A novel 852-nm tunable fiber laser

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We report a novel fiber laser operating at 850-nm band by using semiconductor optical amplifier and fiber grating. The laser system is stable, compact, and the operating wavelength can be tuned continuously from about 851 to 854 nm for Cs atomic clock system by stretching the fiber grating. An output power up to 20 mW is obtained with a signal-to-background ratio beyond 30 dB.

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For hot thermal beam laser pumped Cs atomic clock systems, narrow linewidth, tunable, and stable laser at 852 nm is required[1−4]. So far, most of the lasers in the Cs atomic clock systems are semiconductor laser diodes (LDs) such as vertical external cavity surface emitting laser (VECSEL)[2] and distributed feedback (DFB) LD[3,4] because of their compactness and easy realization. However, complicated control circuits (for temperature and current control) are needed for the stability of the LD operation. In contrast, fiber lasers have many advantages such as high efficiency, high beam quality, narrow linewidth, as well as compactness. So fiber lasers will play a very important role in the applications of Cs atomic clock systems. To the best of our knowledge, up to now, no fiber laser has been reported in the application of Cs atomic clock systems.

In this letter, we report a novel fiber laser operating at 852 nm for Cs atomic clock systems. An output power up to 20 mW is obtained with the intensity fluctuation less than 1%. The signal-to-background ratio (SBR) is better than 30 dB. The operating wavelength of our laser can be tuned from about 851 to 854 nm continuously by stretching the fiber Bragg grating (FBG)[5−8].

Figure 1 is the scheme of the fiber laser, which includes one FBG, one 850-nm band semiconductor optical amplifier (SOA)[9,10] with fiber pigtail in each port, one 850-nm isolator (ISO), and one 60/40 fiber based coupler. The SOA whose center wavelength is 844 nm is used to provide gain in our laser system, its gain bandwidth is about 11 nm, and saturation output power is 25 mW at 400-mA driving current. Figure 2 shows the amplified spontaneous emission (ASE) spectrum of the SOA. One port of the SOA (we call it as input port, port b in Fig. 1) is connected to port 2 of the coupler, the other port of the SOA (output port, port a) is connected to the input port of the ISO, while the output port of the ISO is connected to port 1 of the coupler, as shown in Fig. 1. The FBG with a reflectivity of 93% is connected to port 3 of the coupler. Thus a unidirectional cavity is formed and the spatial hole burning (SHB) effect in the laser cavity, which will broaden the linewidth of the output laser, is removed. The center wavelength of the FBG is about 851 nm. In order to get the laser operate at 852 nm, a tuning device is fabricated to tune the reflected wavelength of FBG, that is, to tune the operating wavelength of the laser system.

In our laser system, the laser starts working when the driving current of the SOA is tuned to 200 mA, and the operating wavelength is about 851 nm. The curve (a) in Fig. 3 shows the laser spectrum when the driving current of the SOA is tuned to 300 mA, the center wavelength is at 851.23 nm with the output power of 10.4 mW, and the SBR is over 30 dB. The operating wavelength of the laser can be tuned by stretching the FBG through the tuning device, as shown by curves (b) and (c) in Fig. 3. Because of the limit of the tuning device, the tuning range given in Fig. 3 is from 851 to 853 nm continuously. But when the FBG is stretched directly, that is, without the tuning device, the output wavelength can get longer, for instance, to 854 nm. In our experiment, we find that the coupling ratio of optical coupler is very important to the laser operation. We have tried many different coupling ratios, and the 60/40 coupler was chosen finally. The 60% port of the coupler was used to output the laser.

In conclusion, we report a novel tunable fiber laser using SOA for Cs atomic clocks. Our laser operates at 852 nm and can be continuously tuned from about 851 to 854 nm. The laser is stable and compact with its

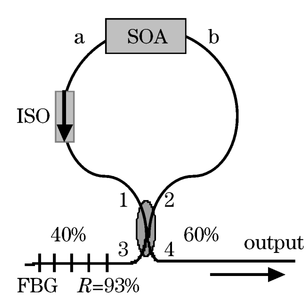

Fig. 1. Schematic diagram of the fiber laser.

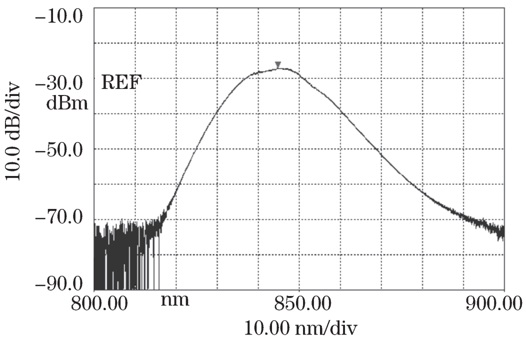

Fig. 2. ASE spectrum of the SOA, the 3-dB gain linewidth is 11.2 nm, and the peak wavelength is 844.7 nm.

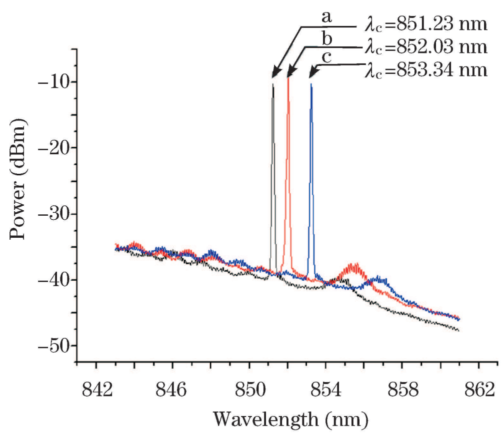

Fig. 3. Spectra of the laser. Curve (a) corresponds to the state of the FBG free stretching, the operating wavelength of the laser is 851.23 nm; (b) when tuning the FBG, we get the operating wavelength of 852 nm to meet the Cs atomic clock requirement; (c) the operating wavelength can be tuned continuously to 853 nm or longer.

intensity fluctuation of less than 1%. Up to 20-mW output power and a SBR beyond 30 dB are obtained. The single-frequency fiber laser will be set up in near future.

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