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High-Power Multiple-Quantum-Well Distributed Feedback Laser Arrays and Fabry-Perot Laser Arrays at 1.5 μm Wavelength

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ABSTRACT

We report on coherent high-power 12-element laser arrays of both the DFB and FP types. Pulsed emission up to 450 mW/facet and CW output to 85 mW are demonstrated with a single-wavelength spectrum for DFB arrays and multi-mode output from FP arrays.

The semiconductor laser array has been widely investigated for achieving high power coherent emission in the short wavelength regime from 0.8 to 1.0μm [e.g., 1-4]. However, there are only a limited number of reports of laser arrays at 1.3μm and 1.55μm [5,6]. We report in this paper 12-element InGaAs/InGaAsP multiple-quantum-well (MQW) laser arrays of both the distributed feedback (DFB) and the Fabry-Perot (FP) resonator types, and demonstrate high power emission at 1.5μm wavelength. Low threshold, single wavelength oscillation was observed for the 12-element DFB laser arrays.

The laser arrays were grown by metal-organic vapor phase epitaxy (MOVPE) and were fabricated using a self-aligned-contact ridge-guide structure [7]. Figure 1 shows the DFB laser structure and a schematic of the 12-element array. The FP laser array has a similar structure, but without the grating. The lasers have a SCH-MQW InGaAs/InGaAsP/InP active region with four compressively strained quantum wells. A combined dry-wet etch technique [7], which has demonstrated excellent process uniformity, was used to fabricate the arrays. The ridge guides in the array are 2.5μm wide (with vertical side walls), and they are separated by 3.5μm. Both evanescent wave coupling and optical gain in the inter-element regions (due to current spreading) can contribute to phase-locked operation of the ridge guide arrays.

The pulsed L-I curves at room temperature for a DFB array (350μm length) and a FP array (500μm length) are shown in Fig. 2. The output reaches 450 mW/facet for both laser arrays with uncoated facets. The FP arrays have thresholds in the 200 mA to 400 mA range, and external differential efficiencies approach 40%. The threshold currents of DFB arrays range from 120 mA to 250 mA. The lowest threshold, corresponding to 10 mA/emitter, is consistent with the 10 mA threshold of discrete DFB lasers fabricated from the same wafer. The CW L-I curve for a DFB array with 180 mA threshold is shown in Fig. 3. The CW output of 85 mW is thermally limited.

The DFB laser arrays oscillate with a single longitudinal mode above threshold. Figure 4a shows a typical single-line spectrum from a DFB array. This is in contrast to the multimoded spectrum from a FP laser array shown in Fig. 4b. The far-field patterns of the laser array chips exhibit either a dominant lobe or multi-lobes with narrow ($\sim 5°$ width) peaks, indicating coherent coupling between array elements, as can be predicted by a simple diffraction model.

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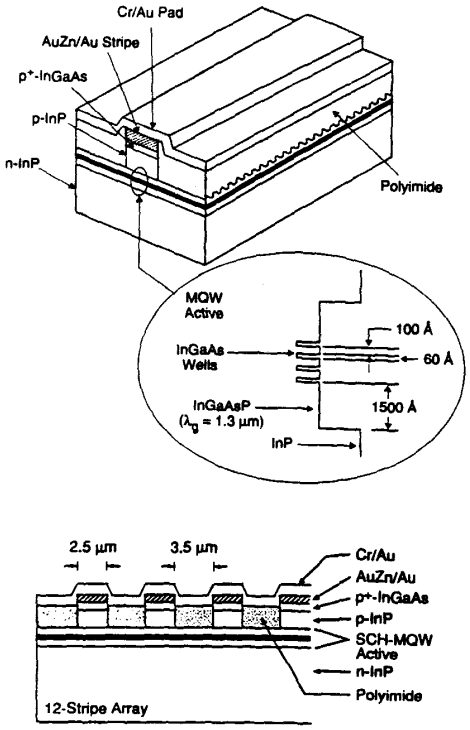

Fig. 1 Schematic of the DFB laser and the array geometry. (FP array has similar structure, except no grating).

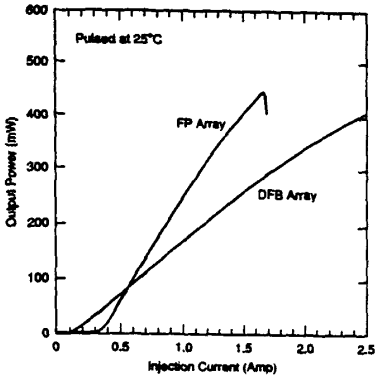

Fig. 2 Pulsed L-I curves of a DFB laser array and a FP array.

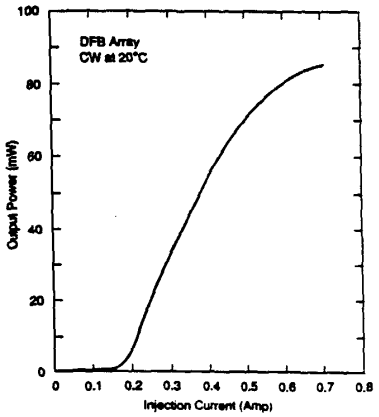

Fig. 3 CW L-I curve of a DFB array at 20°C.

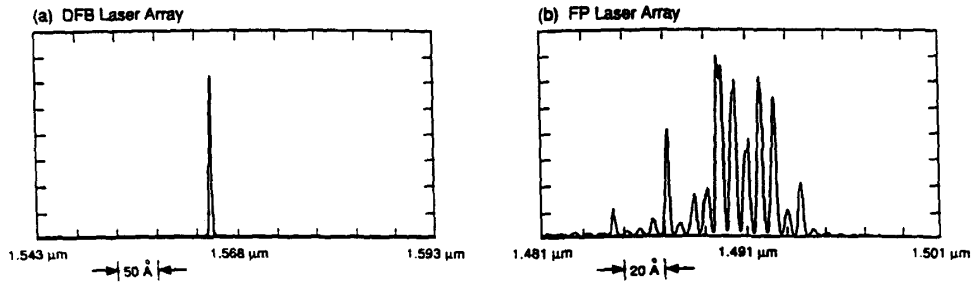

Fig. 4 Emission spectra from (a) a DFB array and (b) a FP array.