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CThR3 3:00 pm

Polarization-maintaining, Harmonically Modelocked Soliton Fiber Laser with Repetition Rate Stabilization Using Optical Pumping of a Saturable Bragg Reflector

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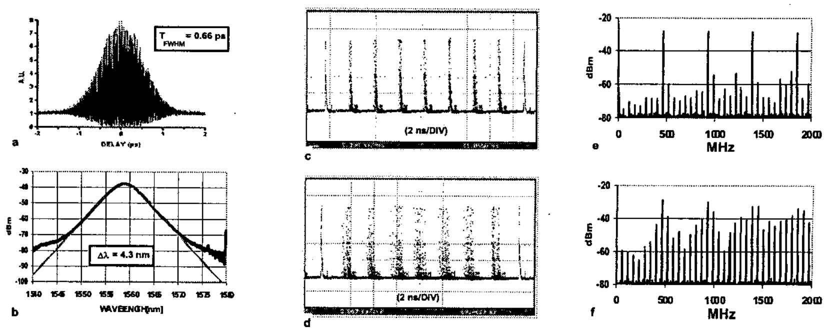
The interest in ultrafast, high repetition-rate laser sources continues to develop as a result of their growing usefulness, particularly in broadband lightwave systems.[1,2] The saturable Bragg reflector (SBR) modelocked fiber laser is a likely candidate in such systems because it exhibits attractive features such as self-starting capability, simplicity, and ability to generate femtosecond, high repetition rate pulse trains through soliton harmonic modelocking.[3] Unfortunately, data modulation is problematic with these lasers because they typically do not exhibit a fixed polarization state, and previous efforts for achieving such have been limited to low repetition rates with only a single pulse in the cavity.[4,5] Excessive timing jitter also arises in these lasers because even spacing between pulses relies primarily on weak, passive gain depletion and recovery effects.[6]

This work addresses these two constraints in a new SBR laser design shown in Figure 1 that utilizes a single, ~1 m piece of anomalous dispersion (D = +14.5 ps/nm/km at 1560 nm), polarization-maintaining (PM) panda erbium fiber in the cavity to achieve for the first time to our knowledge soliton harmonic modelocking at well-defined harmonic repetition rates. This soliton laser does not require any dispersion compensating elements which introduce splice losses and also increase the cavity length.[3] Additionaly, we accomplish timing jitter suppression by optical pumping above the SBR absorber bandgap similar to[7] but using a more robust approach that applies the optical feedback signal to the SBR via the output coupler designed with high transmissivity at the stabilization wavelength. This method is simpler to align and it eliminates polishing the SBR backside.

A significant improvement is observed in the quality of the pulse train with the laser running at 463 MHz (the eighth cavity harmonic) and the stabilization at 1.388 GHz (the 24th cavity harmonic). Parts (c) and (d) of Figure 2 displays digital sampling scope traces triggered with a 1-by-8 frequency divider showing a reduction in root-mean-square timing jitter from 280 to 53 ps (7.3 dB). The RF spectrum of the modelocked pulse train in (e) and (f) of Figure 2 also shows jitter correction by an improvement from 0 dB to 23 dB in the suppression of the non-modelocked harmonics below the modelocked harmonics. The less drastic improvement in the laser timing characteristics compared to[7] may be due to low gain which necessitates high population inversion throughout the fiber that weakens the gain depletion effects,[3,8] and by nonabsorbed 980 nm pump radiation that bleaches the differential reflectivity in the SBR. Larger jitter reduction could be obtained by using more heavily doped PM erbium fiber, filtering the 980 nm light, and/or adding more quantum wells to the SBR.

In conclusion we have demonstrated a soliton harmonically modelocked PM SBR laser with built-in dispersion compensation, a robust polarization output state, pulsewidths in the 400 to 700 fs range, and 7.3 dB timing jitter reduction from stabilatex cleolization of the SBR. The authors acknowledge and thank Dr. Shu Namiki for providing the PM erbium gain fiber.



CThR3 Fig. 2. Typical autocorrelation (0.66 ps) (a) and corresponding measured and predicted ($sech(\lambda)^2$) optical spectrum (b) observed in the laser; together these yield a time-bandwidth product of 0.356. The digital scope trace and RF spectrum with stabilization (c, e) and without stabilization (d, f), respectively.

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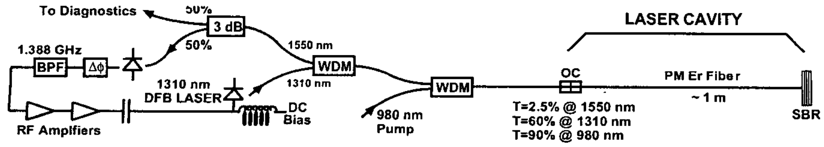

CThR3 Fig. 1. Schematic of the stabilized PM SBR fiber laser. The 1310 nm DFB laser functions as the feedback signal. OC, output coupler; SMF, single mode fiber; SBR, saturable Bragg reflector; WDM, wavelength-division multiplexor: BPF. electrical bandpass filter.

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A Novel All-optical Actively Mode-locked Semiconductor-fiber Ring Laser Based on Gain-transparent Semiconductor Optical Amplifier

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Recently, the study of the generation of short pulses at high repetitive rates and all-optical signal processing exploring the nonlinear effects of