Amplification and nonlinear wavelength conversion of the burst optical pulses generated from a semiconductor laser

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INTRODUCTION High-peak-power and narrow-bandwidth optical pulses in sub-nanosecond and nanosecond regions have many applications such as LiDAR, bio-imaging, and material processing [1-2]. We have demonstrated 40-W peak-power, sub-nanosecond duration, 0.65μm optical pulse for stimulated-emission-depletion (STED) nanoscopy application [3]. This technology is based on the gain-switching of a semiconductor-laser optical amplifier (GS-SOA) for generating smooth-shaped sub-nanosecond optical pulse, the optical pulse amplification and the second-harmonic-generation (SHG) wavelength conversion. In a recent report, we have shown a novel method to generate sub-nanosecond burst-optical-pulses (BOPs) from a gain-switched laser diode (GS-LD) under continuous laser light injection [4]. In the present paper, we describe that the BOPs have potential applications even more than the single-envelope sub-nanosecond or nanosecond optical pulses.

EXPERIMENT and RESULTS In the experiment, 1.06-μm BOPs (shown in Fig.1 (a)) were generated from a pulse-driven Fabry-Perot (FP) LD incorporating the injection of CW laser light generated from a distributed-feedback LD (DFB-LD) at 10-MHz repetition rate. The averaged output power of the BOPs from the FP-LD was 37 μW, and we amplified these to average power of 2.2 W. As shown in Fig.1 (b), there were no apparent changes in temporal waveforms (and in optical spectrum: not shown here) after amplification. The amplified BOPs were converted to 0.53-μm SH pulses by using a bulk periodic-poled stoichiometric lithium tantalite (PPSLT), and we confirmed an SHG conversion efficiency of over 60%. The BOP waveform after SHG was shown in Fig.1 (c), and the entire burst duration was kept 490 ps; this was determined by 4 periods of optical pulses inside. All the BOPs were stably generated without obvious intensity fluctuation. Based on the results described here, it is expected that the present BOP technology is also useful for other nonlinear wavelength conversion techniques such as higher-order harmonic generation and optical parametric generation.

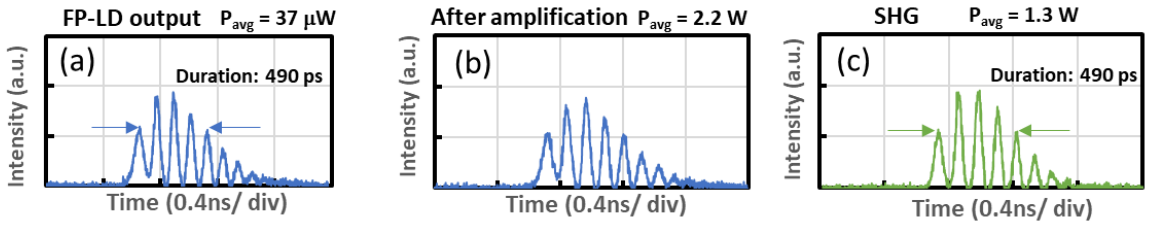

Fig. 1. BOP oscilloscope waveform traces in SHG experiment. (a) The seed pulse just after FP-LD, (b) after amplification, and (c) SHG pulse. No averaging applied when taking above data.

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