

Terahertz dynamics in single InAs quantum dots and single molecules detected by photocurrent spectroscopy

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THz electromagnetic wave is a powerful tool for studying nanomaterials, but it is very difficult to perform THz spectroscopy on single nanostructures. THz wave has a very long wavelength (1THz: 300 μ m), which is 3-4 orders of magnitude larger than the size of the nanostructures such as self-assembled InAs QDs (20-100nm). The cross section of a single QD for scattering THz wave is therefore very small. Furthermore, since there are only a few electrons in the QD, the THz absorption by a single QD would be extremely weak, making conventional THz transmission or reflection spectroscopy impossible for single QDs.

In this work, we propose a novel method for performing THz spectroscopy on single InAs QDs. We used nanogap electrodes integrated with a bowtie antenna to tightly focus THz wave on a single QD, and we measured the intersublevel excitations by measuring the THz-induced photocurrent through the QD-single electron transistor (SET)[1]. Photocurrent distribution with respect to the Coulomb diamonds indicates that there are two mechanisms for the photocurrent generation. We observed high-quality intersublevel transition spectra in single QDs that show interesting dependence on the electron configuration in the QDs[2-3]. By using the same method, we have observed the THz vibrational excitations in single molecules [4]. These results indicate that THz photocurrent spectroscopy is a powerful tool for studying the interaction between THz electromagnetic wave and single quantum nanostructures.

Reference

- [1] Y. Zhang et al., Nano Lett. 15 (2), pp. 1166 -1170(2015).
- [2] Y. Zhang, et al., Phys. Rev. B, Rapid communication, 91, 241301(2015).
- [3] Y. Zhang, et al., Physical Review B 93 (23), 235313(2016).
- [4] S.Q. Du, et al., Nature Photonics 12 (10), 608 (2018).

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研究方向

- Terahertz (THz) dynamics in single quantum nanostructures

太赫兹波与量子点, 单分子等量子纳米结构之间的相互作用

代表论文: Y. Zhang et al, Nano Lett. 15 (2), pp. 1166 -1170(2015) etc.

- Uncooled, sensitive THz detector by using microelectromechanical beam resonators

基于微机电振荡器的室温/高灵敏度太赫兹探测器

代表论文: Y. Zhang et al, Appl. Phys. Lett., 108, 163503(2016). etc.