Transition dynamics of noise like pulse from net normal dispersion Yb-doped fiber laser

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Nowadays, passive mode-locked fiber lasers (PML-FLs) have provided a platform to investigate various intriguing pulse dynamics like dissipative solitons (DSs) [1], rectangular pulse [2], bound solitons [3], dark soliotns, noise like pulse (NLP) and so on. Since the first experimental demonstration by the Horowitz et al in PML Er-doped fiber laser, the NLP has attracted great attention with the characteristics of relative wide spectrum bandwidth [4] that can be used for bio-medical diagnostics. However, the dynamics of NLP in PML-YDFLs has been seldom reported. In this work, we investigated the soliton dynamics of transition of DSs to the NLP after insertion of slit inside cavity of YDFL.

The schematic setup of a PML YDFL with ring cavity configuration is shown in Fig.1. The gain medium is a single mode ytterbium-doped fiber, which was pumped by a pigtail 976 nm LD through a 980/1060 nm WDM. The mode-locked mechanism was based on the NPE that comprised of two quarter-wave-plates ($\lambda/4$), one half-wave-plate ($\lambda/2$) and polarization beam splitter (PBS) cube in free space. The net normal laser cavity dispersion was produced by the insertion of the dispersion delay line, comprising two GPs with 600-lines/mm groove density. The optical isolator (ISO) was use to ensure uni-directional propagation inside laser cavity. Besides, the slits was put inside laser cavity to control the spectrum bandwidth. The laser output was taken from the NPE rejection port and collected by the collimator outside resonator for pulse monitor and further pulse compression.

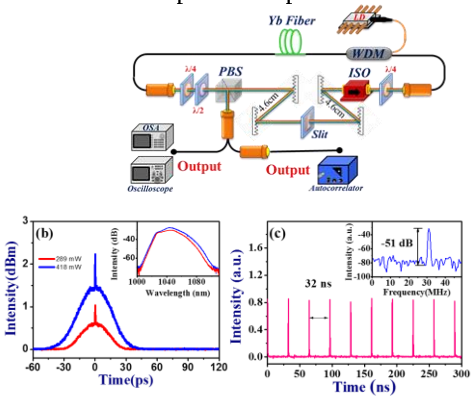

Fig.1 (a) Schematic set-up of PML YDFL and the oscilloscope (WaveRunner 620Zi, LeCroy Inc.), OSA (optical spectrum analyzer, AQ 6370, Yokogawa Inc.) and Autocorrelator (FR-103XL, Femtochrome Research inc.). (b) Time trace of IAC traces and corresponding optical spectra. (c) Time trace of ML sequential pulses (Inset, RF spectrum).

Without slit inside laser cavity, the NLP would be generated once the YDFL was mode-locked with the characteristic of double scale femto/pico-second intensity autocorrelation trace (IAC) with pump power P_p=289 mW (red curve) and P_p= 418 mW (blue curve) as shown in Fig. 1(b). The corresponding optical spectrum (Inset of Fig. 1(b)) reveals an asymmetric broadening toward long wavelength at higher pump power. In Fig. 1(c), the measured time trace of NLP pulses from oscilloscope indicates that time interval between sequential pulses is about 32 ns. The corresponding repetition rate of pulse about 32.2 MHz can also be revealed in the RF spectrum, (inset of Fig. 2(c)) with the high supermode suppression about 51 dB. After insertion the silt between two GPs, the NLP pulse can also be observed at higher pump power but with slightly narrower spectrum bandwidth than that shown in the inset of Fig. 1(b) (blue solid curve, Fig. 2(a)). As pump power was lower below certain threshold, the dissipative solitons (DSs) would be produced with the characteristic of steep edge spectrum (P_p=200 mW, red solid curve, Fig. 2(a)). Besides, the corresponding IAC traces (red curve) in Fig. 2(b) can be depicted by a typical Gaussian shape.

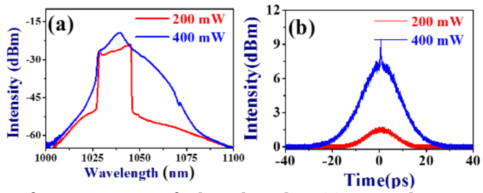

Fig.2 After insertion of the slit, the (a) optical spectra and (b) corresponding IAC trace as YDFL operate at NLP (red curve) and DS (blue curve)

In conclusion, we have experimentally investigated the pulse dynamics of a PML YDFL in operation at net normal dispersion region. Without insertion of slit, the spectrum of NLP reveal broad bandwdith and the double scale femto/pico-second IAC trace. After insertion of slit inside laser cavity, we demonstrate the operation state of YDFL can be switched from DSs to the NLP by the pump power. Through the spatial tuning of the slit, the operation state and central wavelength can also be controlled in the near future that show the abundant dynamic of the PMLYDFL.

Acknowledgement

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Reference

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