3.5-W, 42-MHz, Single-Mode Chirped Pulse Amplification Fiber Laser System at 1560 nm

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There is much interest in the development of high power ultra-short fiber laser systems due to their significant properties and applications. Among them, Er-doped fiber lasers are showing more attention, especially in silicon processing and photovoltaic industries [1]. Chirp pulse amplification (CPA) is the most common approach to stablish high-power/high energy fiber lasers [2].

Here, we demonstrate a CPA fiber laser system operating at 1560 nm. The system provides 3.5 W average output power at 42 MHZ pulse repetition rate corresponds to 83 nJ pulse energy. The laser system comprises a passively mode-locked oscillator and two amplifier stages, where the power amplifier is based on cladding-pumped 10 µm-core EY co-doped fiber. The output pulses are compressible to 180 fs by using of two compressor gratings. The schematic of experimental setup is shown in Fig. 1(a). Seed source is a home-built dispersion-managed passively mode-locked oscillator delivering 5-ps long pulses at 42 MHZ repletion rate and 8 mW average power. We are using 70-cm long positive dispersion fiber (OFS, β_2=56.7 fs^2 /mm) after the gain fiber to manage group velocity dispersion delay (GDD) of the cavity and achieve broad spectrum. The output from oscillator delivers to stretch fiber including a 10-m long fiber (OFS). 30-ps long pulses after that delivers to the first stage amplifier, which consists of 1-m long Er 80-4/125 (CorActive) pumped by a single-mode diode laser at 976 nm via a wavelength-division-multiplexer (WDM). The first stage amplifier generates 120 mW of average power. The power amplifier is based on 1.4-m long Er-Yb co-doped fiber with 10 µm core and 128 µm cladding diameter. The pump source is a 16-W wavelength-stabilized diode laser at 976 nm. The pump and signal are combined with a multimode pump signal combiner (MPC). A 10/128 fiber pigtailed collimator is used to collimate output beam.

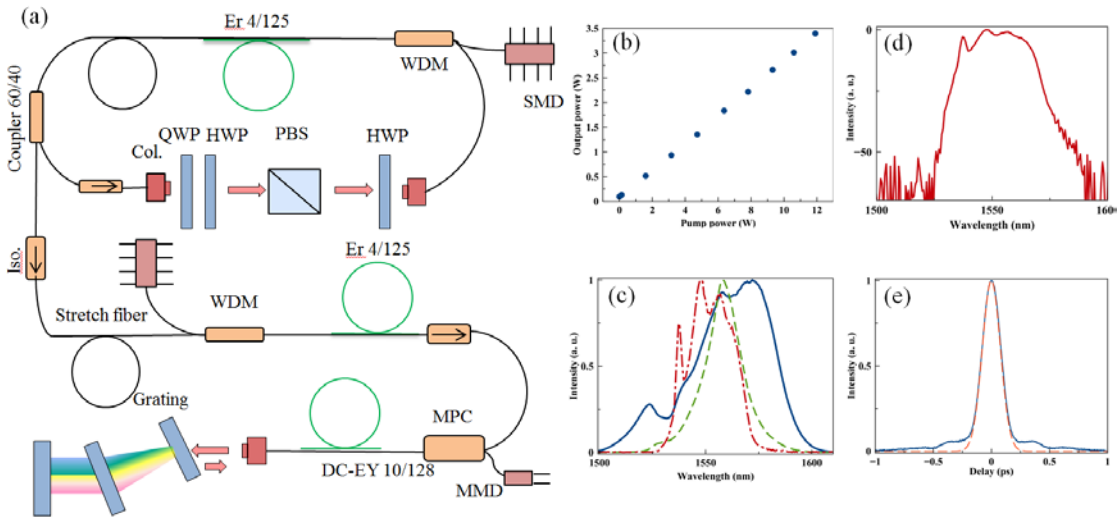

Fig. 1 (a) The schematic of experimental setup. SMD, single mode diode laser; WDM, wavelength division multiplexer; Col, collimator; QWP, quarter wave plate; HWP, half wave plate; MPC, multimode pump-signal combiner; MMD, multimode diode laser. (b) Output power scaling. (c) Measured output optical spectra: oscillator (blue solid-line), pre-amplifier (green dashed-line), and power amplifier (red-dashed-dotted-line). (d) Measured output optical spectrum of power amplifier at 3.5 W output power. (e) Measured intensity autocorrelation at 3.5 W output power (blue solid-line) and fitting by Gaussian shape (red dashed-line).

The maximum average power achieved by the system before emerging Raman effect is 3.5 W. The output pulses then delivers to a pair of diffraction grating with 900 line/mm line density and de-chirped to 180 fs.

In conclusion, we demonstrated a single-mode 3.5 W average power fiber laser at 1550 nm. The pulse repetition rate is 43 MHZ and 180-fs long pulse is achieved after de-chirping by a grating compressor.

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