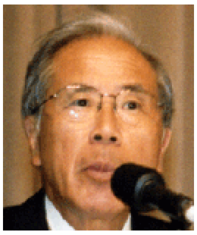
Presentation of Foundation-Assisted Research Findings 2001
New Applications for Glass Nano-Composite Materials

On July 17, the Ninth Presentation of Foundation-Assisted Research Findings was held at the United Nations University. Chairman Seya opened the presentation with a greeting, which was followed by salutary remarks from Shohei Inoue, chair of the Selection Committee for Natural Sciences Area 1, a Foundation director and professor, Science University of Tokyo. Professor Tsutomu Minami from Osaka Prefecture University and a member of the same committee outlined the main theme of the presentation and joined committee member Professor Makoto Misonoo of Kogakuin University in chairing the presentation of results from the following five research projects.


Chairman Seya


Professor Inoue, Director


Professor Minami, Presentation Co-Chair


Professor Misonoo, Presentation Co-Chair

Expectations for Nano Glass
---Using Nano Technologies to Control Structures and Functions---
Professor Kazuyuki Hirao, Department of Material Chemistry, Graduate School of Engineering, Kyoto University

Nano technologies are technologies for manipulating and controlling atoms and molecules at the nanometer scale. By controlling the structure and alignment of a material, it can be endowed with special nano-sized properties that provide new functions and superior characteristics. Since they are technologies that make use of special functions derived from controlling structures at an extremely small scale, they are expected to give rise to new materials and devices. By embedding lasers and/or electronic beams in glass to create nano-sized structures, we can obtain extremely high refractive characteristics not achievable with glass alone. Thus using technologies unique to glass materials that are difficult to achieve with metals or crystalline structures, we can realize optical devices with three-dimensional structures. Development of glass that can control optical signals and high-density optical memories is also progressing.

Bioactive Inorganic Materials
Professor Tadashi Kokubo, Department of Material Chemistry, Graduate School of Engineering, Kyoto University

Among inorganic materials, glass, glass-ceramics and titanium metal stimulate cells in living organisms and bond with the surrounding cellular structures. With the body's actions, these materials create a layer of calcium phosphate related materials similar to those of bones on that surface and bond with bones. In the medical applications of these materials, work is underway on the development of materials that will restore bone mass lost in accidents, *et cetera*. In addition, we are using inorganic materials that include radioactive elements to destroy cancerous cells. We have succeeded in fabricating glass microspheres that are normally stable but emit radiation for a set period of time when irradiated with neutron radiation. We are proceeding with experiments on animals to destroy liver cancer and other cancers by sending the microspheres to the cancerous cells via the blood vessels and applying the neutron radiation externally.

Development of Noncrystalline Solid State Electrolytic Materials for Solid State Rechargeable Lithium Batteries
Professor Masahiro Tatsumisago, Department of Applied Materials Science, Graduate School of Engineering, Osaka Prefecture University

Although transistors are solid state devices, batteries presently use liquid electrolytic materials. The search is now on for exceptional solid state substitutes for these materials. We created an oxysulphide glass with a high ion conductance that can be used in rechargeable lithium batteries. We determined the composition of a glass that is highly efficient and has a potential window of 10V or more. In order to actually mould this glass in batteries, it is necessary to render the glass into a microscopic powder form and create numerous contacts between the electrode and the glass. To manufacture the microscopic powered glass, the raw glass materials were heated and mixed for approximately 20 hours in a ball mill, which induced a mechanochemical reaction allowing the production of a glass with minute particles with high performance at room temperature. By using this finely powered glass, we succeeded in developing a process that can be used to readily cast the battery cells.

Bioanalysis Chip and a Glass Substrate
Professor Hiroshi Imagawa, Department of Applied Chemistry, Faculty of Engineering, Toyo University

Analysis of ultra-minute quantities of substances on the order of one nanogram (one-billionth of a gram) to one picogram (one-trillionth of a gram) have become vital for medical analysis and the measurement of environmental pollutants. We are developing compact high-performance analytical equipment that combines immune antibodies, oxygen, the advanced ability to distinguish between substances that is characteristic of the cells of living organisms, optoelectronics and microscopic assembling technologies. To create portable bioanalysis systems, we are currently conducting unique research into a precision protein separator that uses electrophoresis in microcapillaries made from fused quartz and a red blood cell separator that uses immune responses. In this research field, microscopic processing technologies are extremely important for the surface preparation of the thin glass substrates, which are only a few centimeters or millimeters in size, used to mount the analytical elements and for the electrode deposition process.

Transparent Oxide Semiconductors
Professor Hideo Hosono, Materials and Structures Laboratory, Tokyo Institute of Technology

Although oxides such as ITO or ZnO that are transparent and have high conductivity are widely used in liquid crystal displays, transparent semiconductors have not been developed until now because the p-type transparent oxides required for the p-n junctions of semiconductors were not known. By introducing an electron carrier, transparent oxides have an n-type conductivity and it is easy for the electron holes to become localized on the lattice's oxygen. Therefore, as a result of setting the design objective to finding a way to prevent the localization of the electron holes on the lattice oxygen, we learned that the dumbbell-shaped structure of O-Cu-O caused significant movement and discovered in our example using Ca^{2+} and Sn^{4+} ions added to $CuInO_2$ that it is possible to control the p-n junctions. In addition, we succeeded in developing an ultraviolet light producing diode element of ZnO and

$SrCu_2O_3$ with hetero p-n junctions.