Development of low-temperature THz near-field microscopy with a confocal optics

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Passive THz Scattering-type scanning near-field optical microscopy (s-SNOM) without any external light source provides nanometer spatial resolution to probe fluctuating electromagnetic evanescent waves induced by fluctuating charge/current below the sample surface [1,2]. For expanding the application of the passive THz s-SNOM to low-temperature (LT) studies such as phase transition materials and energy dissipation of LT electrotransport devices, we have developed a LT THz optical microscope containing a chamber, providing 4.2 K environment for both CSIP and sample stage, as shown in Fig. 1(a). To efficiently extract the near-field component submerged within a large background component emitted from the focal area of the objective shown in Fig. 1(b), we introduced a confocal optics to exclude the radiation out of the focal area on the surface. In this report, we prepared a NiCr filament as a heater to heat up a Au/SiO₂ sample. In Fig. 1(c), the far-field signals of Au and SiO₂ are clearly distinguished due to the difference in emissivity. The spatial resolution of the confocal microscope is about 70 µm, better than the 110 µm obtained from the single lens optics [3]. Based on the optics improvements, we have observed the thermally excited near-field signals on the heated NiCr wire with the passive LT s-SNOM.

Reference: