Terahertz generation from low-temperature solution grown GaSe crystals

Chao Tang [1], Kouki Ishioka [1], Tadao Tanabe [1], Yutaka Oyama [1]

[1]Tohoku University
E-mail: tang.chao.s5@dc.tohoku.ac.jp

1. Introduction

The terahertz (THz) wave has been widely applied in many fields, including medical diagnosis, high-speed communication, and nondestructive detection [1]. The difference frequency generation (DFG) implemented with nonlinear optical crystals like GaP and GaSe can generate terahertz with high power and monochromaticity. However, the commercial GaSe crystals are grown by the Bridgman technique, which is conducted under a temperature higher than the melting point of GaSe. The defects and coexists of polytype restrict generation efficiency [2]. In this study, the high-quality GaSe crystals have been grown from a solution whose temperature is lower than that used in the Bridgman technique. The generation efficiency increased for about ten times compared with previous results [3].

2. Experiments and results

Crystal growth

High-quality GaSe crystals have been grown by two methods, the temperature difference method under controlled vapor pressure (TDM-CVP) and the indium flux method (IFM). In TDM-CVP, the GaSe crystal is grown from a diffusion induced supersaturated solution, in which the temperature gradient in a crucible leads to the diffusion in the crucible [4]. In IFM, the indium acted as the solvent, which decreases the melting point of the system. The growth temperature and crystallinity of GaSe are both optimized with these novel crystal growth techniques.

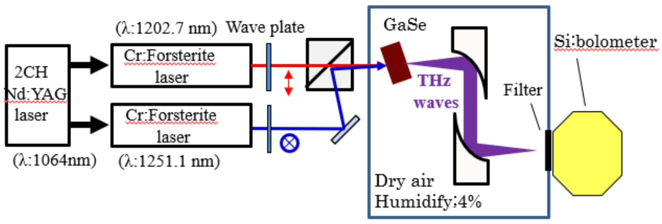

Fig. 1: the THz generation with GaSe crystal

Terahertz generation

Terahertz waves with a frequency range from 2 THz to 9 THz are generated via the DFG process using the as-grown crystals. Two OPO Cr: Forsterite lasers pumped by a two-channel 1064 nm YAG is used as the pump and probe beam in the DFG system, the generation is conducted with the oeo mode of the GaSe crystals (Fig. 1). The generation efficiency is ten times larger than that of Bridgman-grown GaSe, attributing to the smaller absorptions of THz in solution grown GaSe. Moreover, the phase matching condition has also been investigated [5].

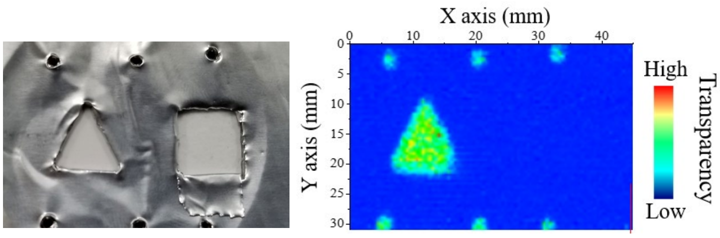

Fig. 2: The THz imaging of diphenyl phthalate using THz generated by GaSe crystal

Applications

The imaging of diphenyl phthalate, one kind of transparent harmful plasticizer, is demonstrated in Fig. 2 as an example of applications. The difference between innoxious polyethylene (left triangle) and diphenyl phthalate can be distinguished using the imaging at 1.5 THz

3. Conclusions

THz waves have successfully generated from low-temperature solution grown GaSe via the DFG process. It is confirmed that the as-grown crystals are suitable for high-intensity changeable monochromatic THz generation and able to be applied for detection.

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