半導体レーザーからの狭線幅高ピークパワー光パルスの発生

High-peak-power narrow-bandwidth laser pulse generation from semiconductor lasers

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INTRODUCTION High-peak-power smooth-shaped and narrow-bandwidth optical pulses in sub-nanosecond and nanosecond regions have many applications such as LiDAR, bio-imaging, and material processing [1,2]. However, at present, there are no good lasers to generate such optical pulses with simple operation. Gain-switched laser diode (GS-LD) is commonly used to generate short pulses (<100ps) with a peak-power of tens of milliwatt [2]. In this paper, we describe a study to generate high-peak-power (~1W) smooth-shaped optical pulses having a temporal duration of sub-nanosecond to a few nanoseconds by intensive GS operation under CW laser light injection.

EXPERIMENT AND RESULTS A Fabry-Perot LD (FP-LD) was gain-switched by an electric pulse generator producing nanosecond to a few nanosecond pulses with maximum voltage of 37V at 1MHz repetition rate. Figure 1(a) shows an optical pulse temporal waveform for the conventional GS operation without laser light injection. A typical feature of GS spike can be observed in the initial portion of the waveform. At this time, the pulse width of the electrical pulse was 2.3ns and the driving voltage was 26V; the peak power of 0.3W for sharp spike and the pulse energy of 0.7nJ was confirmed. Therefore, it is expected that the narrow-bandwidth watt-level peak-power optical pulses could be obtained by incorporating optical injection locking. In the experiment, CW laser light was produced by a distributed-feedback LD (DFB-LD) under constant DC current excitation. Temperatures of two LDs used were separately controlled. Figure 1(b) shows the optical pulse waveform in the case of the injection locking situation. We can observe the single-envelope pulse shape and the initial GS spike is suppressed after CW laser light injection. The peak-power was estimated to be 0.23W. The quasi-single-mode spectral feature was observed as shown in Fig. 2(b). It is to be noted that under different operation conditions, we have observed the generation of burst optical pulses [3] instead of single-envelope optical pulses. We expect that further detailed studies can enable the generation of duration controllable multi-watt peak-power single -envelope optical pulses.

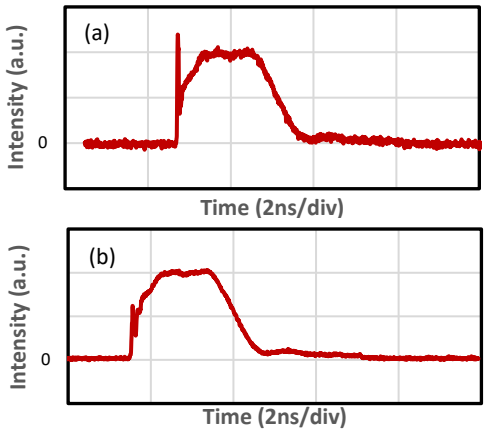

Fig. 1. Temporal waveforms for the optical pulses generated from an FP-LD under intensive GS operation: (a) without and (b) with CW laser light injection. Comparing (a) and (b), the initial GS spike is suppressed after CW laser light injection. Operation conditions: electric pulse width: 2.3ns, voltage: 26V, injection laser light power: 1.2mW.

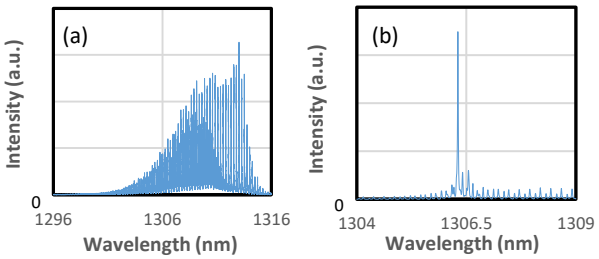

Fig. 2. Optical spectra for the GS operated FP-LD: (a) without and (b) with CW laser light injection.

References:

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