Equipment Development Center

URISU, Tsuneo	Director
MIZUTANI, Nobuo	Technical Associate
AOYAMA, Masaki	Technical Associate
YANO, Takayuki	Technical Associate
KONDOU, Takuhiko	Technical Associate
YOSHIDA, Hisashi	Technical Associate
UTCHIYAMA, Kouichi	Technical Associate
TOYODA, Tomonori	Technical Associate
NAGATA, Masaaki	Technical Associate
TAKADA, Noriko	Technical Associate
MIYASHITA, Harumi	Technical Fellow
TAKAMATSU, Yoshiteru	Technical Fellow
SUGITO,Shouji	Technical Fellow
URANO, Hiroko	Secretary

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 a Multi-Coincidence Electronic Circuit for Time-Resolved Reaction Microscopy of Electron Compton Scattering

The ultimate purpose of our project, by Prof. M. Takahashi and Dr. M. Yamazaki at Tohoku University, is to develop a new method that enables one to visualize the change of electron motion in transient species, which is the driving force in any chemical reactions. The method, time-resolved electron momentum spectroscopy (TREMS), is an experimental technique to probe vector correlations among the two outgoing electrons and fragment ion produced by Compton scattering by transient species using an ultrashort-pulsed electron beam. Here, a multidimensional coincidence electronic circuit specialized for the TREMS is required and has thus been developed in close collaboration with the IMS equipment development center.

The circuit (Figure 1) processes output signals from two position-sensitive-detectors (PSDs) of the TREMS for the electrons and ion, in the emitter coupled logic (ECL) levels. Each PSD produces seven separate output signals for each arrival of the charged particles; a time-reference signal from the microchannel plate and two delayed signals from both ends of three delay-line anodes. The function of the circuit can be divided mainly into two parts; one is AND gate logic to efficiently collect coincidence signals from the two electrons and the other is that to do so for the fragment ion associated with the electron signals. The circuit eventually produces 20 ECL logic signals (2 for time-reference signals of each PSD, 18 for delayed signals of three charged particles), only when the two electrons and ion are detected in coincidence within a certain time interval. The time sequence of the output signals is measured by a multichannel time-to-digital converter with a time resolution better than half-nanosecond. The circuit has successfully been tested using our conventional EMS apparatus; the results have completely met our expectations.

Figure 1. The multi-coincidence electronic circuit.

Micro Fabrication of Plastic Substrates for the Multichannel Incubation Type Planar Patch Clamp Biosensor

We are developing the multichannel incubation type planar patch clamp biosensor supporting Urisu group. It is required to fabricate sub micron-level fine structures on plastic (PMMA) substrates which is the key component of the biosensor (Figure 2). As the first step, we are trying to form thin film regions with 10 µm or less thickness by hot embossing. That is, a heated metal mold is pressed against the one side surface of the plastic substrate as shown in Figure 2. At present, we have succeeded in forming about 7.8 µm-thick thin film regions with no cracks by selecting suitable thickness of plastic substrates and heating conditions. In addition, we are now developing a new both side embossing technology to fabricate micro fluidic structures on the other side surface of the plastic substrate for cell patterning. We are also developing in parallel LIGA process technology to form micro through holes with 1–2 µm diameter around at the center of the thin film region of the substrate. Here, the alignment of the through hole position, the cell soma setting area in the micro fluidic structure and the thin film region in the substrate is the most important technological problem to be solved.

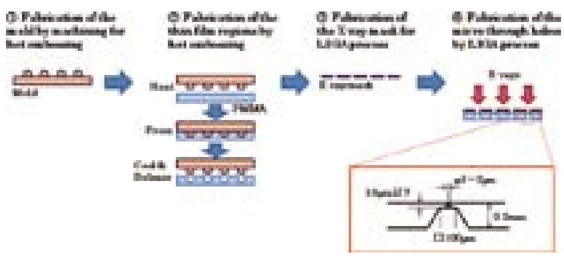

Figure 2. The structure of plastic substrates for the multichannel incubation type planar patch clamp biosensor and the fabrication process.

Modification of ^{1}H-^{13}C Double Resonance Solid State NMR Probe for 920MHz Ultra High Magnetic Field NMR

NISHIMURA group, in Department of Materials Molecular Science, is working on the new methodology and peripherals developments for solid state NMR. And we are cooperating to remodel of NMR probe.

In NMR probe, essentially, sample spinning mechanism and high voltage circuit parts for irradiation of radio frequency pulses are tightly arranged in the limited space. In this time, to realize sample temperature regulation in ^{1}H-^{13}C double resonance solid state NMR MAS probe used in ultra high magnetic field 920MHz NMR in IMS, we have modified existing parts and also built newly designed parts. Especially, the T shape glass tube shown in Figure 3 may be worthy to mention. This is vacuum insulated double layer structure with the geometry of 14 and 12 mm outside diameter for branch and straight pipes, and 6 mm inner diameter, respectively. In order to maintain constant temperature with sample spinning at high speed, low-temperature compressed air up to 0.4 MPa is introduced from the branch pipe and a heater raised up to 400 °C is inserted into straight pipe: Therefore high insulation efficiency is required on both high and low temperature conditions. The T shape glass tube was set into the NMR probe together with other built parts (Figure 4) and the probe was tested under the supply of –40 °C compressed air, This T shape glass tube demonstrated excellent insulation efficiency and no troubles due to dew condensation has been observed. This T shape glass tube has been developed by Mr. OMARU based on his wealth of experiences and excellent techniques.

This is the first solid state NMR probe realizing sample temperature regulation on over 900MHz ultra high magnetic field NMR in Japan.

Figure 3. The T shape glass tube.

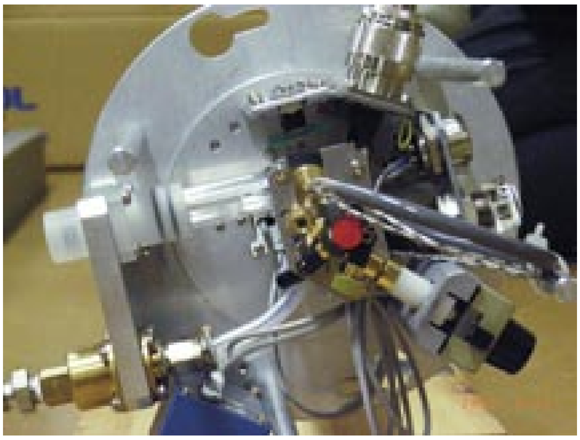

Figure 4. The T shape glass tube set into the NMR probe together with other built parts.