# 1999 Presentation of Foundation-Assisted Research Findings

## Controlled Micro-Structure of Thin Layer Materials for New Optical Functions

Chairman Jiro Furumoto

On July 15, 1999, the results of Foundation-assisted research were announced at the United Nations University. The public lecture was opened by Jiro Furumoto, chairman of the Foundation and Professor Takuo Sugano, President of Toyo University, representing the FoundationŐs Directors, explained why the theme was selected for this yearŐs presentation. Chaired by Professor Takao Yotsuyanagi of Tohoku Univeristy and Professor Koichi Mukasa of Hokkaido University, presentations of five grant recipients followed.

Prof. Takuo Sugano

Prof. Takao Yotsuyanagi

Prof. Koichi Mukasa

Contributions of Research on High-temperature Superconductivity: Atomic level structure control and the optical functions of thin-layer oxides
Professor Hideomi Koinuma,
Materials and Structures Laboratory, Tokyo Institute of Technology

The discovery of high temperature superconductivity has made it obvious that ceramics, such as metal oxides, have potentialities of remarkable new functions. The results of research on an unique layer structure or the electron status in high temperature superconductive materials have established technologies of artificially controlling crystal lattices, accumulating oxides by its atom layer, or a technology of generating thin layers that have structures of nano-scale level. Technologies developed through this research, where laser is spattered on solid to generate molecular beam and to produce artificial crystal structure, have been utilized for further development of new areas of atom-level or molecular-level ceramics research. By applying this laser molecular beam epitaxy method, systematic
researches are actively being performed on oxides that have various functions, such as optical, magnetic or superconductive functions.

Control of Spin Arrangement with Light: Development to molecular spinics
Professor Kizashi Yamaguchi,
Graduate School of Science,
Osaka University

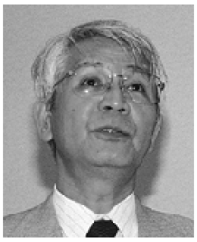
In recent years, with a remarkable increase in the rate of computer processing, it has become possible to perform theoretical design of substances or materials. Researches are being conducted on material design of cohesive molecules such as magnetic macromolecules that have organic radicals as the origin of spins and molecular magnetism of polynuclear transition metal complex or their integrated solid. Present magneto-optical devices adapt a method that uses a laser beam as thermal energy to raise local temperatures of the recording media, and an externally introduced strong magnetic power to magnetize the media. This research has shown many new possibilities. For instance, light is used to generate a source of spin and to convert the spin status for magnetization. It is expected that new methods of high-density recordings shall be applied to specific areas.

Development of Super Stable Light Wave Circuit: Optical wave-guide made of glass and polymer unaffected by temperature change
Professor Yasuo Kokubun,
Division of Electrical and Computer Engineering, Yokohama National University

A high-density optical communication with wavelength-division multiplexing or frequency multiplexing, which is expected to be the optical communication of the next generation, can be improved in efficiency for frequency utilization by several hundreds or thousands times compared to the present optical communication. This optical communication utilizes a light wave circuit (wavelength filter) to segregate the original signals from the multiplexed optical signals. However, the conventional light wave circuit has a serious problem in fully utilizing the light wave in that the phase of light wave changes by several wavelengths along with a temperature change by one degree. In order to realize an athermal wave-guide with an optional path-length that is independent of temperature, glass and polymer materials were combined in this study, and a lowest possible optical guide temperature coefficient approaching zero was achieved. As a result, a new circuit has successfully reduced the amount of the change down to 3% of the conventional filters. Now, a further study is being performed for its commercialization.

Super High Speed Optical Memory Element: New development of non-linear optical device
Professor Hitoshi Kawaguchi,
Department of Electrical and Information Engineering, Yamagata University

Although a current optical fiber communication system realizes fast transmission at 10 Gbit/s, the processing speed of the total system has limitations, because electronic signal processing is carried out within a repeater or an exchange switch board. It is predicted that hundreds or thousands of times faster transmission can be accomplished if the whole frequency band is utilized. A bi-stable optical element that utilizes an optical non-linear effect of the media has two stable output strengths of light for each input of light, and exhibits a memory effect. The element is manufactured based on a semiconductor laser, and operated by a weak light. Therefore, it is applicable to the connection of optical fibers. This study confirmed an all-optical high-speed flip-flop operation, using virtual cavity surface-emitting lasers, and reached a computer simulation for a new device that has the function of segregating a 5 Gbit/s signal from multiplexed signals of 50 Gbit/s.



InGaN Type Blue luminescence Semiconductor Device: Investigation of the mechanism of luminescence
Professor Shigeo Fujita,
Department of Electronic Science and Engineering, Graduate School of Engineering,
Kyoto University

A blue luminescence semiconductor device is a key device for processing, transmission and display of information such as a super high-density optical disk memory and an information display element. Recently, samples of short-wavelength violet semiconductor-lasers that utilize InGaN type semiconductors, are available in the market. It is expected that large-capacity optical disks will be created in near future. This study showed that the mechanism of luminescence based on the relationship between nano-scale structures of InGaN type semiconductors and characteristics for luminescence. This study also investigated a guideline for achieving high efficiency and performance, introducing a method of confirming the microstructures of the element. As a result, it was concluded that development of a technology to artificially adjust the structures of a luminescent center, by quantifying substances of non-radiation recombination center, and also by developing a method of nano-scale control of quantum conditions to reduce the substances, is valuable in increasing the efficiency in luminescence.