§15. Development of THz-wave Detection System Based on Nonlinear Optical Up Conversion

Notake, T. (RIKEN, ASI),
Akiyama, T.

1. Introduction

Developments of coherent terahertz (THz) radiation sources and detection systems are indispensable to enhance THz-wave research and to create industrial applications. Here, we propose high sensitive, fast time response THz-wave detection system which working at room temperature based on nonlinear optical (NLO) process.

Among many NLO crystals, organic materials owning loosely bound π electrons are more attractive because of their large nonlinear susceptibilities and ultra-fast response. Recently, a new excellent organic material N-Benzyl-2-methyl-4-nitroaniline (BNA) was successfully invented [1]. The molecular mass of organic materials is quite large and their structure is complex compared with inorganic materials. In addition, binding forces between organic molecules such as the Van der Waals force and hydrogen bonding are relatively weak. Therefore, it is generally difficult to grow high-quality large-size single organic crystals. In order to use BNA for THz-wave detection, we tried to grow BNA crystal from solution phase to much improve crystal quality. At present, despite some difficulties growing organic crystals, we have succeeded in growing large size single BNA crystals with high optical quality which is confirmed by using X-ray diffraction analysis [2].

2. THz-wave detection

To detect THz-wave via nonlinear difference frequency optical mixing in BNA, optimum phase matching condition should be clarified. Especially, for THz interferometer measurement system in LHD, we focus on 6 THz detection. Refractive index of BNA at around 6 THz is determined from the measurement of absorbance based on the Lorentz oscillator model as shown in Fig.1. By using the refractive index at optical region, coherent lengths are also calculated as a function of one of pump wavelengths as shown in Fig. 2. From the analysis, optimum pump waves should have wavelengths of around 800 nm for efficient difference frequency optical mixing. Optical parametric oscillator which can radiate tunable beam with wavelengths of around 800 nm is under development.

3. Summary

We tried to crystallize organic single BNA crystals by means of solution growth method to enhance crystal quality. Besides, optimum phase matching condition is revealed to detect 6 THz-wave efficiently for THz interferometer measurement in LHD.

Acknowledgments

We thank Professor H. Ito, Dr. Minamide, and Ms. Saito of RIKEN for many useful discussions and comments. This work was partially supported by JSPS KAKENHI (23760058).

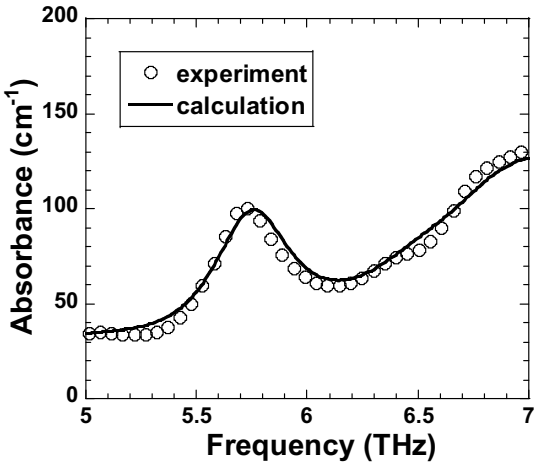

Fig.1. Absorbance of BNA at THz region

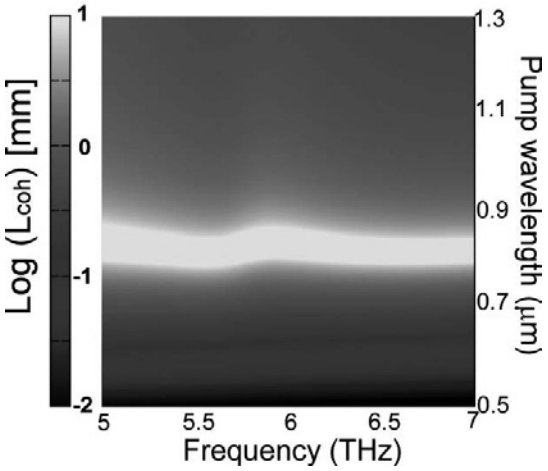

Fig.2. Coherent length of BNA

1) H. Hashimoto, et al., Jpn. J. Appl. Phys. **36**, 6754-6760 (1997)
2) T. Notake, et al., Optical Mat. Exp. **2**, 119-125 (2012)