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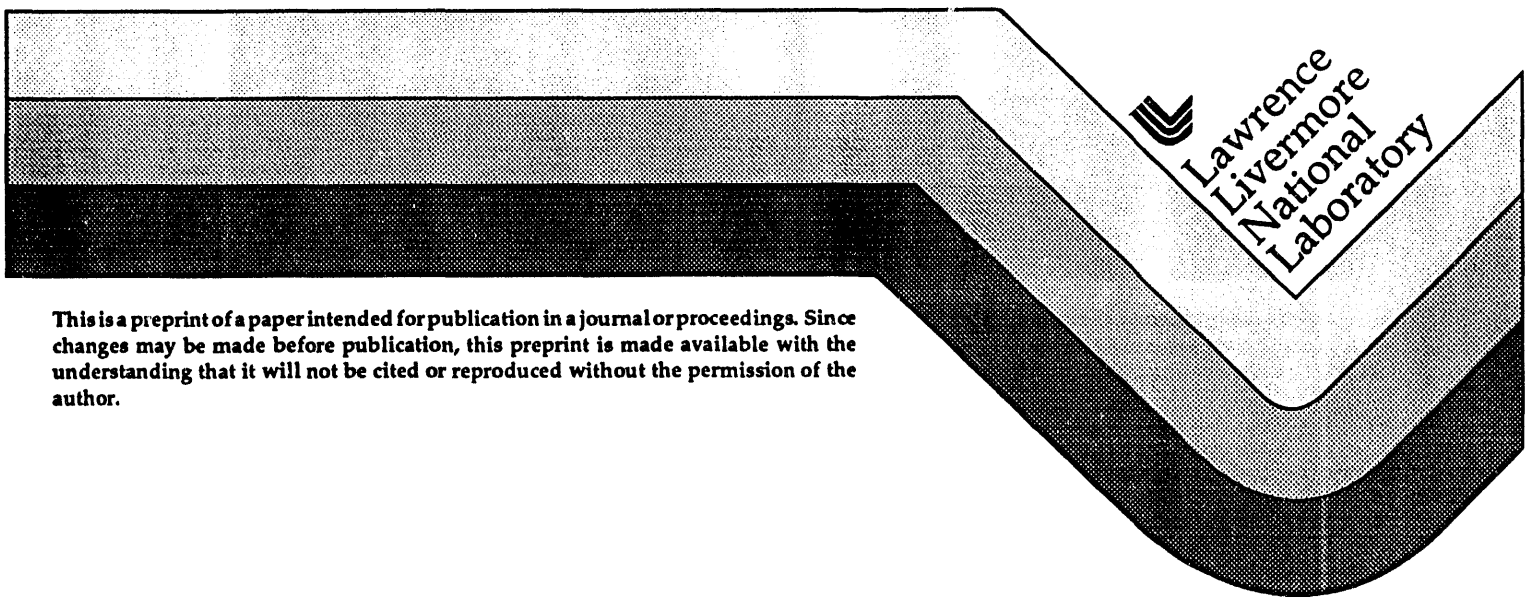

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Abstract

We report 40 W cw power output with 40% power conversion efficiency from an AlGaInP diode laser array mounted on a microchannel cooled heatsink.

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High-power visible diode lasers in the 630-690 nm wavelength range are important for applications in photodynamic therapy, and are required for pumping single-frequency, tunable Cr:LiSAF solid-state, laser sources which are planned for the DIAL laser-radar systems that are to be used for monitoring global climate change. Silicon microchannel cooled heatsinks have been show to be a superior technology for meeting the requirements for high-average power pump arrays.[1] To assess the high-power potential of AlGaInP diode-laser arrays for such applications, we have fabricated and mounted 1 cm wide AlGaInP diode bars on silicon microchannel coolers. Under cw operating conditions at a wavelength of 684 nm, these arrays have typically demonstrated 40 W power output with 40% power conversion efficiency, as illustrated in Figure 1. Although, one array with a lower power-conversion efficiency of 25% was successfully operated at 60 W cw power output. These performance characteristics represent the highest cw power output and conversion efficiency reported, to date, for a visible AlGaInP diode-laser array.

The laser structure, grown on a GaAs substrate, was comprised of a 1 μm thick $Al_{0.5}In_{0.5}P$ n-clad layer, a 0.14 μm thick $Al_{0.6}GaIn_{0.5}P$ undoped confinement layer, an 80 Å thick $GaIn_{0.57}P$ quantum well, a 0.14 μm thick $Al_{0.6}GaIn_{0.5}P$ undoped confinement layer, a 1 μm thick $Al_{0.5}In_{0.5}P$ p-clad layer, a 0.05 μm thick $GaIn_{0.5}P$ cap barrier layer, and a 0.2 μm GaAs cap

