Signal-to-noise ratio improvement of the passive near-field microscope with a helium-free cryostat

°林 冠廷[1]、小宮山 進[2]、金 鮮美[1]、河村 賢一[3]、梶原 優介[1]
（1. 東大生産研、2. 東大総合文化、3. 東京インスツルメンツ）
°Kuan-Ting Lin[1], Susumu Komiyama[2], Sunmi Kim[1], Ken-ichi Kawamura[3], and Yusuke Kajihara[1]
(1. Institute of Industrial Science, Univ. Tokyo, 2. Department of Basic Science, Univ. Tokyo, 3. Tokyo Instruments, Inc.)
E-mail: kuanting@iis.u-tokyo.ac.jp

Passive THz s-SNOM (scattering-type scanning near-field optical microscope) is a powerful tool, which can reveal the weak spontaneous radiation on a sample surface (e.g. Au, GaAs, or SiC) without external light source [1,2]. However, the scan speed of the present passive s-SNOM is limited by its low SNR. To get a better SNR for increasing the scan speed, we improved the confocal microscope as follows: (1) The solid immersion lens, where an extremely sensitive CSIP (charge-sensitive infrared phototransistor [3]) detector is sealed. It can achieve smaller focusing spot on a sensing area of the CSIP to enlarge the detected photon. (2) The metal-mirror type Cassegrain objective (N.A.: 0.4) whose thermal emission is almost zero. Besides, we introduced a helium-free cryostat to make cooling process more conveniently. Mechanical and He gas dampers are used to attenuate the vibration from the cold head [see Fig. 1(a)]. Figure 1(b) shows that we have successfully observed the near-field signal on a Au stripe (lower panel), which was 5 times larger than former record [2]. The SNR is derived to 5 with a time constant of 1s. Furthermore, the smooth topography (upper panel) indicated that the vibration problem has almost been solved.

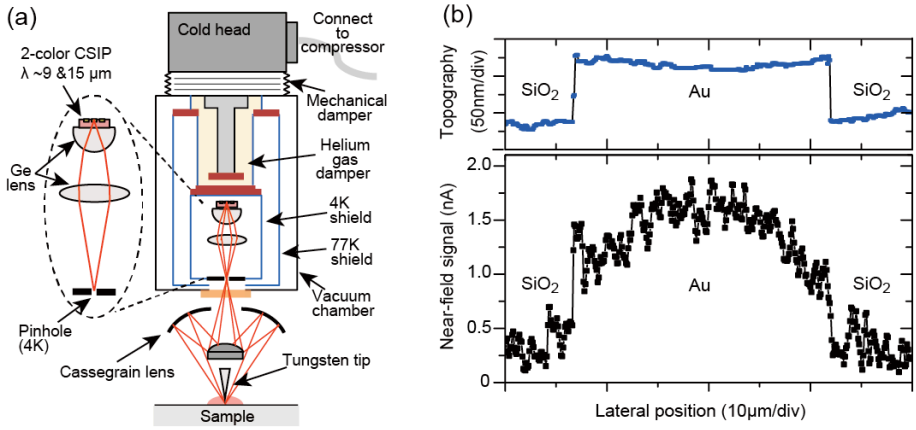

Fig. 1 (a) Schematic diagram of the passive s-SNOM equipped with helium-free cryostat. (b) An AFM topography profile (upper panel) and an intensity profile of the near-field signal across a Au stripe deposited on a SiO_2 substrate (lower panel).

Reference:

[1] Y. Kajihara, et al., Rev. Sci. Instrum., 81, (2010) 033706
[2] Y. Kajihara, et al., Opt. Express, 19, (2011) 7695
[3] T. Ueda, et al., J. Appl. Phys., 103, (2008) 093109