ファンデルワールス結晶の低温液相成長及び非線形光学応用

The low-temperature liquid phase growth and nonlinear optical applications of Van der Waals crystals

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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 about ten times compared with previous results [3].

Experiments and results

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.

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 conduct-ed with the oeo mode of the GaSe crystals. The generation efficiency is ten times larger than that of Bridgman-grown GaSe, attributing to THz's smaller absorptions in solution grown GaSe. Moreover, the phase-matching condition has also been investigated [5].

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