Equipment Development Center

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Design and fabrication including the research and developments of the new instruments demanded for the molecular science are the mission of this center, which consists of the mechanical, electronics and glass work sections. We expanded our service to the researchers of other universities and research institutes since 2005. The main aims of this new attempt are to contribute to the molecular science community and to improve the technology level of the center staffs.

The technical staff of the Equipment Development Center is engaged in planning, researching, designing and constructing high technology experimental instruments in collaboration with the scientific staff. And these experimental instruments are manufactured by incorporating with new technologies and new mechanical ideas. A part of our activity in the current fiscal year is described below.

Development of Universal Data Logger with USB 2.0 Interface for NMR Spectroscopy

This project was proposed by Associate Prof. Kawamoto (Faculty of Science, Hokkaido University). Since FID (Free Induction Decay) signal of NMR spectroscopy decays fast and amplitude of the signal is very small, the high speed and high resolution A/D system is required. However, commercially available products are expensive and some of them are obsolete. Although USB is the most popular interface between A/D devices and computer, it is difficult to make an original interface circuit board for transmitting A/D data to a personal computer. Then, we developed the universal data logger with USB connection for high speed and high resolution A/D converter evaluation board.

We assumed the evaluation board of AD9248BCPZ-40, 14bit, dual inputs, 40MSPS A/D converter (Figure 1, left) as the target A/D device. The data from A/D converter are stored to 4Mbits SRAM controlled with CPLD XC95144XL-10TQ144 with the hardware description language, VHDL, and transmitted to computer via USB by CY7C68013A-56, high speed USB 2.0 microcontroller. The system (Figure 1, right) can be constructed with commercially available components and some customized codes.

The transfer rate of this equipment is about 13.08 msec for transmitting 4 Mbits data (4 Mbit/13.08 msec) 305.8 Mbps). This rate is sufficient for NMR Spectroscopy and most of transient measurements. Our system can be easily upgraded to up to date A/D device with minimal modifications of the source code.

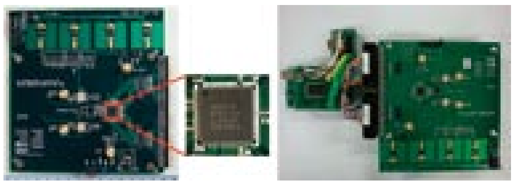

Figure 1. A/D converter and evaluation board (left) and constructed data logger (right).

Fabrication of Acrylic Substrate for 4x4 Points Type Ion Channel Biosensor

For fabrication of 4×4 points type ion channel biosensor which is currently under development in Urisu group, it is required to precisely form the 4×4 electrode inserting parts in the acrylic thin-plate (Figure 2, left). The most important point in this device is the control of thickness X in Figure 2 less than 10 µm in the acrylic substrate homogeneously at the 4×4 electrode points. In order to form this structure, we are trying hot embossing method: a heated metal mold is pressed against the acrylic substrate (cooperated by National Institute of Advanced Industrial Science and Technology (AIST)). To date, we have formed 17µm-thick thin-film in acrylic substrate. SEM image of acrylic substrate after hot embossing is shown in Figures 2 (right).

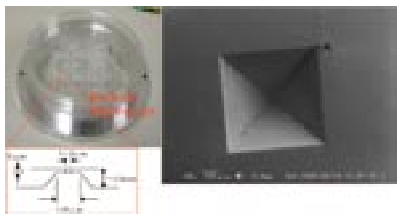

Figure 2. Multipoint type ion channel biosensor (left) and SEM image of acrylic substrate at the electrode inserting part after the hot embossing using a pyramidal mold (right).

Development of LD Pumped Passively Q-Switched Micro-Laser

We developed this equipment requested by Dr. Masaki TSUNEKANE, a member of Advanced Laser Development Division TAIRA Group, in Laser Research Center for Molecular Science. The research and study of a LD-pumped passively Q-switched micro-laser aim for laser ignition of vehicle engines taking the place of a spark plug. The developed passively Q-switched micro-laser module and a commercial spark plug are shown in Figure 3.