layer. The array elements were defined by 100 μm wide openings in SiO_2 and were placed on 140 μm centers. Isolation trenches were etched between each element of the array. The wafer was cleaved to give 1 cm wide bars with cavity lengths of 800 and 500 μm long cavity. A reflectivity coating of > 95% was used for the high-reflect facet and a 10% reflectivity was used for the output facet. The cw operating characteristics of an array with an 800 μm cavity length appear in Figure 1. At an inlet coolant temperature of 15 °C, the spectral output under cw operation of this device was 685.4 nm with a bandwidth at full-width half-maximum of 1.5 nm. At the same coolant temperature, for low-duty pulsed operation with a 1 Hz rep rate and 5 μsec pulse lengths, the device operated at a wavelength of 676.4 nm. Under high-repetition rate pulsed operation at a 10% duty cycle with 100 μsec pulse lengths, peak power outputs in excess of 70 W were observed from 500 μm long cavity arrays. The power-current characteristic for pulsed operation is shown in Figure 2 and the corresponding power conversion efficiency curve is presented in Figure 3. The maximum power output is over 70 W and the corresponding power conversion efficiency is 42%. Reliability and lifetime issues will be discussed and results will also be presented on the performance characteristics of two-dimensional arrays of AlGaInP diode lasers.

The record cw and pulsed performance characteristics displayed by the AlGaInP diode-laser arrays mounted on silicon microchannel heat sinks meet the requirements for applications in photodynamic therapy and pump sources for single-frequency, tunable Cr:LiSAF solid-state, laser systems.

References

1. R. J. Beach, W. J. Benett, B. L. Freitas, D. Mundinger, B. J. Comaskey, R. W. Solarz, M. A. Emanuel, "Modular microchannel cooled heatsinks for high average power laser diode arrays," IEEE J. Quantum Electron. 28, 966-975, (1992).

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Figure 1. The cw power-current characteristic of a 1 cm wide by 800 μm long cavity AlGaInP diode-laser array under cw operation.

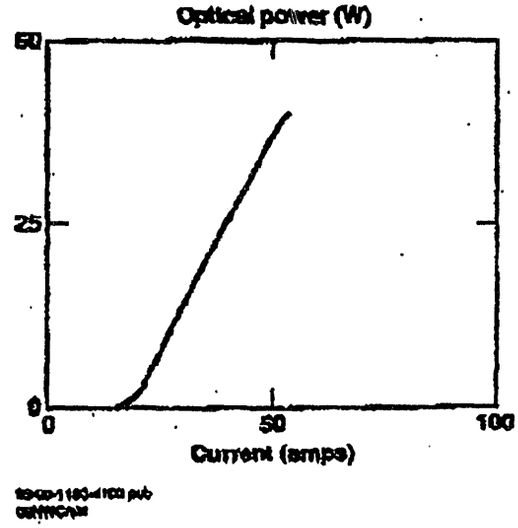


Figure 2. The cw power-current characteristic of a 1 cm wide by 800 μm long cavity AlGaInP diode-laser array under cw operation.

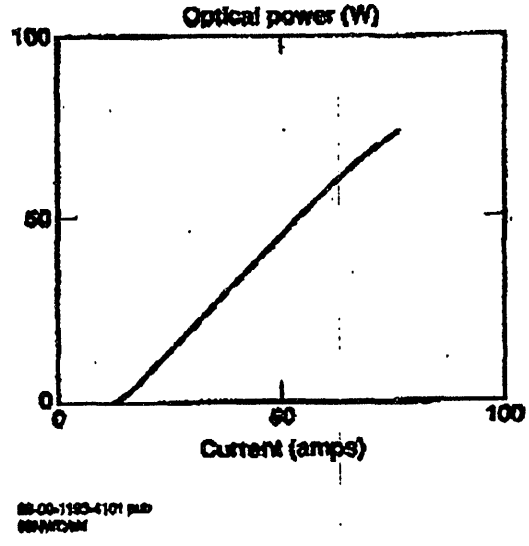
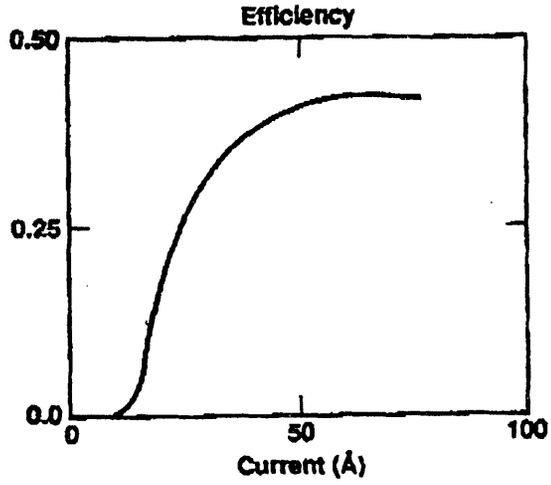


Figure 3. The power conversion efficiency versus current curve of a 1 cm wide AlGaInP diode-laser array under cw operation.



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