Enhancement of Coherence and Intensity in a Broad-area Semiconductor Laser Array with Injection Locking*

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The need for high-power semiconductor laser sources has been considerably increasing in recent years due to their potential application to free-space optical communication, optical measuring, and material processing. Although broad area lasers (and/or laser arrays) provide high-power output (on the order of tens of watts), high order transverse modes and an incoherent phase relationship between individual lasers largely deteriorate the beam quality and therefore limit the usefulness of these high-power lasers in many applications.

Theoretical investigation shows that coherent coupling of N lasers results in total output intensity proportional to the square of N. In this paper, we describe a method of enhancing coherence and intensity of a broad-area laser array. We experimentally demonstrate injection locking of a few multi-mode broad-area laser diodes assembled on a compact laser array with a single-mode laser diode. The laser array used in the experiment has 19 broad-area laser diodes, each one is capable of emitting output power of the order of 1W. The wavelength of each laser is around 808 nm with a spectral width about 1 nm. The injection laser is a single-mode wavelength tunable laser with 1 MHz linewidth and output power of 30 mW. The output from the master laser is passed through a 60 dB optical isolator and then split into multiple beams, each injected into a different broad-area laser of the array. Experimental results demonstrate that multiple diodes are injection-locked simultaneously to the same injection frequency. When injection locking occurs, most of the output power is concentrated on one longitudinal and transverse mode determined by the injection. A considerable improvement on both temporal and spatial coherence is verified.

In summary, injection-locking of multiple broad area lasers is observed and a dramatic enhancement of the total power density of the laser array is achieved by appropriately coupling output beams from different diodes.

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