低温 THz 散乱型走査近接場顕微鏡の開発

Development of low-temperature THz scattering-type scanning near-field microscope

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Passive THz Scattering-type scanning near-field optical microscopy (s-SNOM), where no any external light source is needed, has been applied to probe spontaneous fluctuating electromagnetic (EM) evanescent waves induced by fluctuating charge/current below 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 developed a THz confocal microscope with a vacuum chamber, providing 4.2 K for both THz detector (λ = 10.2 ± 0.9 μm) and AFM system, as illustrated in Fig. 1(a). We use a tungsten probe to scatter the near-field (NF) component, shown in Fig. 1(b). To demonstrate the LT s-SNOM capability, we fabricated a NiCr narrow wire (thickness and width of 30 nm and 3 μm, respectively) as a filament on a SiO_2 substrate to generate Joule heating by the bias voltage (~169 mW). Fig. 1(c) shows an NF signal detected on the NiCr/SiO_2 sample with a step of 300 and 10 s of integration time. We kept the tip-sample distance at 5 nm during the scan. The NF signals observed on the NiCr surface is ascribed to the EM evanescent waves induced by the thermal excited random motion of conduction electron. The results successfully demonstrate the nanoscale thermal excited NF detection on the NiCr narrow wire using the LT THz s-SNOM. After establishing the LT THz s-SNOM, we expect it enables us to further study kinetics energy of charge/phonon in non-equilibrium nano-devices.

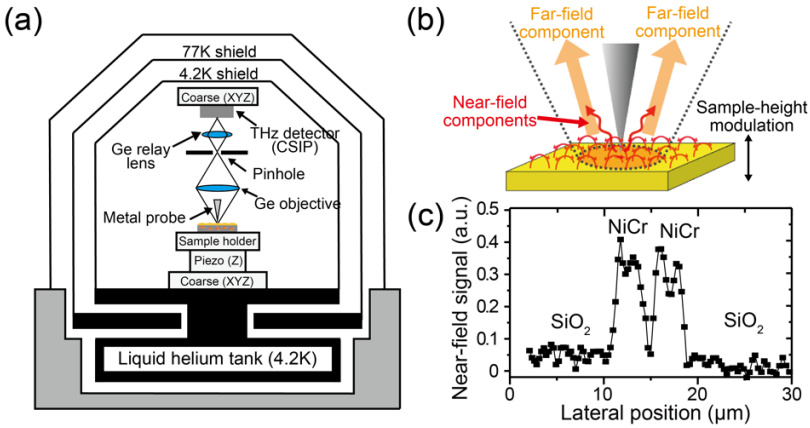

Fig. 1 (a) Schematic view of the low temperature passive THz scattering-type near-field optical microscope. (b) Concept of probing fluctuating evanescent waves with the metal probe. (c) Plot of THz near-field intensity cross a Joule-heated NiCr/SiO_2 sample.

Reference:

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