

Terahertz spectroscopy of single molecules and single atoms by using nanogap electrodes



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Professor Kazuhiko HIRAKAWA was awarded the 15th Leo Ezaki Prize in October, 2018.

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Clarifying electronic and vibronic properties at individual molecule level provides key insights to future chemistry, nanoelectronics, and quantum information technologies. Here, we report on the terahertz (THz) spectroscopy of single molecules by using a single molecule transistor (SMT) geometry. From the time-domain THz measurements, we have obtained THz spectra associated with the THz-induced center-of-mass oscillation of the molecules. The observed spectra reflect the potential profile experienced by the molecule on the metal surface when the number of electrons on the molecule fluctuates by one during the single electron tunneling process. Such an ultrahigh-sensitivity to the electronic/vibronic structures of a single molecule upon adding/removing a single electron has been achieved by using the THz spectroscopy in the SMT geometry. This novel scheme provides a new opportunity for investigating ultrafast THz dynamics of sub-nm scale systems.

References:

- 1) K. Yoshida, K. Shibata, and K. Hirakawa, *Phys. Rev. Lett.* 115, 138302 (2015).
- 2) S. Du, K. Yoshida, Y. Zhang, I. Hamada, and K. Hirakawa, *Nature Photon.* 12, 608 (2018).