Abstract—We report on the generation of a new kind of nanosecond high-energy square pulses in passively mode-locked Yb-doped fiber laser with all-normal-dispersion ring cavity configuration. The generated square pulses have a triangular spectrum with a 3 dB spectral bandwidth of only 0.18 nm. The square pulses are wave-breaking-free and have pulse energy of 34 nJ at the pump power of 323 mW.

Keywords—fiber laser; nanosecond square pulses; triangular spectrum; passively mode locking; normal dispersion

I. INTRODUCTION

Yb-doped mode-locked fiber lasers possess practically important applications in material processing, medicine, biology and nuclear physics due to the high-energy pulses output [1]. We demonstrate a nanosecond, all-normal-dispersion, all-fiber passively mode-locked square pulse fiber laser that delivers maximum pulse energy of 34 nJ.

II. EXPERIMENT AND RESULTS

The experimental setup is shown in Fig.1. The single mode Yb-doped fiber (YDF) (25 cm, 6/125 μm) is core-pumped by a 974 nm laser diode (LD) via a fiber wavelength division multiplexer (FWDM). The bandwidth of FWDM centered at 1060 nm is ±3.5 nm. Two polarization controllers (PCs) and a polarization maintaining isolator (PM ISO) are used to achieve mode locking through nonlinear polarization rotation (NPR) regime. About 100 m standard single mode fiber (SMF) is utilized in the laser. The laser is coupled out through the 30% end of the coupler.

![Schematic diagram of the experimental setup.](image)

In our experiment, when changing the cavity parameters by adjusting the PCs properly, a nanosecond square pulses train with a fundamental repetition rate of 1.85 MHz is shown on the oscilloscope as illustrated in Fig.2 (a). The pulse duration broadens when increasing pump power while the peak of the pulse almost keeps constant and no wave breaking is observed. The average power and peak power of output is 62.1 mW and 7.4 W and the pulse energy is 34 nJ at the pump power of 323 mW. The spectral shape is triangular and the 3 dB spectral bandwidth is only 0.18 nm as shown in Fig.2 (b). It is different from other nanosecond square pulses generated from passively mode-locked fiber laser reported in [2, 3]. To the best of our knowledge, this is the first observation of a nanosecond square pulse with such kind of spectrum. It may have relationship with dissipative soliton resonance [1, 4].

![Typical square pulses shape and (b) typical spectrum](image)

III. CONCLUSION

In conclusion, we have experimentally generated a new sort of nanosecond high-energy square pulses with a triangular spectrum and pulse energy of 34 nJ in passively mode-locked fiber laser by NPR regime. It can serve as a seeding source to be further amplified in a fiber amplifier for high power application, such as material processing.

REFERENCES