

## Citation

For seminal contributions to VCSEL photonics in proposing high speed modulation and beam steering capability toward advanced optical communications and optical sensing



## Dr. Fumio Koyama

### Positions and Organizations :

Director-General, Institute of Innovative Research (IIR)  
 Professor, Laboratory for Future Interdisciplinary Research of Science and Technology (FIRST)  
 Tokyo Institute of Technology (Tokyo Tech)

Degree : Doctor of Engineering (Tokyo Institute of Technology, 1985)

Date of Birth : May 16, 1957

### Brief Biography :

1980 B.S. in Physical Electronics, School of Engineering, Tokyo Tech  
 1982 M.S. in Engineering, Tokyo Tech  
 1985 Doctor of Engineering, Tokyo Tech  
 1985 Assistant, Precision and Intelligence Laboratory, Tokyo Tech  
 1988 Assistant Professor, Precision and Intelligence Laboratory, Tokyo Tech  
 2000 Professor, Precision and Intelligence Laboratory, Tokyo Tech  
 2016 Director and Professor, FIRST, Tokyo Tech  
 2018 Director-General, IIR, Tokyo Tech

### Main Awards and Honors:

1985 IEE Electronics Letters Premium Award  
 1985 IEEE Best Student Paper Award  
 1988 IEE Electronics Letters Premium Award  
 1998 Marubun Research Promotion Foundation Academic Award  
 2004 Ichimura Foundation for New Technology Academic Performance Award  
 2006 The Institute of Electronics, Information and Communication Engineers Electronics Society Award  
 2007 Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology  
 2008 IEEE William Streifer Scientific Achievement Award  
 2012 The Japan Society of Applied Physics Opto-Electronic Integrated Technology Achievement Award  
 2015 Tokyo Metropolitan Government Award of Merit for Achievements in Technology Promotion  
 2016 Ichimura Foundation for New Technology Industrial Performance Award  
 2017 Sakurai Kenjiro Memorial Award

Fellow of IEEE, Institute of Electronics, Information and Communication Engineers, and Japan Society of Applied Physics. Past President of Electronics Society, the Institute of Electronics, Information and Communication Engineers. Past Board of Governors of the IEEE Photonics Society and Past General Chair of IEEE ISLC 2010.

### Main Achievements :

Toward the goal of creating high capacitance optical links and optical interconnectors, Dr. Fumio Koyama realized the world's first room temperature cw operation of vertical cavity surface-emitting laser (VCSEL) in 1988. He has spent much effort on improving and creating new functions for VCSELs. Through combining VCSELs and MEMS (micro-electromechanical system) technologies he was able to create the world's first semiconductor laser that was not dependent on temperature for its wavelengths. With the aim of producing new functionality, Dr. Koyama also proposed the creation of a new platform that laterally integrated VCSELs and optical functional devices. This allowed for the creation of a variety of new functions including high-speed intensity modulators, coupled resonators for high-speed direct modulation, high-resolution beam scanners, optical amplifiers, and spatial light switches. This progression of achievements created new possibilities for VCSELs in next-generation high-speed optical communications, high-capacity optical interconnectors, and in the fields of information and communications. This has placed Dr. Koyama in a central position as a second-generation researcher of VCSELs.

VCSELs are an innovative technology invented by Dr. Kenichi Iga in Japan, Professor Emeritus at the Tokyo Institute of Technology. Various applications of these lasers are now accelerating, and they are now being used in optical interconnects in data centers, face recognition systems in smartphones, LiDAR systems used to provide advanced driving assistance systems in vehicles, laser mouse devices and more. They have grown to become a key component in IoT (Internet of Things) technologies worldwide.

Dr. Koyama achieved the first room temperature cw operation of VCSELs in 1988. Then he realized a 2-dimensional array of VCSELs that could be used to increase the capacity of optical communications. He has laid the foundation for research and development of these lasers, which is progressing on a global scale. In particular, by managing to operate these lasers at room temperatures, thereby verifying their potential, he played a leading role in the development and research of VCSELs and has contributed greatly to recent dramatic advancements in their use. His more than 30 years of contributions to VCSEL photonics are widely acknowledged.

He has also actively worked with industry and has pursued the creation of high-performance single-mode VCSELs with selective oxidation confinement. At the same time, he has made improvements to the single-mode power of VCSELs by pioneering new control techniques. By completing a complete control technology through polarization control that makes use of high-index plane substrates, he made contributions to create a high-performance single-mode VCSEL for the first time. The results of this research have partially been put into industrial use by research collaboration with industry. This has led to 2-dimensional VCSEL arrays being used in devices such as high-definition color laser printers, a world first, and has contributed to the application of VCSELs in Japanese industry.

Dr. Koyama has also worked to realize new functional VCSELs such as wavelength-tunable VCSELs, ultra-high-speed VCSELs, and non-mechanical high-resolution beam scanners. He has also made progress in cutting-edge research related to VCSEL photonics, and he has contributed greatly to the development of optoelectronics. Specifically, his creation of a new wavelength-tunable VCSELs that use unique methods to combine MEMS has led to success in creating semiconductor lasers that, for the first time, do not rely on temperature for wavelengths but are also able to tune their wavelengths. In addition, he proposed a platform that laterally integrates VCSELs and optical functional devices, which has led to the creation of the world's fastest high-speed VCSEL that can achieve speeds of up to 30GHz, and a high-resolution beam-steering function that makes use of VCSELs. These results have been reported on in over 460 international journals, and presented about in over 600 international conference papers (this includes more than 100 invited lectures and papers).

He has also been involved in education since 1985 for more than 30 years. He has provided guidance to more than 100 graduate students, including 30 Ph.D. students. This has contributed to the educational environment at the Tokyo Institute of Technology. Since 2007 he has worked as a project leader for the Ministry of Education, Culture, Sports, Science and Technology's Global COE Program "Photonics Integration Core" and has contributed to the advanced education for Ph.D. students. Since becoming Director of the Laboratory for Future Interdisciplinary Research of Science and Technology in 2016 he has promoted amalgamated research among different fields, as well as research that involves collaboration with industry. Since 2018 he has worked as the Director-General of the Institute of Innovative Research, leading a research organization that includes approximately 180 faculty members.

He has performed leading research in VCSEL photonics while also contributed to both industrialization and education in the field. For his great contributions to academia, industry, and society, Dr. Fumio Koyama is hereby awarded the Okawa Prize.