JOINT STUDIES PROGRAMS

As one of the important functions of an inter-university research institute, IMS undertakes joint studies programs for which funds are available to cover research expenses as well as travel and living expenses of individuals. The proposals from domestic scientists are reviewed and controlled by an inter-university committee.

The programs are carried out under one of the following categories:

(1) Joint Studies on Special Projects (a special project of significant relevance to the advancement of molecular science can be carried out by a team of several groups of scientists).
(2) Research Symposia (a symposium on timely topics organized by collaboration between outside and IMS scientists).
(3) Cooperative Research (a research program carried out by outside scientists with collaboration from an IMS scientist).
(4) Use of Facility (a research program carried out by outside scientists at the research facilities of IMS except the UVSOR facility).
(5) Joint Studies Programs using beam lines of UVSOR Facility.
(6) Use of Facility Program of the Computer Center (research programs carried out by outside scientists at research facilities in Computer Center).

In 2005 Oct.–2006 Sep., the numbers of joint studies programs accepted for the categories (1)–(6) were 2, 12, 95, 48, 115, and 238, respectively.

(1) Special Projects

A. Integration of Recognition Reaction System with Biomolecules on Solid Surfaces and Structure Analysis

URISU, Tsuneo; TERO, Ryugo; MISAWA, Nobuo; UNO, Hidetaka; ZHANG, Zheng-Lon[1]; ABU, Sayed[1]; WATANABE, Hidekazu[2]; WAN, Li-Jun[3]; LEI, Sheng-Bin[3]
([1]SOKENDAI; [2]RIKEN; [3]Chin. Acad. Sci.)

Membrane proteins play important roles in signaling of life systems and have relation with many intractable diseases such as central nervous system diseases, neuronal degeneration diseases and many circulatory organs system disease *etc*. Integration of membrane proteins and lipid bilayer on the solid surfaces are not only interesting subjects in the surface science field but also an important elementary technique for the fabrication of membrane protein biosensors. In this project, we have established several elementary techniques for fabrication of membrane protein biosensors.

A-1 Supported Phospholipid Bilayer Formation on Hydrophilicity-Controlled Silicon Dioxide Surfaces

We investigated the influence of surface hydroxyl groups (-OHs) on the supported planar phospholipid bilayer (SPB) formation and characteristic.[1)] We prepared SiO_2 surfaces with different hydrophilicity degree by annealing the SiO_2 layer on Si(100) formed by wet chemical treatments. The hydrophilicity reduced with irreversible thermal desorption of -OHs. We formed SPB of dimyristoylphosphatidylcholine on the SiO_2 surfaces by incubation at a 100-nm-filtered vesicle suspension. The formation rate was faster on less hydrophilic surfaces. We proposed that a stable hydrogen-bonded water layer on the SiO_2 surface worked as a barrier to prevent vesicle adhesion on the surface. Theoretical calculation indicates that water molecules on vicinal surface -OHs take a stable surface-unique geometry, which disappears on an isolated -OH. The surface -OH density, however, little affected the fluidity of once formed SPBs, which was measured by the fluorescence recovery after photobleaching method. We also describe about the area-selective SPB deposition using surface patterning by the focused ion beam.

A-2 Orientation of Avidin Molecules Immobilized on COOH-Modified SiO_2/Si(100) Surfaces

Avidin molecules were immobilized on COOH-modified SiO_2/Si(100) surfaces with subnano-level flatness (R_a < 0.1 nm) forming covalent bonds between COOH groups on the substrate surface and NH_2 groups of the avidin molecules. Structures of avidin-immobilized surfaces were investigated by atomic force microscopy (AFM), ellipsometry, infrared reflection absorption spectroscopy using buried metal layer substrate (BML-IRRAS), and transmission infrared absorption spectroscopy (TIRAS). It is concluded from these data that the avidin molecules are immobilized with the symmetry axis of the tetramer almost perpendicular to the substrate surface.

A-3 AFM Characterization of Gramicidin-A in Tethered Lipid Membrane on Silicon Surface

Tethered lipid bilayers were formed on oxidized Si surfaces using the avidin-biotin interaction to investigate the lipid-membrane protein interactions by using gramicidin-A (g-A) as a model membrane protein. The morphology of the tethered lipid bilayer, observed by in situ atomic force microscopy (AFM), changed drastically by the reconstruction of g-A. The aggregation behavior of

g-A was clearly different in the tethered membrane from those in simple supported membranes on mica and SiO_2 surfaces.

