Vibron-assisted transport in single $Ce@C_{82}$ molecule transistors

[1]Institute of Industrial Science and [2]INQIE, University of Tokyo
°Shaoqing Du[1], Kenji Yoshida[1], Ya Zhang[1], Kazuhiko Hirakawa[1,2]
E-mail: sqdu@iis.u-tokyo.ac.jp

Terahertz (THz) spectroscopy is a powerful tool for clarifying electronic structures and vibrational dynamics of various kinds of molecules. However, it is a great challenge to greatly exceed the diffraction limit [1] and perform single molecule spectroscopy, because there is a huge size difference (a factor of ~10^5) between the THz wavelength (~100 μm) and the size of single molecules (~1 nm).

In this work, we have investigated the electron transport in single molecule transistor (SMT) under THz radiation. By employing an antenna structure with a sub-nm-wide gap, we concentrated the THz radiation onto a single $Ce@C_{82}$ molecule. We measured THz-induced photocurrent and its spectra in the SMTs.

Fig. 1(a) shows the Coulomb stability diagram and THz-induced photocurrent of a $Ce@C_{82}$ SMT. The crossing pattern indicates that we capture a single molecule in the nanogap and the single electron tunneling takes place through the molecule. The transport mechanism at the white point is shown in the inset of Fig. 1(b) (THz-induced vibron-assisted tunneling). Fig. 1(b) shows the spectra of the measured THz photocurrent for a $Ce@C_{82}$ SMT. A series of photocurrent peaks appears around 4 meV, 7 meV, 11 meV, 14 meV, 18 meV, and 22 meV. Although the origin of these peaks is not clear at present, we think the peaks arise from the THz-induced vibron-assisted transport [2].

References: [1] Y. Zhang et al, Nano Lett. **15**, 1166 (2015). [2] R. Leturcq et al, Nature Physics **5**, 327 -331 (2009).

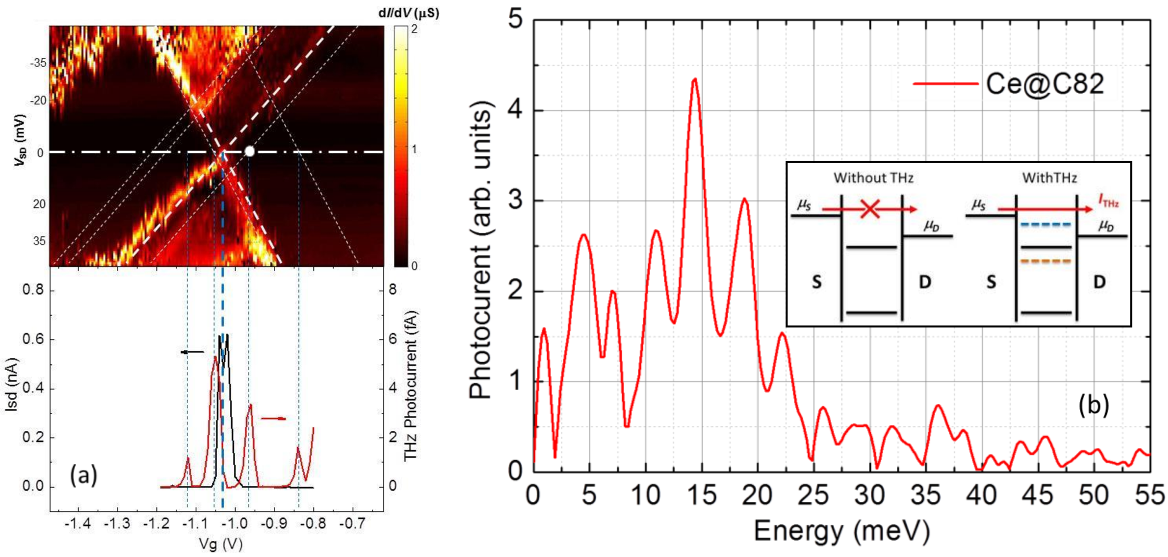

Fig. 1 (a) Coulomb stability diagram and THz-induced photocurrent measured on a $Ce@C_{82}$ SMT. White dashed lines are eye guides for the Coulomb diamonds and the white dotted lines denote the positions of vibrational excitations. (b) THz spectrum measured near the charge degeneracy point (V_{SD} = 0.1 mV, V_G = -1.03 V) shown in Fig. 1(a). The resolution of the measurement was 1 meV. The inset schematically illustrates the process of the THz-induced vibron-assisted transport.