The automatic mode-locking system for the generation of near infrared optical comb

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Recently the near infrared fiber femtosecond lasers are in demand for applications such as metrology, spectroscopy and telecommunication. Nonlinear polarization rotation mode-locking technique is widely used to generate short pulses for fiber lasers and has good performances. However, the NPR technique requires painstaking polarization control using wave-plates to mode-lock. Therefore, the automatic mode-locking system makes optical comb generation easier and faster, and it is essential for turn-key operation of industrial applications.

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1. Introduction

Femtosecond fiber lasers are attractive short-pulse sources because of their compact design, high efficiency, robustness to vibration, ease of optical pumping, low production cost and spectral extension to near infra-red light in comparison to the crystal-based counterpart [1]. For fiber based oscillators, nonlinear polarization rotation (NPR) and saturable absorber (SA) modelocking techniques are used to generate femtosecond short pulse [2]. In case of NPR modelocked oscillator, it has good characteristics such as broad spectral bandwidth and narrow pulse width. However, polarization control is needed to initiate short pulse for NPR mode-locking, which requires time consuming and labor sum manual operation. In this research, we develop the automatic NPR modelocking system which generates optical comb easier and faster. The near infrared femtosecond laser s using automatic modelocking system are useful for industrial applications

2. The automatic NPR modelocking system

2.1 The principle of the automatic NPR modelocking system

The automatic NPR modelocking system is divided to three main parts; i.e. automatic polarization control part, modelocking detection part and application program. The process of automatic modelocking is as follows. The modelocking system is started by 'turn-key' operation using application program, and then motorized wave plates start to rotate with different speeds in the oscillator for automatic polarization control. At the same time, photo diode (PD) from modelocking detection part starts to detect output of the oscillator. If the fiber laser is modelocked, PD detects a specific signal which recognizes generation of optical comb, and then application program makes the automatic polarization control stop. From this process of automatic NPR modelocking, the near infrared optical comb can be generated and can be maintained in stable mode-locking condition.

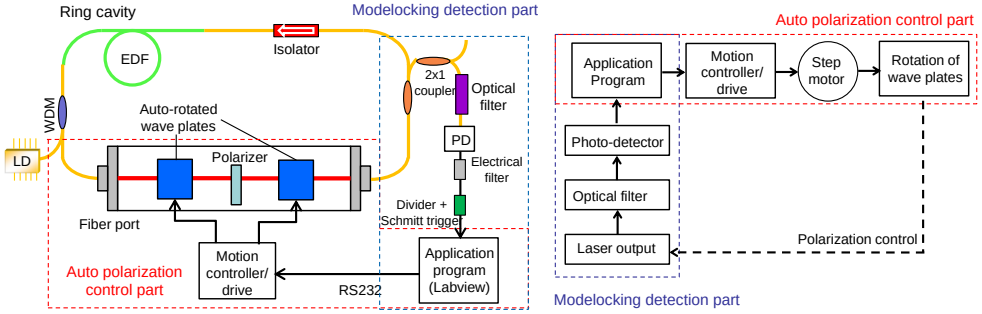

Fig. 1 The schematic diagram and process of automatic mode-locking

2.1.1 The experimental setup and results of an automatic NPR modelocking system

Fig. 2-a. shows the experimental setup of fiber ring cavity and the automatic modelocking system. Ring cavity consists of fiber components, and compact motorized wave-plates connected to motor controllers of automatic polarization control part. For modelocking detection, fiber bragg grating is used to distinguish spectrums before and after modelocking, and detected modelocking signals are digitalized by Schmitt-trigger. Finally frequency counter measures the frequency of modelocking signal, and application program analyzes whether the system is mode-locked or not. Fig. 2-b indicates results of modelocking laser using automatic modelocking system. It takes under ten minutes to modelock the oscillator using automatic mode-locking system. The output of fiber femtosecond laser has 55 nm spectral bandwidth, 95 fs pulse duration and 30 mW average power. The mode-locked condition can be maintained over a week.

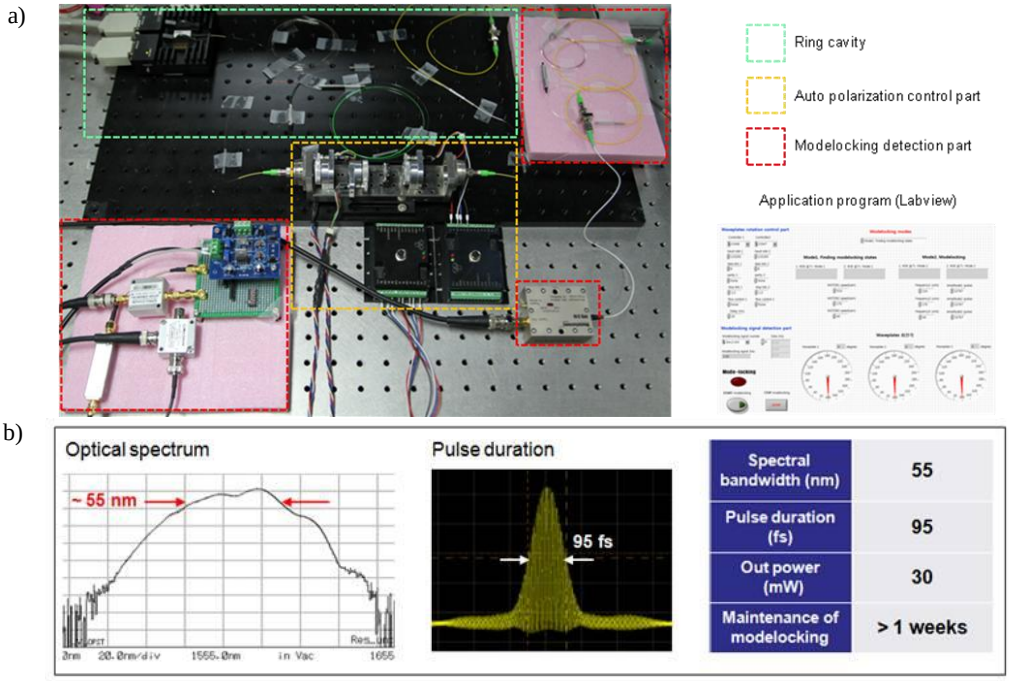

Fig. 2 Experimental setup and results of automatic NPR modelocking

3. Conclusions

In conclusion, we show that automatic mode-locking system can generate faster and easier, and maintain stable optical comb for a long time. These automatic mode-locked fiber femtosecond lasers are considered to be useful for industrial applications. In addition, if the repetition rate control parts are installed in the automatic mode-locked fiber lasers and frequency of optical comb is stabilized, we also expect that it will be good sources for applications such as precision metrology, spectroscopy and astronomical spectrograph calibration.

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