The 7th JSAP Research Achievement Award

Yasuharu Suematsu

Pioneering research in Semiconductor Lasers for Optical Fiber Communications

Yasuharu Suematsu was the first in the world to advocate the importance of transmission methods using single-mode fibers and lasers that can dynamically maintain single modality as a leading approach to achieving broadband optical fiber communications. He conducted research into GalnAsP/InP lasers that oscillate in the 1.5-1.6μm band, which minimizes transmission losses in optical fibers, and in 1979, he became the first in the world to achieve low-threshold operations and continuous operations at room temperature.

To develop a "Dynamic single-mode laser" that can maintain single modality even with direct modulation at 1GHz or more, he focused on a laser realization that uses distributed Bragg reflection, and achieved continuous operations at room temperature in the L.5-1.6μm band for the first time in 1981. In 1982, he pointed out for the first time that wavelength variations during direct modulation in "Dynamic single-mode lasers" was due to variations in the carrier density on the active layer, and in 1985 he demonstrated the relationship between optical fiber transmission bands and the factors in wavelength variation in semiconductor lasers. These achievements represent substantial contributions to the building of scientific foundations that are essential to practical applications of optical fiber communications and to the transition to ultra-broadband. In 1983, he became the first in the world to develop a wavelength tunable laser that could continuously control wavelengths using electrical methods by separating the active region of "Dynamic single-mode lasers" and a wavelength control region, thereby demonstrating the potential of optical integrated circuit methods in the context of large capacity optical fiber communication with wavelength multiplexing.

In this way, Dr. Suematsu has demonstrated outstanding achievements in the pioneering development of the high-performance lasers that are essential to optical fiber communications, which support the advanced information society, and at the same time has made great contributions to the semiconductor material characteristic and process fields using optical electronics, and to the development of applied physics as a whole.

Dr. Suematsu's pioneering research in lasers for optical fiber communications, and his training of researchers in this field have both accelerated and strengthened related research in Japan, and have formed the foundations for dramatic contributions on a worldwide scale. Some of the seeds of optical fiber communications are reaching their maturity, but the dynamic single-mode lasers and wavelength tunable lasers that were the focus of Dr. Suematsu's work are expected to play an important role in future applications such as quantum information communications, optical information processing, and various forms of optical sensing, and will no doubt have an enormous effect on the future development of applied physics. These outstanding achievements are truly worthy of the JSAP Research Achievement Award.

Eiichi Maruyama

Pioneering research in high-performance imaging devices using non-crystalline semiconductors

From the latter half of the 1960s to through to the early 1970s – the dawning of the development of TV image pickup tubes, Dr. Eiichi Maruyama was working on research in original image pickup tubes using selenium non-crystalline semiconductors, and developed an image pickup tube that demonstrated truly outstanding characteristics. This technology was utilized in video cameras for use both in broadcast stations and in the home, and received a high degree of recognition as an original Japanese technology. This technology was also used in the development of high-definition TV, which was still in the early stages of research, and in program production for experimental broadcasts, thereby making notable contributions to the evolution and establishment of high-definition TV. It has also been used in x-ray imaging, enabling real-time observation of the movement in lattice defects, which represents a great contribution to science as well.

In the image pickup tubes developed by Dr. Maruyama, the resistance of photoconductive semiconductor film is changed in response to the strength of the incident light; this is read by a scanning electron beam and used as the image signal. Dr. Maruyama continued his attempts to control the photodiode contact characteristics of selenium non-crystalline semiconductors and to control electrical and heat characteristics by adding impurities, eventually discovering that it was possible to achieve outstanding photoconductive characteristics using 3-dimensional materials with tellurium and arsenic added. He also developed a graded structure that controlled component distribution on the nanometer level, as well as a method for forming this construction, thus overcoming the fatal flaw of images being burned onto the screen, which had occurred with earlier image pickup tubes. In 1973, with the assistance of joint researchers and based on the research results outlined above, he successfully developed an image pickup tube that demonstrated the most outstanding characteristics of that era, including high sensitivity, low noise, low residual images, and low level of flickering. The development of non-crystalline semiconductor film with graded composition distribution uses computer-controlled thin-film growth methods that were still undeveloped at that time, so this research could also be considered pioneering research in the field of material investigation using combinatorial methods.

With the later development of CCD imaging elements, most video cameras used by broadcast stations and in the home converted to CCD type, but image pickup tubes using non-crystalline photoconductive film offer advantages in the detection of areas with high-energy photons (such as X-rays), so are still used even today, for example in facilities conducting research in synchrotron radiation.

Dr. Maruyama's research in image pickup tubes was carried on by other researchers, and later became the foundation for the birth of ultra high-sensitivity avalanche photomultiplier image pickup tubes. These photomultiplier image pickup tubes enable clear images to be captured even in very dark environments, so are used in a wide range of observation applications, including filming incidents in the dark, observations of deep-sea life and other ecosystems, filming of weak auroras, microvascular imaging, and analysis of the structure of proteins. Dr. Maruyama also made a joint proposal in 1979 – the first of its kind in the world – regarding a technology for forming low temperature poly-silicon TFTs on a glass substrate as a means of forming an image display panel and peripheral circuits on a single substrate. He has made notable contributions to the operation of organizations for promoting fundamental and investigative research, and in the execution of government policy on science and technology.

Based on the development of original thin-film technologies, Dr. Maruyama has created outstanding imaging devices, and has made exceptional contributions to science, society, and industry. For these reasons, he is truly worthy of the JSAP Research Achievement Award.