Unit for the development of terahertz sensing and imaging systems

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Members of the unit

- Institute of Laser Engineering, Osaka University
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- National Institute of Information and Communication Technology (NICT)
  Iwao Hosako
Application for THz sensing and imaging
—Technology for a secure and safe society—

Microprocessor analysis

IC card

Drug inspection

Security check

Tablets in a envelope

Cutter knife in a envelope
Growth of DAST and derivative crystal (M. Yoshimura, T. Matsukawa, R. Murai)

Development of QCL (I. Hosako)

Study of superconducting THz detector (I. Kawayama, Y. Doda)

Evaluation of DAST emitter (H. Koga)
Development of THz system (K. Takeya)

Growth of DAST and derivative crystal (M. Yoshimura, T. Matsukawa, R. Murai)

ILE, Osaka Univ.

ILE, Osaka Univ.

Dep. of Electrical Eng., Osaka Univ.

Broad-band THz sensing and imaging system

THz system with QCL and superconducting detector

Development of superconducting detector (J. Chen, Nanjin Univ.)

Development of THz system (D. Mittelman, Rice Univ.)

Advisers

Main research groups

National Ins. of Info. and Comm. Tech. (NICT)
Broad-Band THz Spectroscopy

Observation and application of THz waves at high frequency region (over 4 THz) using DAST crystal (4-dimethylamino-N-methyl-4 stilbazolium tosylate).

Experimental system

- Time-delay stage
- Off-axis parabolic mirror
- Detector
- Beam splitter
- Optical chopper
- DAST

Er doped fiber LASER
(Wavelength: 1.5μm, pulse width: 70fs, repetition rate: 50MHz)

detector: 47mW
emitter: 20mW

Amplitude spectra from DAST (Black) and LT-GaAs (Red)
Growth of DAST derivatives for THz emitter

DAST crystals is expected as a candidate for broadband THz-wave source.

However,

(1) Absorption around 1.1 THz ⋯ it is important to apply the imaging, and so on
(2) Recently the crystal growth of DAST derivatives and the properties of THz-wave generation have been reported.

We attempt to develop new DAST derivatives for THz-wave generation.

- No absorption around 1.1 THz
- Generation of high-power and broadband THz wave
Approach

1. New DAST derivatives
   - Ex. MC-pTS
   - Okada lab. (Yamagata Univ.)
   - Umezawa lab. (FNCT)

2. Crystal growth
   - Mori lab.
   - Slope Nucleation Method (SNM)
   - Fig. 1 single crystal of MC-pTS

3. THz wave generation
   - Tonouchi lab.
   - THz-wave application

Tonouchi lab.

Okada lab. (Yamagata Univ.)
Umezawa lab. (FNCT)
Development of a New Technique for the Crystal growth

Research of the Mechanism of Femtosecond Laser-induced Nucleation

\[ \text{Laser Irradiated Growth Technique} \]

We irradiate supersaturated solution with femtosecond laser, and induce nucleation actively.

\[ \text{Supersaturated solution} \]

\[ \text{Crystal} \]

\[ \text{Objective lens} \]

\[ \text{Femtosecond laser} \]

\[ \text{Mirror} \]

Successful examples

- \text{organic molecules}
  - urea
  - anthracene
  - DAST
- \text{biomacromolecule}
  - water-soluble protein lysozyme
  - membrane protein AcrB

We can grow crystals at low supersaturation \( \rightarrow \text{high quality crystals} \)

The optimum laser irradiation condition is not determined
Some samples did not crystallize by laser irradiation

\[ \text{Clarify the mechanism of Laser Irradiated Growth Technique and optimize laser irradiation condition} \]
Superconducting THz detector

Previous Researches
- Detection of Photomixing Signals -

Introduce Quantum Cascade Laser (QCL) that should be powerful THz source for high speed imaging systems
Plans

• Broad-band THz-TDS with DAST
• Growth of DAST derivatives as the candidates of new THz emitters
• Superconducting THz detectors
• Imaging system with QCL

New THz sensing and imaging systems
(Broad-band, High sensitivity, High speed etc.)