The 6th JSAP Research Achievement Award

Kenichi Iga

Pioneering Research in Surface Emitting Semiconductor Lasers

In 1977, Prof. Kenichi Iga became the first researcher in the world to propose the concept of surface emitting lasers, and in 1979 he achieved laser oscillation for the first time using current injection. He also proposed extremely short resonator constructions with a cavity length of 10μm or less, and developed a micro-cavity laser that operates with an extremely low current compared to conventional semiconductor lasers. Later, his research team created a device that enable continuous operation at room temperatures, opening the doors for practical applications, and in 1995 he succeeded in the miniaturization of components, achieving a threshold current of 70 microamperes, the world's lowest threshold value for a semiconductor laser at that time.

Based on this pioneering research, the new academic field of surface emission laser devices has been formed on a global scale, and many research institutions have undertaken extensive research and development activities, many of which are aimed at practical applications. Prof. Iga is recognized throughout the world as the inventor of these devices. Particularly in the U.S., several projects are currently underway with regard to optical interconnect and massively parallel optical transmissions using surface emitting lasers, and these lasers are also introduced on the U.S. government homepage for nanotechnology initiatives as a revolutionary aspect of information technologies originating in Japan.

Prof. Iga's achievements in the field of optical electronics — particularly his extensive research ranging from the discovery of surface emitting lasers to laying the foundations for new technologies and developing new devices — have created an entirely new field of research, and have made significant contributions to industrial development as well. In this way, Prof. Iga has demonstrated Japan's unique creativity to the world. His achievements in the field of surface emitting lasers have had a dramatic effect on the academic world as well, giving rise to new research fields in optical and quantum electronics, including photonic crystals and naturally controlled release using extremely short resonators. His central work in surface emitting lasers and in massively parallel optical electronics integrated with planar microlens arrays, have received outstanding recognition from the academic world as well; for example, the research team working on this project was selected as a "Center of Excellence" in the first year that the COE program was implemented by the Ministry of Education, Culture, Sports, Technology and Science (MEXT).

In recent years, surface emitting lasers as a light source for short-distance data communications (for example, in Gigabit Ethernets) have grown into a market estimated at several tens of billions of yen, and are essential devices in the context of short-distance, high-speed communication networks. Ultra high-speed optical interconnect technologies that take advantage of the low power consumption and high-density integration characteristics of surface emission lasers are considered revolutionary technologies that will eliminate the wiring bottlenecks in large-scale electronic devices and integrated systems. These technologies are expected to have find uses in a wide range of applications, including home optical networks and sensors, and have had a major impact on society as well, for example by promoting the creation of countless venture companies throughout the world working in the field of surface emitting lasers. These achievements are truly worthy of the JSAP Research Achievement Award.

Ryuichi Shimizu

Contributions to Pioneering Fundamental Research in Micro-beam Analysis, and in Surface Analysis Technologies

Since the late 1950s, Ryuichi Shimizu has been involved in pioneering research on the fundamentals and applications of microbeam analysis using electron and ion beams. One of his most important and world-renowned achievements was a proposal for the world's first method of simulating scattering processes of charged particle in solid using Monte Carlo analysis. Because this method could be applied even when it was difficult to derive solutions with conventional analytical methods, it could be used in a wide range of microbeam analysis applications, including scanning electronic microscopy (SEM) image analysis; quantitative analysis with electron probe micro analyzers (EPMA), which are widely used as a micro analysis method; and analysis of sputtering processes in secondary ion micron spectroscopy (SIMS), which is well known as a highly sensitive micro analysis method. This analysis method is widely used in the evaluation of industrial materials and devices, and has played an extremely critical role in the proliferation of those materials and devices. Over the course of many years, Prof. Shimizu has built up the foundations of this microbeam analysis.

In electron optic systems, it is difficult to eliminate spherical aberrations because in principle, these systems contain no concave lenses. Attempts to eliminate aberrations had been made since the 1930s, when the electron microscope was invented, but none of these attempts were successful. Prof. Shimizu applied the "active image processing method" that was proposed by his former student as a new method for eliminating spherical aberrations, and became the first in the world to successfully obtain a clear image of a surface atom without artifacts for the first time in the world. As the leader of a Project for JSPS-Research for the Future (RFTF) Program "Development of Super Electron Microscope in next generation" he successfully developed a super-resolution phase contrast electron microscope.

In addition to these achievements, Prof. Shimizu made significant contributions to the development of high-brightness electron sources such as LaB_6 and Zr-O/W by elucidating the electron emission mechanisms of these substances. Regarding the practical applications of single-crystal LaB_6 cathodes in particular, he developed products by obtaining numerous patents through joint research with companies, thereby making significant contributions to the development of electron beam devices. In this way, as a leading figure in the field of microbeam analysis, he has demonstrated outstanding achievements that have had a positive effect not only in the context of academia, but in the industrial world as well.

Prof. Shimizu's achievements are not limited to those outlined above. It is also worth noting that he has made numerous international contributions, and has assisted in the development of this field in Japan. In fields directly related to industry, he has represented Japan on the ISO technical committee (TC) 201 on Surface Chemical Analysis, and has been active as chairman of the ISO - TC201, thereby contributing to the improvement of surface analysis technologies in Japan. These achievements are truly worthy of the JSAP Research Achievement Award.