Fine Tuning of Terahertz Generation in Fan-out Type Periodically Poled Lithium Niobate Using Femtosecond Laser Pulses

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***Abstract*— The terahertz pulse generated from a fan-out type periodically poled lithium niobate was investigated. Due to the position-different period of the fan-out type structure, the center frequency of the terahertz radiation changes when an incident position of a pump laser varies. The center frequency of terahertz pulse can also be tuned finely by changing an incident angle of the pump laser.**

I. Introduction

The terahertz (THz) sources have the important position in the THz techniques such as spectroscopy, imaging, medical diagnostics etc. The widely used generation methods of THz pulse radiations are photoconductive antenna, optical rectification, and surface current charge acceleration with the femtosecond lasers [1-2]. In general, the pulse-type THz sources have broadband spectra in the frequency region. Recently, tunable narrowband THz sources based on the difference frequency generation (DFG) mechanism were introduced using the periodically poled structures [3-4]. There were shown the multi-cycles THz time-domain waveforms. They can provide the domain structure information such as the periodicity and the poling. In this work, we present the position-dependent THz pulse generation using a fan-out type periodically poled lithium niobate (PPLN). We also show that the fine frequency tuning can be achieved by rotating the sample.

II. Experimental Results

As a pump laser, a 190-fs pulse laser with the center wavelength of 800 nm was utilized. For detecting THz pulses, a photoconductive dipole antenna was used. It was fabricated on the low temperature grown GaAs with a hyper-hemi spherical lens. The fan-out type PPLN crystal was fabricated by the electrical field poling method [5]. It has 60 μm to 80 μm periods continuously. The fan-out type PPLN is located on the rotation stage. To measure the THz frequency shift by the different periodicity, the femtosecond laser pulse was pumped 3 different positions around left and right edges, and the center of the sample. The measured THz radiations in time domain (left) and their spectra (right) were shown in Figure 1. In the time-domain waveforms, the different cycle period was observed due to the position-dependent periodicity. In the frequency domain, the backward and forward THz pulse is shown in the 0.5 THz region and 1.5 THz region. In the forward THz pulses, the center frequency shifts from 1.6 THz to 1.3 THz as the period increases.

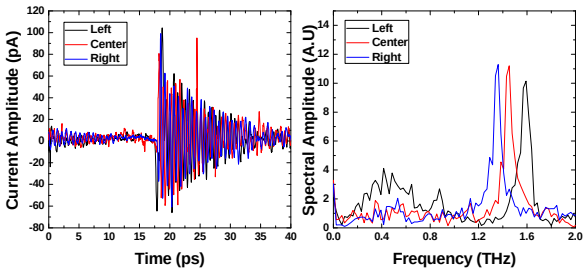

Fig.1. Measured THz waveforms (left) in time domain and the corresponding Fourier-transformed spectra (right)

Figure 2 shows the shift of the center frequency with the change of the incident angle when the femtosecond laser pulse was pumped at the center of the sample. . The center frequency shifts from 1.5 THz to 1.37 THz as the incident angle was rotated from 0 to 40 degree. The shift of the center frequency is not linear. The result indicates that the frequency of THz radiation can be tuned finely by rotating the fan-out type PPLN.

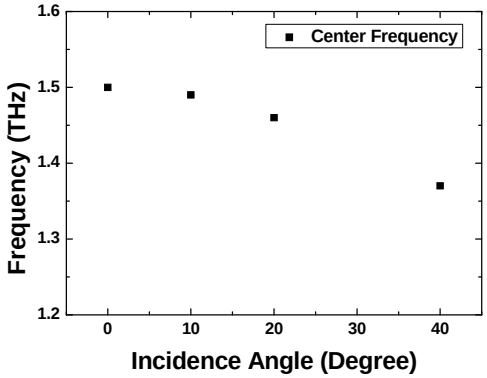

Fig.2. Dependence of the center frequency on the incident angle

In conclusion, we proposed the tunable THz generations using a fan-out typed PPLN. We observed the frequency shift with different input position of the sample. Also, we demonstrated that the fine frequency tuning could be achieved by just rotating the fan-out typed PPLN.

References

[1] Q. Wu and X.-C. Zhang, Appl. Phys. Lett. **68,** 1604 (1996).
[2] M. Exter, Ch. Fattinger, and D. Grischowsky, Appl. Phys. Lett. **55,** 337 (1989).
[3] Y.-S. Lee, T. Meade, V. Perlin, H. Winful, T. B. Norris, and A. Galvanauskas, Appl. Phys. Lett. **76,** 2505 (2000).
[4] N. E. Yu, C. Jung, C.-S. Kee, Y. L. Lee, B.-A. Yu, D.-K. Ko, and J. Lee, Jpn. J. Appl. Phys., **46,** 1501 (2007).
[5] N. E. Yu, S. Kurimura,Y. Nomura, M. Nakamura, K. Kitamura, Y. Takada, J. Sakuma and T. Sumiyoshi, Appl. Phys. Lett. **85,** 5134 (2004).

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