Wide-band Terahertz Communication at Ambient Atmosphere

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***Abstract*—Communication band becomes more and more crowded, terahertz (THz) technology can obtain more than 300GHz frequency, and easy to obtain the transmission rate of Gbit/s. This paper demostrated the wide-band terahertz communication on a THz time domain spectroscopy system by adding the signal on the photoconductive antenna as bias voltage, and using ZnTe crystal as receiver.**

I. INTRODUCTION

WITH the increasingly high demand for wireless communications networks for high-speed transmission, the researchers are trying to extend to terahertz (THz) frequency. THz wave for the transmission rate of the wireless communication can be achieved 10 Gb/s [1], thousands of times faster than the UWB technology at present.

However, terahertz communication is still not perfect in many theories, and many technical problems still to be resolved, such as, the appropriate atmosphere window has not been found; THz radiation is usually less power. To improve the quality of THz communication, further tackling high power THz emission source, high bit rate modulation technology, high sensitivity, anti-jamming receiver technology and sophisticated and reliable high-gain receiving antenna is critical [2,3].

This paper reports a kind of wide-band THz communication based on a THz time domain spectroscopy (TDS) system, which uses photoconductive antenna as a THz source, ZnTe crystal as a receiver. The photoconductive antenna was fabricated on semi-insulating GaAs with the gap size of 50 µm, was biased using a square wave signal from a function generator with the frequency of 5 kHz and the voltage of 20 V, and was illuminated by a mode-locked Ti: sapphire laser with pulse width of 70 fs and the repetition rate of 80 MHz. The transmission distance between the modulated source and the receiving crystal was about 0.65 m.

II. EXPERIEMNT

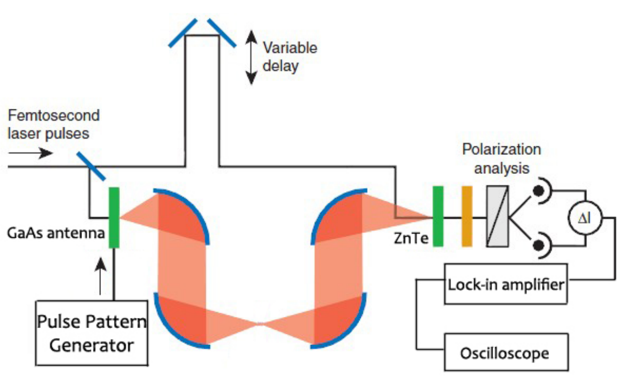

Fig. 1. Schematic diagram for experimental demonstration of the THz communication link.

A schematic diagram of the experimental setup is shown in Fig. 1. A mode-locked Ti:sapphire laser with the pulse width of 60 fs and the repetition rate of 80 MHz was employed to excited a photoconductive antenna. The powers of pump beam and probe beam were 120mW and 6mW, respectively. The antenna with the gap size of 50µm was fabricated by LT-GaAs. The transmission distance between the modulated source and the receiving crystal was about 65 cm. In the experiment, the modulation mode is the on-off keying (OOK) [4] method based on amplitude-shift keying (ASK) [5]. The detection part was a traditional EO detection using ZnTe crystal.

III. RESULTS

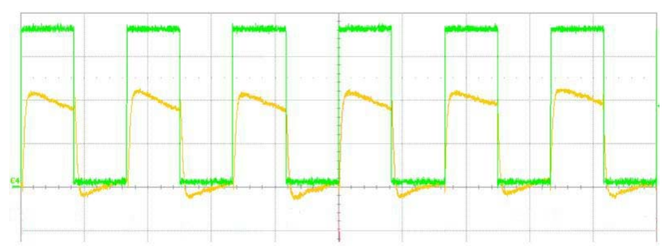

Fig. 2. Modulation signal (Green) and received signal (Yellow) .

