単結晶人工ダイヤモンド可飽和吸収体を用いたQスイッチファイバレーザ

Q-switched fiber laser using a synthetic single-crystal diamond saturable absorber

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The saturable absorber properties of synthetic single-crystal diamond is demonstrated, and a Q-switched fiber laser using synthetic diamond as saturable absorber (SA) which could achieve multi-wavelength output is proposed and demonstrated. The synthetic diamond we used as saturable absorber here is a single-crystal that fabricated by an economic-efficient CVD method. The synthetic diamond we used here is a 9 mm × 9 mm thin film with thickness of 1 mm. The result of I-scan and Z-scan [1] experiment both predict good saturable absorber properties of synthetic diamond, proving it promising for Q-switching or mode-locking [2]. So we think it is competent as saturable absorber, and build a Q-switched free-space-included fiber laser to demonstrate its saturable absorber properties.

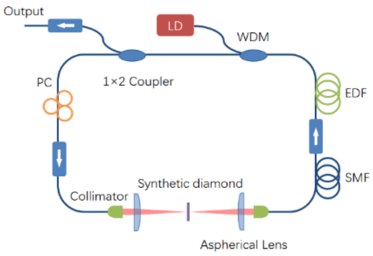

Figure 1. Experimental setup

The experimental setup for Q-switched fiber laser is shown in Fig.1, in which a 980 nm laser diode is used to provide pump with a 980/1550 nm wave-length division multiplexer (WDM). The total length of this ring cavity is 24 m, of which the length of single mode fiber (SMF) and Erbium doped fiber (EDF) in this ring cavity is about 10 m and 2 m respectively, to provide enough dispersion and gain. Three isolators are used here to prevent reflection interference, and a polarization controller is added to minimize polarization-dependent loss. A free-space system is built as a part of the cavity, which consists of 2 collimators and 2 aspherical lenses to form a 4f system. The beam diameter of collimators is 2 mm, and the focal length of lenses is 18.40 mm, which result in a theoretical spot size as small as 2.6 μm at focus, where the sample is placed to get maximum power intensity. The sample is mounted on a series of translation stages, thus can be quantificationally moved or rotated laterally by adjusting translation stages.

With this system, we achieve a multiple-wavelength Q-switched pulse output. The waveform of the proposed laser at pump power of 385.6 mW is shown as Fig.2. (a), and the optical spectrum is shown as Fig.2. (b), which barely deforms with change of pump power. Multiple mode is obtained in this laser, which is considered as a result of mode competition caused by inhomogeneous loss. In addition, as the RF spectrum shows, the signal-to-noise ratio (SNR) is as high as 60 dB.

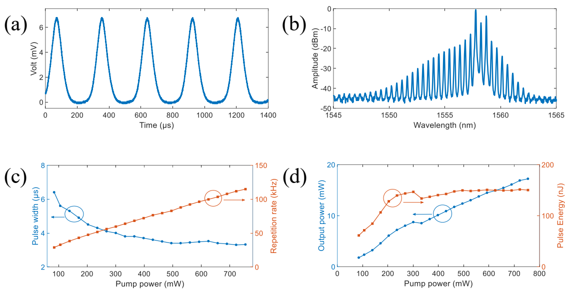

Figure 2. Experimental result

The characteristic of pulse width, repetition rate, output power and pulse energy against pump power is shown in Fig.2. (c, d). As expected, with an increasing pump power, the pulse width gradually decreases from 6.4 μs to 3.32 μs, and repetition rate increases from 28.73 kHz to 114.7 kHz nearly proportionally. The output power also rises with pump power, that changes almost monotonously. The pulse energy is acquired by dividing output power by repetition rate. It rapidly increases with pump power under about 200 mW and tends to be stable from around 300 mW. According to the calculating result, it stabilizes at 150 nJ with pump power higher than 500 mW, and reaches a maximum of 151.25 nJ.

Reference

[1] M. Sheik-Bahae, et al. "Sensitive measurement of optical nonlinearities using a single beam." *IEEE journal of quantum electronics* 26.4 (1990): 760-769.

[2] S.Y. Set, et al. "Ultrafast fiber pulsed lasers incorporating carbon nanotubes." *IEEE Journal of selected topics in quantum electronics* 10.1 (2004): 137-146.