We have tested the various designs of micro-lasers at TAIRA Group and have improved the design for high-power, stabilization, and miniaturization. Since we achieved the energy conservation, effective ignition compared to a conventional spark plug and stable ignition for lean mixtures of gasoline and air by using the micro-laser, we have confirmed the practicality and domination of this equipment as the light source for laser ignition of engines. Now we are optimizing the design for further miniaturization comparable to a spark plug and durability to heating and vibration.

Figure 3. Compact micro-laser module.

Motorized XYZ Stages for Inverted Microscopes

This project was proposed by Prof. Urisu, who is developing an *in vitro* neural network device as a new methodology for the study of biomolecular sensing molecular science. The instrument was designed to place the PDMS stamp on the micro-pore position of the Si chip precisely (Figure 4). The specification of this stage system is shown in Table 1. It is carefully designed to provide high performance for routine applications.

Figure 4. Inverted microscope equipped on the motorized XYZ stage.

Table 1. Specification of the motorized XYZ stage.

Specifications

	PT170C-110X80Y		PA180S-200Z
	X-axis	Y-axis	Z-axis
Travel Range	110mm	80 μm	200mm
Step Resolution	1 μm	1 μm	5 μm
Position Repeatability	±1 μm	±1 μm	±1 μm
Maximum Speed	10mm/sec	10mm/sec	20mm/sec
Linear Slides	ssed roller bearings		Linear ball slide
Weight	2.4kg		17.5kg

Fabrication of a 3D Microfluidic Circuit for Compartmentalized Culture

3D micro-fluidic circuit for compartmentalized cell culture with a 25 μm hole in diameter cross-shape micro channels with 5 μm height was fabricated by injecting PDMS into a specially designed mold composing of two parts. The mold was achieved using a precise CNC milling machine, collaborating with the company supplying these molds.

Support for Outside Researchers

Table 2 shows the list of the titles which we accepted during July 2008 to June 2009. No. 1 is a design and fabrication of the apparatus to analyze the surface condition of TiO_2 photocatalyst by measuring the water contact angle without exposing to the air after cleaning of the TiO_2 surface. The photograph of the apparatus is shown in Figure 5, left. Number 5 is the fabrication of the high luminance reflection spheroid mirror. The mirror with high profile accuracy and the low surface-roughness was produced by the NC lathe followed by the hand polish processing (Figure 5, right). The number of applications to this study support from the outside researcher was about seven per year as average since 2005. More users are welcome to this system.

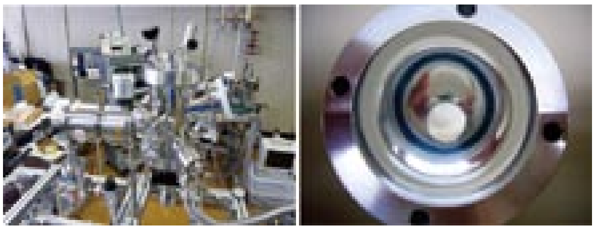

Figure 5. Apparatus for developed for the title No.1 in Table (left), and high luminance reflection spheroid mirror for No. 5.

Table 2. List of orders from outside researchers.

1	Construction of apparatus for analysis of the TiO_2 photoinduced super hydrophilicity mechanisms (HASHIMOTO, Kazuhito/The Univ. Tokyo)
2	Development of the four times reflection type X-rays telescope (TAWARA, Yuzuru/Nagoya Univ.)
3	Fabrication of the high luminance reflection mirror (BABA, Masaaki/Kyoto Univ.)
4	Development of a projection optical system and alignment stage, for ultraviolet radiation and projection exposure system (MEKARU, Harutaka/AIST)
5	Fabrication of the high luminance reflection spheroid mirror (BABA, Masaaki/Kyoto Univ.)
6	Fabrication of the Ga-compression type infrared detector (SUZUKI, Kazushi/Nagoya Univ.)
7	A compact mechanical velocity selector holder of use to analyze molecular alignment (KASAI, Toshio/Osaka Univ.)