Firstly, a square wave signal from a function generator (FMG-8216A) was used as a bias voltage and the peak-to-peak voltages of the signal was 21V. Fig.2 shows the modulation signal (Green) and the received signal (Yellow). The frequency of modulation signal was 300Hz, wihich was applied on the photoconductive antenna as a bias voltage. The yellow signal is the signal obtained by the balance detector, both signals were collected by an oscilloscope.

Secondly, an audio signal with the frequency of 2000 Hz was

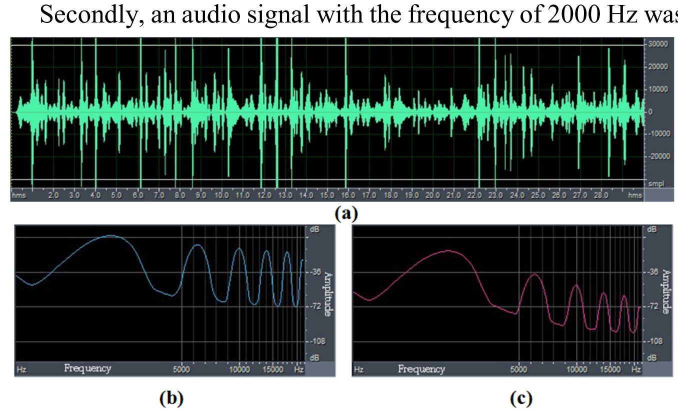

Fig. 2. (a) Time domain waveform of received audio signal with the frequency of 2000Hz; (b) Spectrum of the original audio signal; (c) Spectrum of the received audio signal.

generated by "Goldwave" software, and we put the signal into a voltage amplifier and increase the peak-to-peak voltage to 40 V, which was used as a bias voltage on the photoconductive antenna. Fig.3 (a) shows the time domain waveform of received audio signal with the frequency of 2000Hz; Fig. 2 (b) and (c) are the Spectra of the original audio signal and the received audio signal. We can clearly see the two waveforms are almost the same, which means that the distortion factor is low.

Then the signal to noise ratio of the received audio signal is calculated by the Equation (1).

$$SNR_s = \frac{V_s}{\sqrt{\frac{1}{N}\sum_{i=1}^{N} {V_{n1}}^2}} \quad (1)$$

where, V_s is the maximum voltage of the received audio signal in Fig.1 (a) and the denominator is the root-mean-square of the noise. The calculated result is 51.4. So the received signal is noisier than the original audio signal.

IV. SUMMARY

The wide-band terahertz communication on ambient atmosphere was demonstrated on a THz time domain spectroscopy system. The received signal has the same spectrum with the original audio signal, but noisier than the original signal.

REFERENCES

[1]. A. Hirata, T. Kosugi, H. Takahashi, R. Yamaguchi, F. Nakajima, T. Furuta, H. Ito, H. Sugahara, Y. Sato, and T. Nagatsuma, "120-GHz-band millimeter-wave photonic wireless link for 10-Gb/s data transmission," *IEEE Transactions on Microwave Theory and Techniques*, vol. 54, pp. 1937-1944, may, 2006.

[2]. T. K. Ostmann and T. Nagatsuma, "A review on terahertz communications research", *Journal of Infrared, Millimeter and Terahertz Waves*, vol. 32, pp. 143-171, February. 2011.

[3]. H. J. Song and T. Nagatsuma, "Present and future of terahertz communications," *IEEE Trans. Terahertz Science and Technology*, vol.1, pp. 256-264, September, 2011.

[4]. L. Möller, J. Federici, A. Sinyukov, C. Xie, H. C. Lim, and R. C. Giles, "Data encoding on terahertz signals for communication and sensing," *Optics Letters*, vol.33, pp. 393-395, February, 2008.

[5]. T. A. Liu, G.R. Lin, Y. C. Chang, and C. L. Pan, "Wireless audio and burst communication link with directly modulated THz photoconductive antenna," *Optics Express*, vol.13, pp. 10416-10423, December, 2005.