BL43IR
(Infrared Materials Science)

BL43IR is dedicated to infrared microspectroscopy. The beamline has three microscopes: a high spatial resolution microscope, long working distance microscope, and magneto-optical microscope. The microscopes are used with a Fourier transform spectrometer. Due to more than 19 years of operations, some of the apparatuses have deteriorated. In FY2018, we focused on updating these components.

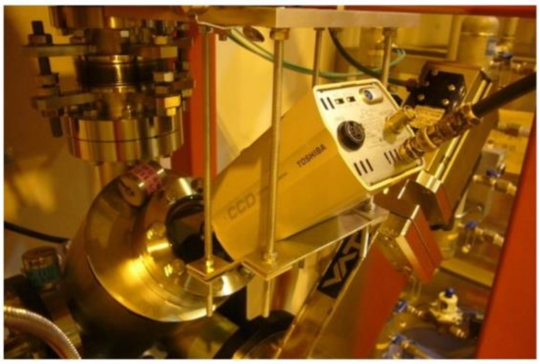

Fig. 1. Observation CCD camera.

Fig. 2. Camera related components.

1. Malfunctions and their measures

In FY2018, we discovered several malfunctioning apparatuses.

1-1. Malfunction of the charge-coupled device (CCD) observation apparatus

The upper part of the beamline light path contains three CCD cameras for beam alignment and to observe the light image scattered from the mirrors. The CCD cameras shown in Figure 1 are connected to a power supply/signal I/O and a signal switcher as shown in Figure 2. Because signs of device failure were routinely observed in FY2018 due to the aging system, we decided to replace these with new components. We are planning to install new devices in FY2019.

1-2. Malfunction of the microscope observation electrics

The infrared microscope Bruker Hyperion 2000 has two halogen lamps to observe samples. We encountered an unknown symptom where a user at the control panel turned off the observation light and rebooted the light path (mirror position) to the default value. Although neither we nor Bruker could identify the origin, the light bulb for the transmittance burned out eventually. The symptom vanished after changing the light bulb. Thus, we provisionally concluded the incident was caused by the electrics related to the transmittance light.

2. Replacement of the AFM equipped in the scanning near-field optical microscopy (SNOM) apparatus

SNOM utilizes near-field light to overcome the diffraction limit of the incident light to observe an area smaller than its wavelength. Infrared synchrotron radiation with the SNOM realizes effective high-intensity broadband spectroscopy. We have achieved a spatial resolution below 200 nm in the mid-infrared wavelength with well-ordered samples such as the edge of a gold thin film.

The next target of this project should be realistic forms of materials such as randomly dispersed minute particles on a substrate. However, this has yet to be achieved because the old AFM apparatus had issues with a weak stability and unreliable reproducibility for the growing demand. In FY2018, we replaced the old AFM unit (UP-100P; Unisoku) with a new one (Nano Observer; CS Instruments). Figure 3 schematically illustrates the SNOM system and shows a photograph of updated AFM apparatus.

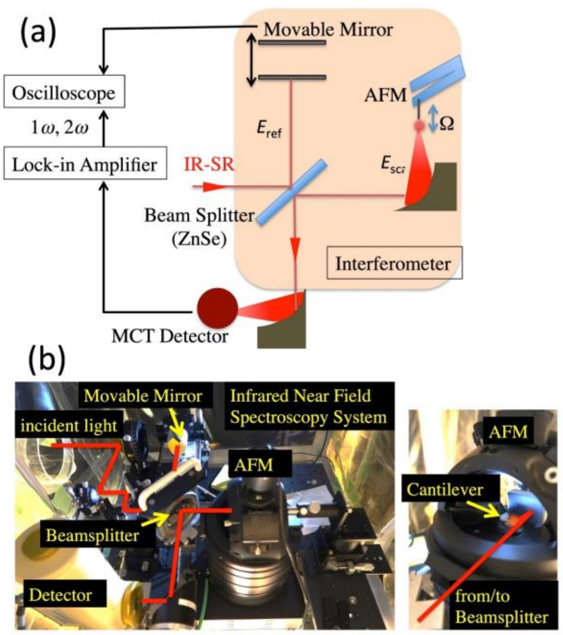

Fig. 3. (a) Schematic of the SNOM system and (b) photograph with updated AFM apparatus.

The collimated IR-SR is injected into the interferometer and split by a KBr/Ge beam splitter (Figure 3(a). One beam goes to a movable mirror, which is a corner cube retroreflector. The back-and-forth motion of the mirror is controlled by a piezo stage. The frequency of the mirror movement is about 7 Hz, and the mirror position is determined by the output signal of the piezo controller. The other beam reflected by the beam splitter is focused onto the probe tip by a parabolic mirror with a 30-mm focal length. The scattered light from the probe tip and the reference beam reflected by the movable mirror interfere with each other. This interference is detected by an MCT (HgCdTe) detector with a 0.25 mm × 0.25 mm sensor size.

Modulation spectroscopy is performed using the frequency of the AFM probe oscillation (ω = 32 kHz) to eliminate background signals other than the near-field one. The first (ω) and second (2ω) harmonic components of the detected signal are extracted using the lock-in-amplifier. The output signal from the lock-in-amplifier is recorded by an oscilloscope. Beginning in FY2019, we will acquire data with the updated system.

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