Passively Q-switched Yb-doped fiber laser based on Ag nanoplates saturable absorber

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Abstract: We experimentally investigated Ag nanoplates as saturable absorber for Q-switched pulse generation in an Yb-doped fiber laser. The pulse train repetition rate increases with the increase of the pump power. At the maximum pump power of 600 mW, the maximum repetition rate and average output power are 184.8 kHz and 10.77 mW, respectively, corresponding to single pulse energy of 58.3 nJ. To the best of our knowledge, it is the first demonstration of the passively Q-switched fiber laser utilizing the material of Ag nanoparticles at the wavelength of 1-μm. Our investigations demonstrate the flexibility of our solution-processed Ag nanoplates-based saturable absorber, making it a promising candidate for a variety of stable and low-cost ultrafast lasers.

Experimental setup and results

Optical deposition procedure is implemented to transfer the Ag nanoplates onto the fiber core area through the thermal effect. The saturable absorber is sandwiched between two fiber connectors, providing simplicity, flexibility and easy integration into the laser oscillator. The modulation depth and saturation incident fluence are measured to be ~5.8% and ~106.36 μJ/cm^2 at 1-μm region, respectively [1].

In the laser cavity, a piece of ~1.8 m moderately ytterbium-doped fiber (Nufern SM-YSF-LO) serves as the gain medium, and is backward pumped by a 980 nm laser diode (LD) through a 980/1060 nm wavelength division multiplexer (WDM). A polarization-insensitive isolator (PI-ISO) is utilized to provide unidirectional operation. Two polarization controllers (PCs) as well as an 8 nm band pass filter centered at 1030 nm, are employed to optimize the Q-switching pulse operation. The rest of the cavity is composed of ~17.7 m standard single mode fibers (SMFs), yielding a total cavity length of ~19.5 m.

Self-started stable Q-switched operation is achieved for a threshold pump power of 180 mW. The repetition rate of the pulse trains ranges from 66.6 to 184.8 kHz when the pump power scales from 210 to 600 mW. The maximum average output power is 10.77 mW, corresponding to the single pulse energy of 58.3 nJ and minimum pulse duration of ~1.01 μs. To the best of our knowledge, it is the first time that the Ag nanoplates saturable absorber are utilized in the 1-μm Yb-doped Q-switched fiber.

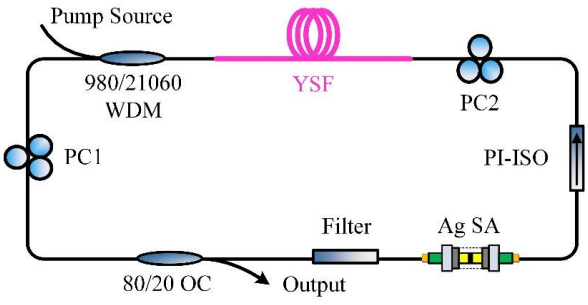

Fig. 1. Scheme of the fiber laser. OC: optical coupler; WDM: wavelength division multiplexer; PC: polarization controller; PI-ISO: polarization-insensitive isolator; Filter: 1030 nm band pass filter; YDF: ytterbium-doped fiber; Ag SA: Ag saturable absorber.

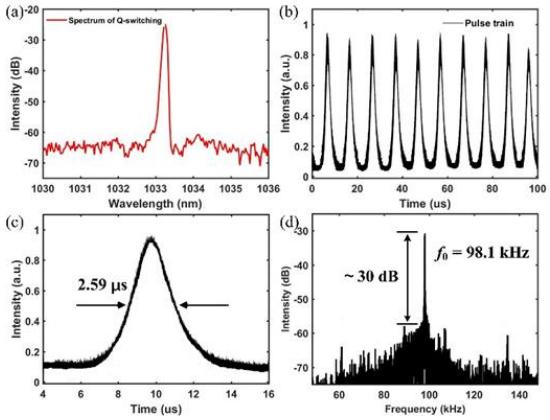

Fig. 2. Stable Q-switched operation at the pump power of 300 mW: (a) optical spectrum; (b) temporal sequences of output pulse recordings; (c) single pulse profile of the Q-switched pulse train; (d) RF spectrum over a 100 kHz span with resolution bandwidth of 10 Hz.

References

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