Square Shape Spectrum in 1550 nm and 1060 nm bands in Passive mode-locked fiber Laser

Lixin xu1, Guoliang Chen1, Chun Gu1, Anting Wang1, Hai Ming1, and P.K.A. Wai1,2
1Photonics institute, University of Science and Technology of China, Hefei, 230026, China
2Photonics Research Center and Department of Electronic and Information Engineering, The Hong Kong Polytechnic University, Hong Kong, China.

Abstract
Square shape spectrum is observed in passively mode-locked fiber laser both in 1550 nm and 1060 nm band, the spectrum is broad and flat, the bandwidth is up to 28 nm in 1550 nm band.

Introduction
It is very simple and economical to realize passively mode-locked fiber laser using nonlinear polarization rotation (NPR) and saturable absorption effect. A characteristic of NPR is that it exploits the weak birefringence and nonlinear optical Kerr effect of optical fiber to generate an artificial saturable absorption effect in a fiber laser. The shortest pulse width of tens of fs has been achieved [1]. Recently, L.M. Zhao et al. reported that the self-started passive mode-locking could be achieved in the cavity with positive dispersion [2]. This cavity generates a kind of gain-guided soliton pulse. The process needs very strong nonlinear effect, which will result in very high pump threshold of the laser. In previous paper [3], we also report the operating of passive mode-locking laser in the cavity with positive dispersion in 1550 nm, the pump threshold is as low as 40 mW and the output spectrum is square shape with 3dB bandwidth 17.61 nm. In this paper, we report that the square shape spectrum can also be obtained in 1060 nm band, and the 3dB band of square spectrum in 1550 nm can be further broaden (more than 30 nm, in our case).

Experimental setup and discussion

The configuration of our passively mode-locked fiber laser is shown in Fig. 1. The passive mode-locking system use nonlinear polarization rotation (NPR) for mode-locking. It includes of one 980 nm LD, one section of rare earth doped fiber (RDF), two polarization controllers (PC1 and PC2), one polarization dependent isolator, one WDM, and one output coupler. The RDF is used as gain medium to provide gain for the passive mode-locking system, for 1550 nm band operation, the RDF is 10 m erbium doped fiber with absorption of 3dB/m at 980 nm, and dispersion parameter D= -12.2 ps/nm/km at 1550nm. While for 1060 nm band operation, the RDF is 50 cm yterbium doped fiber with the absorption of 470 dB/m at 980 nm. A 980 nm LD with maximum output power of 330 mW is used to pump the RDF Through a fiber WDM. The other fibers in the cavity are single-mode fiber (SMF) whose dispersion parameter D is 17 ps/nm/km at 1550nm. Two polarization controller (PC1 and PC2) and polarization dependent isolator are used as NPR mode-locking unit. 95/5 fiber couplers for 1550 nm and 1060 nm are used to output the cavity energy through the 5% port, respectively.

Fig. 2 the output spectrum of the mode-locking laser pump with 225 mW
In 1550 nm operation, the total cavity length is 17.6 m, and the mode-locking operates when the pump power of the 980 nm LD is tuned to 60 mW, and the output...
The square shape spectrum in passive mode-locking laser system can also be obtained in 1060 nm band. In our setup, the gain medium is 50 cm ytterbium doped fiber. The threshold of the mode-locking laser is 90 mW. Fig.5 shows the output spectrum of the mode-locking laser pump with 90 mW in 1060 nm band, the bandwidth is measured about 5 nm. Fig.6 shows the corresponding pulse train. The spectrum can be further broaden through adjusting the polarization controller and increasing the pump power. Fig.7 shows the spectrum of the mode-locking laser at another operating state when adjust the polarization controller and pump power. The 3dB bandwidth is measured 8.8 nm, it become broader.

**References**