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, mechanics, electronics and lithography ones, 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.

Machining with High Accuracy

Researchers need new equipment to realize advanced experimental setups designed for their novel scientific achievements. We, the Equipment Development Center (EDC), receive various requests from researchers. For example, there is a plastic pipe shaped as shown in Figure1. This product was made by a precision lathe owned by the EDC shown in Figure 2, the process of which is full of ingenuity by the staffs with the knowledge on the materials properties. (Figure 3)

The pipe is designed to connect to a custom-made equipment as a gas tube adapter. A commercial product cannot be connected to the equipment due to a limitation in space. Furthermore, tolerance is very strict and needs to be less than 5/1000mm, because a high-pressure gas may blow the tube away from the equipment.

Such strict requirements are difficult to be handled by outsourcing. Even if it is possible, the cost is unreasonably high, or the product may not be available on schedule. We respond to such request from researchers with quick delivery, meticulous work, and less costs in order to contribute to their experiments which will lead to scientific advancements.

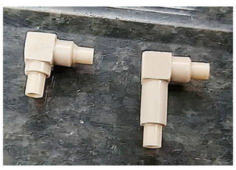

Figure 1. Plastic Pipe.

Figure 2. Precision Lathe.

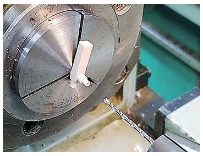

Figure 3. Machining a pipe.

Fabrication of a Signal Splitter

In order to synchronize an AFM system with lock-in amplifier, it is necessary to amplify the system signal whose frequency and amplitude are in the range from 200 kHz to 250 kHz and about 100 mVp-p, respectively, by about 10 times. In addition, when the input signal to the lock-in amplifier has jitter, synchronization cannot be achieved. Thus it is required to remove unnecessary frequency components and amplify the signal with high precision. It is also required to split the signal into two circuits before the amplification for the sake of simultaneous topographic observation. Moreover, an current output which can drive the 50Ω input impedance of the measurement system is mandatory.

We have developed a Signal Splitter shown in Figure 4; it buffers the signal detected by AFM with high input impedance by JFET type operational amplifier (Analog Devices AD825ARZ), and cuts unnecessary frequency components off by active high-pass filter with a cutoff frequency of 100 kHz. Then the signal is amplified by 6 times with another operational amplifier (Analog Devices AD8639ARZ), which allows driving of 50Ω impedance with the help of current feedback operational amplifier (Texas Instruments THS3001CD).

This instrument has enabled vibrational spectroscopy of single proteins and ultrafast nano-spectroscopy.

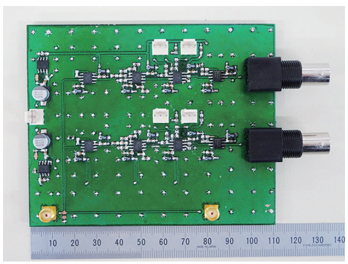

Figure 4. The Circuit Board of the Signal Splitter.

Award

TOYODA, Tomonori; The Chemical Society of Japan Award for Technical Achievements for 2021 (2022).