Ultrafast mode-locked fiber lasers for high-speed OTDM transmission and related topics

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I. Abstract

This talk presents an overview of 10-40 GHz ultrafast fiber pulse lasers and their applications to Terabit/s high-speed OTDM (Optical Time division Multiplexed) transmission. In order to generate a very stable high-repetition rate pulses in a fiber cavity, a harmonic and regenerative mode-locking technique was used, which was originally developed in 1994 [1]. Since the present lasers can emit a 0.5-3 ps pulse train at 10-40 GHz, we can time-domain multiplexed it to realize an ultrahigh speed pulse transmission. In 2000, we succeeded in a 1.28 Tbit/s over 70 km OTDM transmission with the mode-locked fiber laser [2]. This result was recently improved to 5.12 Tbit/s transmission over 300 km [3].

In these days, increasing a spectral efficiency as well as increasing the single-channel transmission speed becomes an important research subject with a view to meeting the growing demand for higher transmission capacity in optical fiber networks. Thus, many people are doing lot of researches on a digital coherent optical transmission. Among them, QAM (Quadrature Amplitude Modulation) plays a very important role in realizing highly spectral efficient pulse transmission. Recently, we proposed an optical Nyquist pulse transmission, in which we use a Sinc-function like pulse with ringings instead of conventional Gaussian or soliton pulses [4]. In a coherent Nyquist pulse transmission, we need to stabilize longitudinal mode frequencies of the mode-locked laser. We achieved this frequency stabilization with the HCN gas molecule absorption at a 1.55 micron band [5]. The configuration of the repetition-rate stabilized and frequency-stabilized fiber laser is shown in Fig. 1. This laser was applied to a 64 QAM coherent Nyquist pulse transmission and we could realize single-channel 7.68 Tbit/s -160 km transmission with a spectral efficiency of 9.7 bit/s/Hz. Thus, we could realize a ultrahigh-speed and spectrally efficient optical transmission for the first time.

II. Image

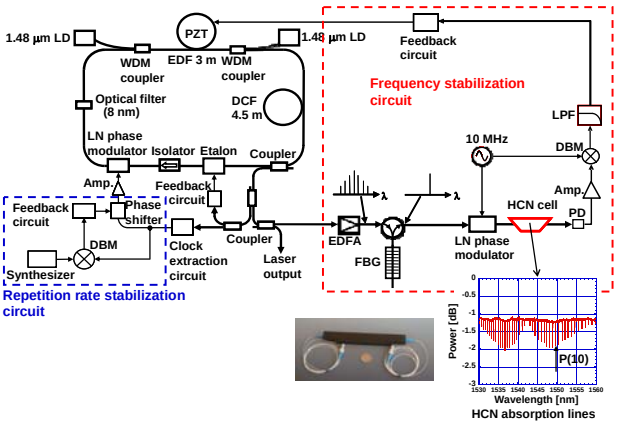


Figure 1: Harmonically and regeneratively mode-locked ultrafast fiber laser for OTDM transmission experiments.

III. Reference

1 M. Nakazawa, E. Yoshida, and Y. Kimura, "Ultrastable harmonically and regeneratively modelocked polarisation-maintaining erbium fibre ring laser", Electron. Lett., vol. 30, No. 19, pp. 1603-1604, Sep., (1994).

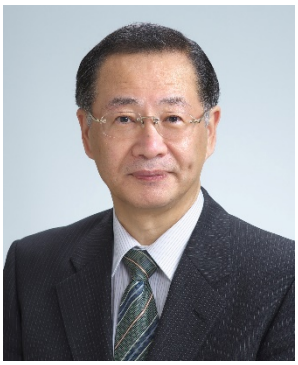
2 M. Nakazawa, T. Yamamoto, K. R. Tamura, " 1.28 Tbit/s-70 km OTDM transmission using third- and fourth-order simultaneous dispersion compensation with a phase modulator," Electron., Lett., vol. 36, No. 24, pp. 2027-2029, November (2000).

3 D. Suzuki, K. Harako, T. Hirooka, and M. Nakazawa, "Single-channel 5.12 Tbit/s (1.28 Tbaud) DQPSK transmission over 300 km using non-coherent Nyquist pulses," Opt. Express, vol. 24, no. 26, pp. 29682-29690, December (2016)

4 M. Nakazawa, T. Hirooka, P. Ruan, and P. Guan, "Ultrahigh-speed "orthogonal" TDM transmission with an optical Nyquist pulse train," Opt. Express vol. 20, no. 2. pp. 1129-1140, Jan. (2012).

5 M. Yoshida, K. Yoshida, K. Kasai, and M. Nakazawa, "1.55 μm hydrogen cyanide optical frequency-stabilized and 10 GHz repetition-rate-stabilized mode-locked fiber laser," Opt. Express, vol. 24, no. 21, pp. 24287-24296, October (2016).

IV. Biography:



After receiving his Ph. D. from the Tokyo Institute of Technology, Dr. Nakazawa joined NTT Laboratories in 1980. He was a visiting scientist at MIT in 1984. In 2001, he was appointed professor at Tohoku University, where he became the director of the Research Institute of Electrical Communication. He has been a distinguished professor since 2008. He engaged in research on optical solitons, ultrahigh-speed transmission, and ultrashort pulse lasers that led on from his invention of the compact EDFA. His recent research is focused on digital coherent transmission. Dr. Nakazawa is a Fellow of the OSA, IEEE, IEICE, and JSAP.