Laser Terahertz Emission Microscope

Osaka Univ., ○**Masayoshi Tonouchi**

E-mail: tonouchi@ile.osaka-u.ac.jp

One can observe terahertz (THz) radiation from various kinds of materials, when excited with a femtosecond laser. THz waves are excited by ultrafast current modulation and its electric field E_{THz} is expressed as follows:

$$E_{THz} \propto \frac{\partial J}{\partial t} \propto ev\frac{\partial n}{\partial t} + en\frac{\partial v}{\partial t}.$$

Where J is current, v and n are carrier velocity and density, respectively. Thus THz waves reflect various kinds of properties such as local electric field, particularly ultrafast transient phenomena, in their waveforms recorded in time domain. The observation of the THz waveforms enables us to explore ultrafast nature of electronic materials and devices as a THz emission spectroscopy. The THz emission images by scanning the laser beam on samples visualize spatial distribution of such carrier dynamics. This imaging method has a distinct advantage that the resolution of the image is limited by the laser beam diameter rather than THz wavelength. Thus construction of a laser-THz emission microscope (LTEM) [1] would provide a new tool for material/device science and application.

We proposed and have been developing LTEM since 1997. In this talk, we will report the basics of LTEM, dynamic pump-and-probe LTEM (DTEM), near field LTEM, and some examples [2-4].

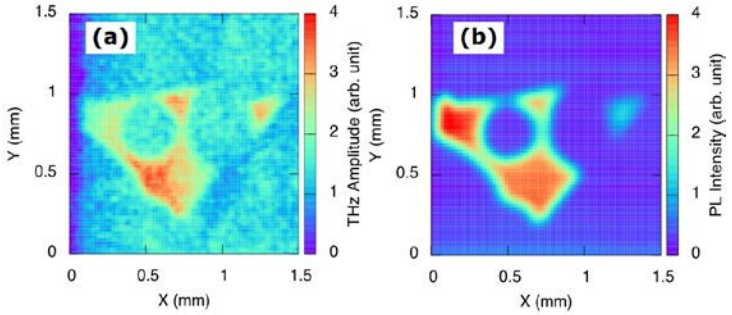

Fig.1 (a) The LTEM and (b) PL image of n-type GaN. [3]

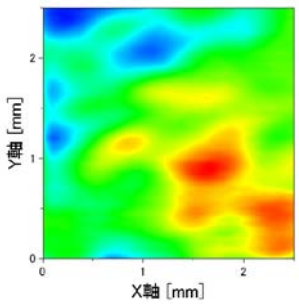

Fig.2 Oxygen molecule distribution. [4]

References [1] H. Murakami, *et al.*, "Scanning laser THz imaging system," Journal of Physics D: Applied Physics 47, 374007(2014). [2] H. Nakanishi, *et al.*, "Comparison between laser terahertz emission microscope and conventional methods for analysis of polycrystalline silicon solar cell, " submitted. [3] Y. Sakai, *et al.*, "Visualization of GaN surface potential using terahertz emission enhanced by local defects, " submitted. [4] Y Sano, *et al.*, "Imaging molecular adsorption and desorption dynamics on graphene using terahertz emission spectroscopy," Scientific Reports 4, 6046(2014).