パッシブ型 THz 近接場顕微鏡における信号温度依存性の観察

Observation of temperature dependence of passive THz near fields

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Recently, our group has developed a passive s-SNOM (scattering-type scanning near-field optical microscope) with an ultrahighly sensitive THz detector, called CSIP (charge-sensitive infrared phototransistor [1]) as shown in Fig. 1(a). The detection wavelength is $\lambda = 14.1 \pm 0.5$ μm. The passive s-SNOM probes thermally excited electromagnetic evanescent field on metal and dielectric surfaces without using any external illumination or excitation [2]. We have increased the SNR to 5.5 with 10 Hz scan rate as shown in Fig. (b) by improvement of optical components in the confocal microscope. To study the temperature dependence of passive near-field (NF) signals, we introduced a ceramic heater into the passive s-SNOM that can heat a sample to 100 °C. We demonstrate the temperature dependence of the thermally excited NF signals on Au [see Fig. (c)]. The NF signals increased by a factor of 3 when the temperature was elevated from 27 to 100 °C. The data can be fitted by theoretical model through the relation $I_{NF} \propto [\exp(\hbar\omega / k_B T) - 1]^{-1} - [\exp(\hbar\omega / k_B T_{rad}) - 1]^{-1}$, where $\hbar$ is the Planck's constant divided by 2π, k_B is the Boltzmann's constants, and T and T_{rad} are the sample temperature and effective radiation temperature, respectively. Here the fitting parameter T_{rad} = 248 K. The result indicates that the sample is exposed to ambient radiation that may come from the optical components in the cryostat.

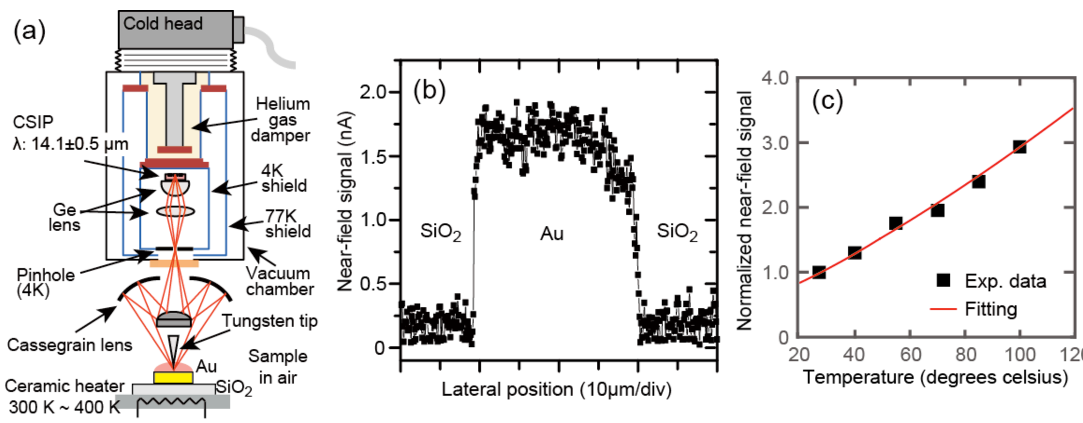

Fig. 1 (a) Schematic diagram of the passive s-SNOM. (b) An near-field profile across a Au stripe deposited on a SiO_2 substrate. (c) NF signal as a function of sample temperature.

Reference:

[1] S. Komiyama, *IEEE Journal of Selected Topics in Quantum Electronics*, 17, (2011), 54

[2] Y. Kajihara, et al., Opt. Express, 19, (2011) 7695