Equipment Development Center

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Research and development of novel instruments demanded in the forefront of molecular science, including their design and fabrication, are the missions of this center. Technical staffs in the three work sections, mechatronics, electronics and lithography are engaged in developing state-of-the-art experimental instruments in collaboration with scientists. We expanded our service to other universities and research institutes since 2005, to contribute to the molecular science community and to improve the technology level of the center staffs. A few selected examples of our recent developments are described below.

Introduction of New Lithography Equipment

Several types of lithography equipment have been installed in our clean room over the past few years.

One is a Reactive Ion Etching (RIE) machine, the "RIE-10NR" from Samco Inc. This machine can etch silicon (Si) and silicon dioxide (SiO_2) using carbon tetrafluoride gas as a process gas, and it can also etch organic materials using O_2 gas (Figure 1 left). Before this equipment was installed, we performed wet etching using corrosive solutions. With the installation of the RIE equipment, dry etching is now possible, allowing us to fabricate finer patterns that were previously unachievable with wet etching.

Another piece of equipment is the Evaporation Equipment, which was donated to us by a research group at the Institute for Molecular Science. It is a customized version of ULVAC's Compact Evaporation Equipment DEPOX Series "VTS-350M/ERH." Since the equipment was not ready for immediate use after relocation, members of the Equipment Development Center collaborated to set it up. We have successfully confirmed that gold can be deposited using this system (Figure 1 right).

We plan to use the aforementioned equipment extensively for microfabrication *via* lithography.

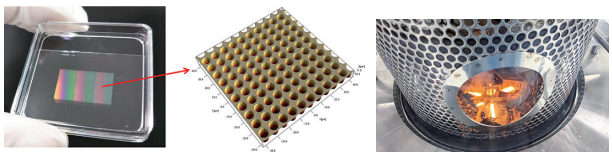

Figure 1. Examples of fabrication using O_2 gas as a process gas (left) and gold evaporation (right).

Electronics Instruments for Low-Temperature Scanning Near-Field Optical Microscopy

By utilizing near-field techniques, scientists can perform optical imaging and spectroscopy below the diffraction limit. To achieve near-field optical measurements at ultra-low temperatures and ultra-high vacuum conditions, we have developed three electronic instruments: (1) an interferometer that precisely detects and amplifies interference light generated in optical fibers; (2) an instrument that provides feedback signals based on fluctuations in the distance between the optical fiber and cantilever; (3) a driver that moves the piezo stage to fine-tune these fluctuations. Since we detect, amplify, and control weak signals, all instruments are constructed entirely with analog circuits.

The interferometer detects interference light from the optical fiber using a four-quadrant photodiode and amplifies it 250,000 times using a detection circuit built with ADA4627-1ARZ (Analog Devices). The feedback instrument smooths and holds fluctuations of less than 10 Hz, which are mixed in the interference light, using an integrating circuit with ADA4084-1ARZ (Analog Devices). The driver, constructed primarily with a high-voltage amplifier PA441DF (Apex), drives the piezo stage to fine-tune the fluctuation correction (Figure 2).

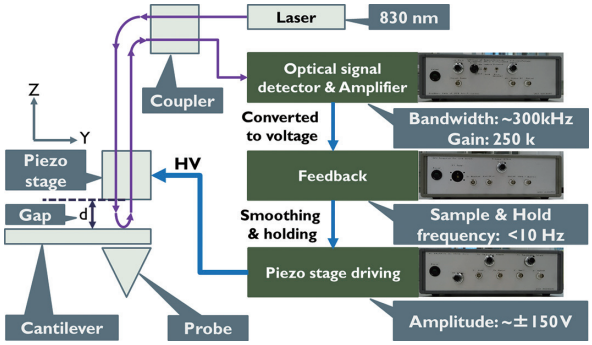

Figure 2. Schematic of electronics instruments for NCAFM (Non-Contacting Atomic Force Microscope) based on optical fiber detection.