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パッシブ型 THz 近接場顕微鏡における分解能 20 nm の実現

THz passive near-field imaging with 20nm resolution

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In recent years, a scattering-type scanning near-field optical microscope (s-SNOM) with an ultrahighly sensitive THz detector, as known as the charge-sensitive infrared phototransistor (CSIP), has been developed. The s-SNOM probes thermally excited electromagnetic evanescent field (wavelength λ = 14.5±0.7 μm) on metal and dielectric surfaces without using any external illumination or excitation [1].

Now our passive s-SNOM achieves 60 nm-spatial resolution, which is much better than any other passive microscopy. However, to study more interesting objects like biomolecules and metal nano-particles, much better resolution (< 20 nm) is strongly required. Previous studies have noted that the spatial resolution of the s-SNOM is relies on the radius of apex curvature of a probe tip. Therefore we have improved electrochemical-etching method. During etching, the passing current between the tungsten probe (anode) and the carbon electrode (cathode) was monitored, and we selected a suitable cut-off current to prevent over-etching. With the new etching method, a sharp tungsten probe with an apex diameter of 20 nm can be fabricated [see inset of Fig. 1(a)]. Figure 1(a) displays the profile of near-fields signal taken along the boundary between SiO_2 substrate and 100 nm thick Au layer. According to this step width, the spatial resolution has been derived to be ~20 nm (λ/725) consisting with the probe size. Figure 1 (b) shows the probe-height dependence of the near-field signal above Au. The curve indicates that the decay length of the near-field signal is ~20 nm. It is also agree well with the probe size.

The results have demonstrated that the spatial resolution of the s-SNOM has been improved to 20 nm.

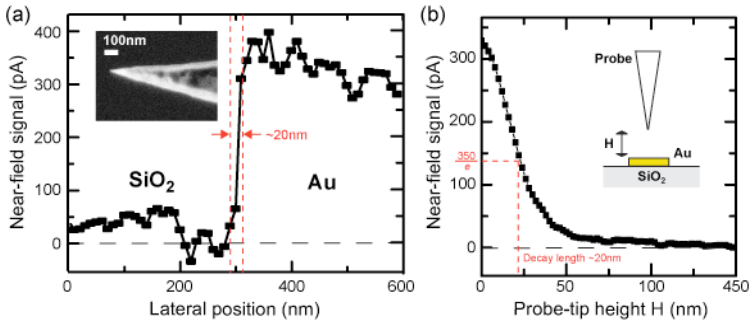

Fig. 1 (a) The spatial resolution ~20 nm shown in the step edge between Au and SiO_2. Inset: SEM image of a tungsten probe with an apex diameter ~20 nm. (b) Probe-height dependence of the near-field signal above Au.

Reference:

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

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