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.

Manufacturing Methods for Soft Materials

When developing original equipment, one of the common challenges is securing materials during machining. This issue became particularly evident in the fabrication of components for the low-temperature goniometer stage we produced last year (Figure 1). The stage is composed of numerous small parts, each requiring precise shaping and surface uniformity.

Typically, a vise is used to fix materials on a milling machine. However, depending on the material and thickness, clamping pressure can cause deformation, leading to uneven surfaces. This problem was especially pronounced with resin parts compared to metal ones. To overcome this, we devised an alternative method based on adhesion rather than clamping.

Specifically, we prepared a centering jig, attached the large surface of the material using double-sided adhesive tape, and constrained three surrounding sides to prevent dislodgement. This approach allowed us to machine the surface uniformly without deformation (Figure 2).

Through such efforts, we continue to refine machining techniques by designing custom jigs and exploring new methods to ensure high-precision fabrication of soft and delicate materials.

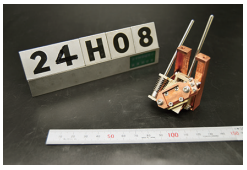

Figure 1. Low-Temperature Goniometer Stage.

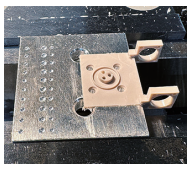

Figure 2. Part attached to original jig.

Development of Network-Compatible 4-Channel AD Converter Module

Many laboratory instruments, such as vacuum gauges, provide analog voltage outputs but lack network connectivity. To enable remote monitoring of such devices, we developed a compact 4-channel AD converter module based on the ESP32 microcontroller and its evaluation board (Figure 3).

The module is powered *via* a USB Type-C connector (5 V, 0.5 A) and can connect either to a 2.4 GHz Wi-Fi station or operate as an access point. An integrated OLED display provides basic information such as the device MAC address, connection status, and real-time voltage readings, making the module suitable for both networked and standalone use.

The system supports simultaneous measurement of four voltage inputs within a ±10 V range, with 16-bit resolution provided by the A/D converter and pre-amplifier circuitry. While the acquisition rate is modest (approximately one second per measurement), the module includes a microSD card slot, enabling continuous long-term operation over several months depending on storage capacity. Data can be retrieved *via* any HTTP or WebSocket client, and a dedicated monitoring dashboard is under development for consolidated observation of multiple units (Figure 4).

Initially, one prototype was produced at the request of a researcher. Following its successful demonstration, ten additional units were manufactured for the UVSOR Synchrotron Facility. These deployments confirm the module's practicality as a flexible solution for extending network capability to analog-output instruments.

Figure 3. Module overview.

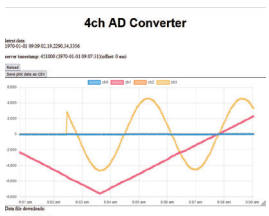

Figure 4. Monitoring web application.