40 GHz Pulse Train Generation by Spectral Filtering for Repetition Rate Quadruplication

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Abstract

We demonstrate a simple method to multiply the repetition rate of an optical pulse train by a fiber Fabry-Parot interferometer (FFPI) spectral filtering. A stable 40 GHz pulse train at 1550 nm is successfully generated by removing unwanted spectral components of a 10 GHz actively mode-locked laser source by passing a high finesse FFPI.

1. Introduction

Harmonic active mode locking has proved to be very effective for the generation of high-repetition-rate short pulses of picosecond duration from fiber lasers, which will be useful for future ultrahigh-speed optical communication [1-3]. The repetition rate of the output pulses from active mode-locked lasers equals the frequency at which modulation is performed and is therefore practically limited by the highest frequency at which modulators can be excited. It is, therefore, very challenging to find ways of increasing the repetition rate of the output pulses from actively mode-locked lasers which do not require a consequent increase in the modulation frequency. The technique in [1] has been proved to be useful for multiplying the repetition rate, but it is difficult to maintain constant amplitude for all the pulses. A method of doubling the repetition rate has also been reported for an AM mode-locked fiber laser where the intensity modulator is driven at the point of minimum transmission [3].

Previously, Gupta [1] has used such an approach to multiply, by as much as 4 times, the rate of an 869.284 MHz pulse train from a mode-locked fiber ring lasers. Here we demonstrate the application of a similar scheme at much higher repetition rates. In particular, we experimentally demonstrate the repetition rate quadruplication of a 10 GHz pulse train at 1550 nm.

2. Experimental Setup

The experimental setup is shown in Fig.1. The mode-locked laser generates a 10 GHz pulse train with 1.9 ps pulsewidth at 1550 nm. The pulses amplified by EDFA are nonlinearly compressed by a pulse compression fiber (PCF) to 0.72 ps and pass a high finesse fiber Fabry-Parot interferometer (FFPI) for repetition rate multiplication. After passing the FFPI, the output is amplified by EDFA to be measured by autocorrelator (ACR) and optical spectrum analyzer (OSA).

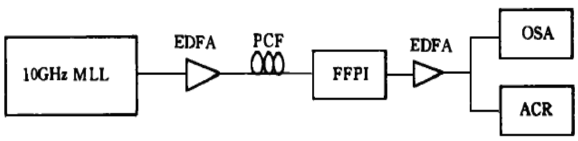

Fig.1. Schematic diagram of experimental setup.

3. Experimental Results

Fig. 2 shows the optical spectra before (a) and after (b) passing the FFPI. Unwanted spectral components of 10 GHz pulses are completely removed to leave 40 GHz spectral spikes only, as shown in (b). This indicates the repetition rate quadruplication of 10 GHz train by the FFPI spectral filtering. Note that the envelope of the 40 GHz train (b) is very similar to that of 10 GHz (a), resulting in a similar pulse shape but four times of repetition frequency.

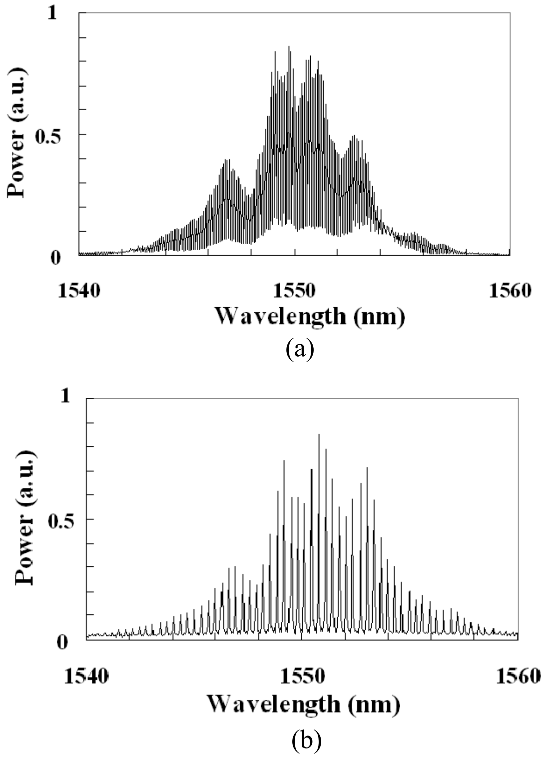

Fig.2. Optical spectra before (a) and after (b) spectral filtering by FFPI.

Fig.3 (a) and (b) show the RF spectrum of the fast detector output and autocorrelation trace of 10 GHz pulse train; while Fig. 4 (c) and (d) show those for the 40 GHz pulse train. Since the frequency measurement range of the spectrum analyzer is limited to 26.5 GHz, the 40 GHz spectral line was not able to be measured. Autocorrelation traces of Fig. 4 (b) and (d) prove the pulse repletion rate has been increased to 4 times. In addition, the RF spectra shown in Fig. 4 (a) and (c) clearly verify the 10 GHz component is completely suppressed.

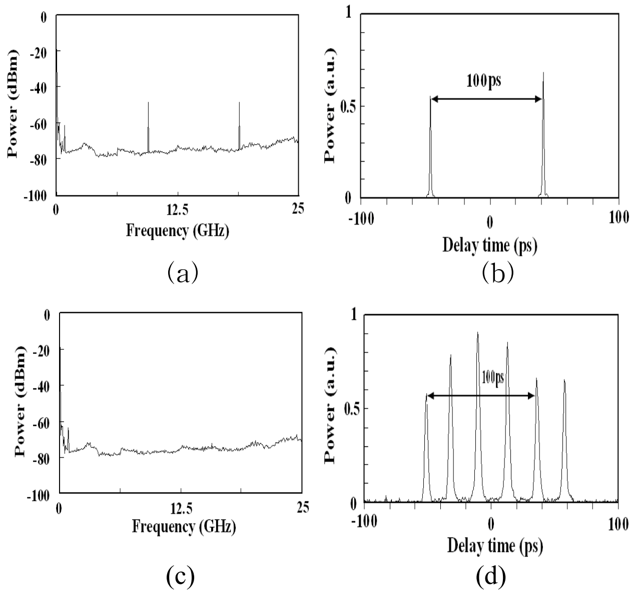

Fig.4. RF spectra and autocorrelation traces for 10 GHz (a and b) and 40 GHz (c and d) pulse trains.

4. Conclusion

We have presented a simple repetition rate multiplication method by spectral filtering using a high finesse FFPI. Fast detector output and autocorrelation traces proved that a stable 40 GHz pulse train at 1550 nm was successfully generated by repetition rate quadruplication of a 10 GHz actively mode-locked laser. Similar spectral filtering method can be used for higher repletion rate multiplication.

Acknowledgement

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References

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