References

1) R. Tero, H. Watanabe and T. Urisu, *Phys. Chem. Chem. Phys.* **8**, 3885 (2006).
2) N. Misawa, S. Yamamura, K. Yong-Hoon, R. Tero, Y. Nonogaki and T. Urisu, *Chem. Phys. Lett.* **419**, 86 (2006).
3) S. B. Lei, R. Tero, N. Misawa, S. Yamamura, L. J. Wan and T. Urisu, *Chem. Phys. Lett.* **429**, 244 (2006).

(2) Research Symposia

(From 2005 Oct. to 2006 Sep.)

1. Frontiers and Perspectives of Nanoscience Using Ultra-High Field NMR Spectroscopy
(Nov. 15, 2005)
Chair: **KATO, Koichi; UOZUMI, Yasuhiro**

2. New Developments in Research of Endohedral Metallofullerenes
(Nov. 20–21, 2005)
Chair: **KUBOZONO, Yoshihiro**

3. Molecular Catalysis for the Future Generation
(Dec. 6–7, 2005)
Chair: **SAWAMURA, Masaya**

4. The 1st Nanomedicine Symposium-from Molecular Science to Clinical-Medical Science
(Feb. 12–13, 2006)
Chair: **URISU, Tsuneo**

5. Chirality in Crystals and Magnetism: Correlation between Magnetic Structures and Properties
(Feb. 18–19, 2006)
Chair: **INOUE, Katsuya**

6. Coherent Control and Ultrafast Dynamics in the Condensed Phase
(March 2–3, 2006)
Chair: **NAKAMURA, Kazutaka**

7. The Role and Utilization of Metal Ions in Biological System
(March 18–20, 2006)
Chair: **WATANABE, Yoshito**

8. Structures and Functions of the Active Reaction Centers Involving Metal Ions-Methodologies of Constructing their Molecular Structures-
(March 23–24, 2006)
Chair: **MASUDA, Hideki**

9. Future Frontier of Molecular Science
(June 2–3, 2006)
Chair: **OKAMOTO, Hiromi**

10. Physical Chemistry Symposium for Young Researchers in Molecular Science
(June 12, 2006)
Chair: **KIMURA, Yoshifumi**

11. Creation of Molecular Systems Having Highly Functionalized Metal Centers, their Structures and Functions
(June 15–16, 2006)
Chair: **KODERA, Masato**

12. New Frontiers of NMR Molecular Science
(July 31, 2006)
Chair: **KATO, Koichi; UOZUMI, Yasuhiro**

(3) Cooperative Research

This is one of the most important categories that IMS undertakes for conducting its own research of the common interest to both outside and IMS scientists by using the facilities at IMS. In 2005 Oct.–2006 Mar., 120 outside scientists from 50 research groups joined the Cooperative Research programs, and 115 outside scientists from 45 research groups in 2006 Apr.–2006 Sep. The names and affiliations of those collaborations are found in the Research Activities sections in this Review.

(4) Use of Facility

The number of projects accepted for the Use of Facility in 2005 Oct.–2006 Mar. amounted 4, 16, and 9 for the Laser Research Center for Molecular Science (LRCMS), for the Research Center for Molecular-scale Nanoscience (RCMN) and for the Equipment Development Center (EDC), respectively. In 2006 Apr.–2006 Sep., the number of projects accepted amounted 3, 16, and 1 for LRCMS, for RCMN, and for EDC, respectively.

(5) Use of UVSOR Projects

In the UVSOR Facility with the 750 MeV electron storage ring, there are sixteen beam lines available for synchrotron radiation research (see UVSOR ACTIVITY REPORT 2005). Under the Use of UVSOR Projects, many synchrotron radiation experiments have been carried out by outside scientists on eight beam lines in close cooperation with the UVSOR staff. The total number of the projects in this category was 115 (65 in 2005 Oct.–2006 Mar., and 50 in 2006 Apr.–2006 Sep.).

(6) Use of Facility Program of the Computer Center

Computer Center provides two types of research programs for outside scientists: (a) Use-of-Facility Program; (b) Cooperative Research Program. The numbers of projects accepted for each programs during the fiscal year of 2005 were (a) 113 with 467 users, (b) 5 with 10 users. Computer time distributed for these projects amounted to 98% of the total annual CPU time available.