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P8-High-power ultrafast InN-based all-fiber laser

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Ultrafast fiber lasers can be applied to a wide variety of applications, including laser micromachining, material processing, surgery, and electronics. Ultrashort pulses can be generated in an inexpensive and simple manner using mode-locked lasers, which have demonstrated greater characteristics, including efficiency, stability, and ease of implementation.1 Furthermore, fiber lasers operating at 1550 nm are compatible with optical communications systems since they are located within a spectral range with a minimum loss region. In this work an all-fiber resonator cavity has been employed for high-power ultrafast mode-locking laser development, based on an InN semiconductor saturable absorber mirror (SESAM) using a graded-index (GRIN) lens as the fiber coupling device.[2] The rest of the fiber components are based on standard single-mode fiber (SMF) and erbium-doped fiber amplifier (EDFA) with a total length of 50 m and a dispersion coefficient of -0. 21 ps^2, thus working in the anomalous dispersion regime as a dispersion-managed cavity. This assembly permits to reduce the insertion losses generated by open-path configurations, as well as to increase the efficiency of the saturable absorber, leading to ultra-stable sub-100 fs optical pulses centered at 1560 nm with a maximum peak power of 65 kW. However, in order to increase the optical power within the fiber laser cavity, we here propose to change the length of the cavity, and thus the emission repetition rate, by adding additional fiber spans of SMF. The stability of the femtosecond pulse duration, spectral bandwidth and repetition rate has been analized for different lengths ranging from 50 m (original set-up) to up to 4km, as depicted in Fig. 1 (a), (b) and (c) respectively. The minimum temporal duration was measured for the fundamental mode for the original set-up with a value of 92 fs (42 nm in the spectral domain) and a repetition rate of 5. 2 MHz, whereas a maximum of 180 fs (20 nm of spectral bandwidth) is obtained when a fiber span of 4 km is incorporated with a repetition rate of 50 kHz. This suggests that the dispersion coefficient is sufficiently high as to deteriorate the quasi-soliton beahvior of the optical pulse propagation through the laser cavity. Furthermore, the central wavelength of the optical pulse is blue-shifted, due to the increase of the dispersion effects within the SMF. However, it can also be seen that as we increase the length of the laser cavity, a higher contribution of the continuous component is measured on the optical spectrum as we approach to the wavelength of the amplified spontaneous emission (ASE) of the EDFA. These effects are translated in a higher chirp estimated from the time-bandwidth product (TBP), ranging from 0. 44 to 0. 64 for the original and the 4 km fiber span configurations respectively. In relation to the peak power, it has been possible to increase the value from the original case, with a peak power of 65 kW to its maximum value of 1. 08 MW for the 4km-long cavity at the output of the ring fiber resonator cavity. In summary, we here expose preliminary results of ultrafast pulse generation at high optical powers by the addition of SMF optical fibers to the ring fiber laser cavity based on the InN SESAM coupled to a GRIN-to-fiber device. The decrease of the insertion losses, along with the reduction of the repetition rate, leads to high peak powers of up to 1 MW.

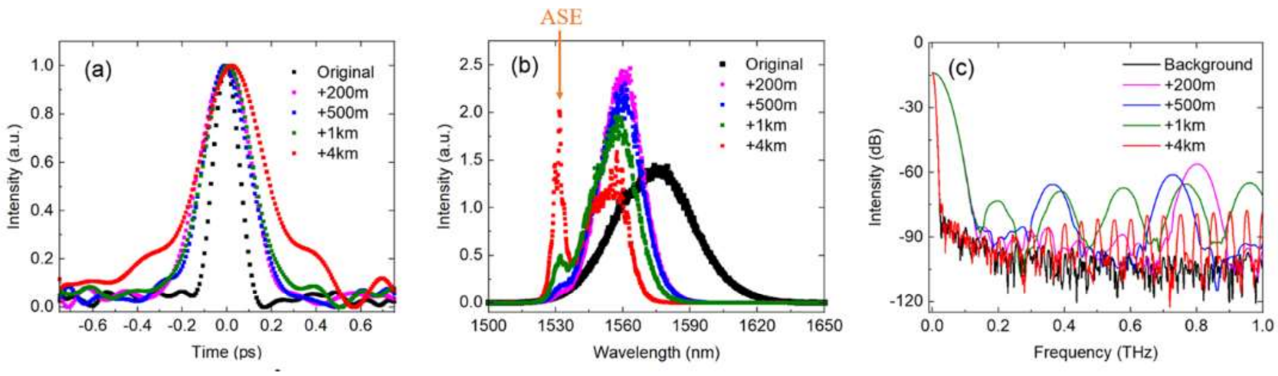

Figure 1. Autocorrelation (a), spectrum (b) and repetition rate (c) results for each fiber span of the laser cavity.

REFERENCES

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