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 two work sections, mechanics and electronics, 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 Electroplating Technology

In the Equipment Development Center (EDC), precise metal patterns are made by spattering after lithography. However, it is difficult to deposit those metals with the thickness more than 10 micrometers that is needed to produce self-standing items like a metal mask or beam stop. In order to achieve those required thicknesses, we are considering the introduction of plating technology.

As a first example, we tried to produce a molecular beam skimmer by electroforming: EDC has an experience of producing a skimmer by machining. However, it was difficult to fabricate a skimmer whose thickness is less than 1mm or to fabricate one with a small hole on the tip because of technical limitation. With electroforming, one can expect a thin metal structure which has been impossible by machining.

For this purpose, we started the process by making a lab size plating equipment and by selecting nickel sulfamate as electrolyte which is often used for electroforming. The electrodeposition by this electrolyte is advantageous in preventing deformation after plating because of smaller stress than those from other reagents. The skimmer was produced after two and half hours, whose deposit thickness was about 100 micrometers. (Figure 1) We also tested outsourced products, but they were difficult to release from the mold. On the other hand, our product was able to be released to give the skimmer easily because of the optimized pretreatment conditions by ourselves. By utilizing the difference in thermal expansion coefficient of materials, the release of the skimmer from the mold was performed by temperature cycling.

Figure 1. Molecular beam skimmer made by Electroforming.

In the near future, we will study and manufacture the optimal shape of the mother mold and aim to incorporate it into the actual experimental equipment for molecular science.

Signal Fan-Out Buffer and Distributor

In experiments using a pulsed laser such as time-dependent spectroscopy on a reaction process, a delayed pulse generator which provides signals with both a long delay time T_d and a short time-width T_w that are triggered by the laser pulse is required. When the size of the target molecule is large, T_d is increased to several milliseconds or longer. On the other hand, in order to collect only the necessary part of reaction signals into a measurement system, T_w should be as short as several microseconds.

We have developed a Delayed Pulse Generator (Figure 2) which satisfies the above specification using an ARM microcontroller (NXP LPC1114FBD48/302) and FPGA (Xilinx XC7A35T-1CPG236C) microchip. The time resolution of this equipment is 5 ns both in T_d and T_w, while the setting range of T_d is 0 ns to 4 sec, and the setting range of T_w is 1 μs to 100 ms. In addition, this equipment has a monitor output for trigger signals, with an output impedance of 50 ohms which is the same as that for output pulse.

Figure 2. Inside of a Delayed Pulse Generator (1ch version).

Award

MIZUTANI, Nobuo; The Chemical Society of Japan Award for Technical Achievements for 2018.