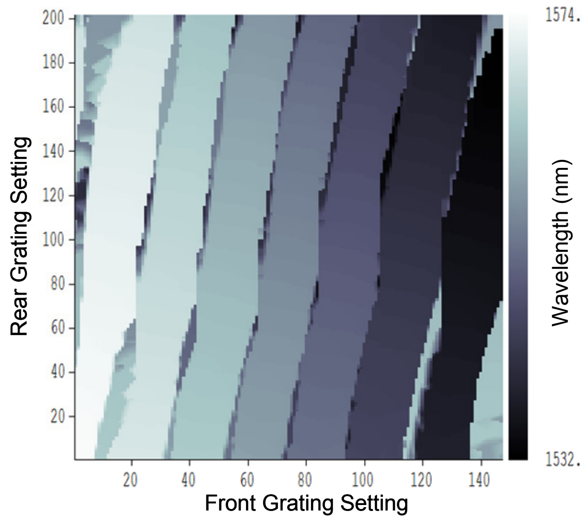

Figure 1: Wavelength map at 25°C.

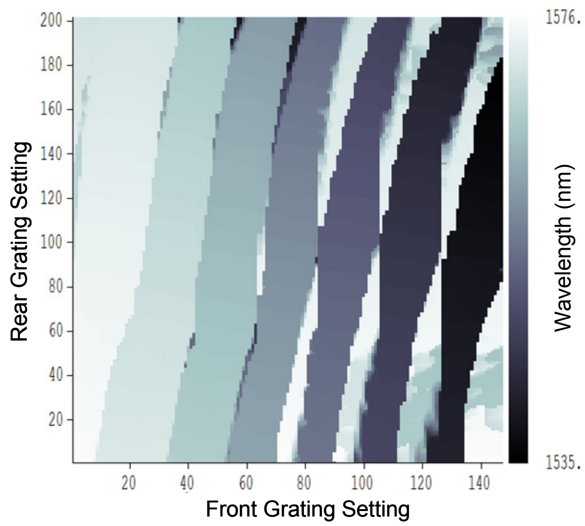

Figure 2: Wavelength map at 55°C.

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At 25°C there are seven evenly matched wavelength bands (supermodes) indicating that the wavelength detuning between the grating reflection response and active region gain spectrum is well optimised at this temperature. There are still seven useable supermodes at 55°C although the detuning is less optimal. This can be readily rectified in future by adjustment of the active region band-gap energy.

The ex-facet output power and side-mode suppression ratio (SMSR) was characterised at all available 50 GHz spaced channel spacing. Figure 3 compares output power at 25°C and 55°C with 150mA applied to both the gain and semiconductor optical amplifier (SOA) sections of the device. The expected wavelength red-shift as temperature is increased is clearly evident. At 55°C there is degradation in performance at shorter wavelengths which is not surprising given the tuning map shown in figure 2. At the long wavelengths, however, the achieved output power is over 40mW. On average there is a 2 dB drop in power from 25°C to 55°C.

The comparison of SMSR between the two temperatures is plotted in figure 4. Although there is an obvious decrease in SMSR as temperature is increased, most channels achieve >40dB at 55°C except those at the extreme short wavelength region of the tuning range.

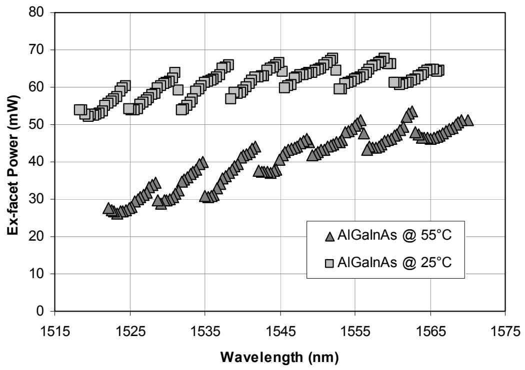

Figure 3: Ex-facet power versus wavelength for AlGaInAs device at 25˚C and 55˚C.

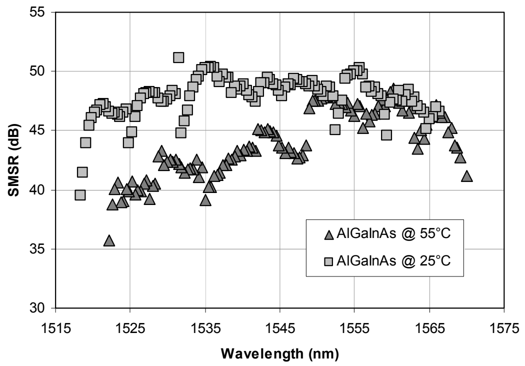

Figure 4: SMSR versus wavelength for AlGaInAs device at 25˚C and 55˚C.

Finally, figure 5 compares ex-facet output power at 55°C between the AlGaInAs based device and a typical example utilising a GaInAsP active region at the same drive conditions. The Al-based device is evidently capable of better power performance at this elevated temperature achieving typically 1 to 1.5 dB greater power across the entire tuning range.

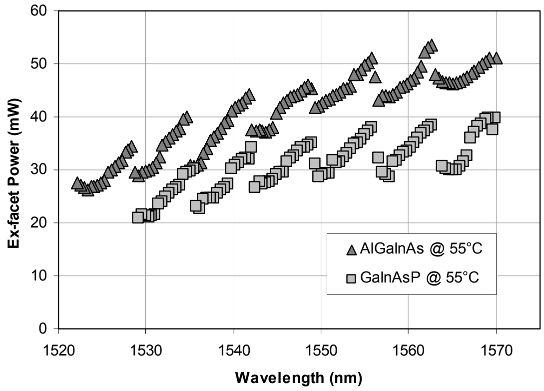

Figure 5: Ex-facet power at 55°C versus wavelength for AlGaInAs and GaInAsP based devices.

Conclusions

We have demonstrated a DS-DBR laser comprising AlGaInAs-InP active regions operating over the full C-band at 55°C. The results were compared to those typically obtained from a standard GaInAsP-InP structure and shown that there are clear performance advantages to be gained in using the Al-based material for elevated temperature operation. Further improvements can be achieved by optimising the band-gap energy of the active regions for a given operating temperature. The results also indicate that the etch-and-regrowth processing of the Al-containing active region has yielded good optical quality butt-joins.

Acknowledgement

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