2012 International Conference on Solid State Devices and Materials
= Short Course (2) =
Breakthrough Technologies for The Limitation in Current Optoelectronic Devices

September 24, 2012, Kyoto International Conference Center, Kyoto, Japan

Organizers

Yu Tanaka (Fujitsu Laboratory), Kazunobu Kojima (Kyoto University)

Speakers

13:00 "Manipulation of Photons by Photonic Crystals"

Prof. Takashi Asano (Kyoto University, Japan)

Photonic crystals are nanostructures for light with periodic refractive index patterns. By developing two- or three-dimensional periodic structures and locally modulating the patterns, various and flexible manipulations of photons become possible. For example, we have successfully demonstrated that photonic nano-devices such as channel add-drop filters with the sizes much less than conventional on-road devices can be produced while achieving excellent optical functions. We have also shown that photonic crystals enable a nanocavity that can confine light very strongly or for long time. Such a nanocavity can be used for slowing and stopping light, and is also important for quantum information processing and communication applications. We also proposed and demonstrated novel photonic-crystal based lasers that can oscillate in a perfect single mode in a broad area and can produce on-demand beam patterns. This type lasers can produce extremely high output powers, can be used as the light source for super-resolution focusing beyond wavelength size spot, and can be used for trapping and manipulation of nontransparent particles. Moreover, an electronic beam steering function has been developed recently based on this laser. Photonic crystals can also manage light emission and detection, which has great potentials to produce extremely high-efficient LEDs and solar cells. Our research has demonstrated that photonic crystals allow manipulating photons almost on demand and can contribute to broad applications including communication, information, storage, processing, and even global energy issues.

13:45 "Integrated-optic input/output couplers for optical interconnection"

Prof. Shogo Ura ((Kyoto Institute of Technology, Japan)

14:30 "Advanced Quantum Dot Lasers"

Dr. Mitsuru Sugawara (QD Laser, Japan)

This talk reviews remarkable progress of self-assembled InAs quantum dot lasers for optical communication, including theoretical background, the advent of self-assembled quantum dots emitting light at the wavelength of 1.3 μm, the state-of-the-art growth method of high-density, highly uniform and dislocation-free self-assembled quantum dots, mass-produced quantum-dot Fabry-Perot (FP) lasers for optical communication, and extremely high-temperature operation of quantum-dot FP and distributed-feedback (DFB) lasers for harsh environments. This talk also introduces a variety of GaAs-based laser products of QD Laser, Inc., such as 50ps short-pulsed 1064nm DFB lasers as seeds of fiber lasers for micro processing, and compact visible laser modules of green, yellow-green, and orange based on long-wavelength DFB lasers with SHG for a variety of applications in life science and laser displays.

Break (20min.)

15:35 "Overcoming the trade-offs in semiconductor-based optical modulators"

Dr. Yasunori Miyazaki (Mitsubishi Electric, Japan)

Semiconductor-based optical modulators are widely used in high-speed optical fiber communication systems. They replaced directly modulated laser diode in the application fields of ultra-high bit rate (>10Gbps) and long transmission distance (>40km), because they offer advantages of low electrical capacitance and low frequency chirp of the emitted optical signal. In this short course, the principles and the development history of two major types of semiconductor-based optical modulator, electroabsorption modulator (EAM) and Mach-Zehnder modulator (MZM), are reviewed. The physical trade-off in some important performance parameters and breakthrough technologies are discussed.

16:20 "Technologies towards highly-reliable operation of white LEDs in high temperature environment"

Dr. Hidenori Kawanishi (Sharp, Japan)

High-power light emitting diodes (LEDs) are widely used as the light source for the backlights of Liquid Crystal Displays (LCDs) and also rapidly penetrating into illumination (Solid state lighting). Its efficiency, however, tends to be degraded when operated at high temperature. In this lecture, technologies for thermally-stable LEDs will be presented.

ZenigataTM LEDs are highly-efficient and highly-reliable white LED modules suitable for various types of lighting systems. The high luminous efficiency of 93lm/W for the 50W class module was achieved by using excellent LED chips with high thermal stability and also by the heat management of the COB (Chip on Board) package. They stay within the MacAdam Ellipse 3step from the chromaticity center at 90 deg.

17:05 "Characteristics of nitride-based laser diodes"

Prof. Ulrich T. Schwarz (Fraunhofer IAF, Germany)

During the last two years great progress has been made towards green-light-emitting laser diodes and short-wavelength, ultrafast laser diodes. In both cases major new applications in the consumer electronics market are the driving force. One is the so-called pico-projector, a device that is small and efficient enough to be part of a handheld, battery-powered device such as a cell phone. These projectors use red, green, and blue laser diodes and will allow us to share images and presentations wherever a white surface is available for projection. It is expected that pico-projectors will become integral to cell phones within a few years, just as cameras are today. The green (Al,In)GaN laser diode is the enabling device for the pico-projector. The other application is again a mass storage device. One challenge is to develop picosecond (Al,In)GaN laser diodes that can replace large-frame, frequency-tripled Ti:sapphire lasers. Beyond the consumer market there are many more applications, most prominently in spectroscopy, materials processing, biophotonics, and the life sciences. One example is the field of opto-genetics, where blue and green laser diodes are used to stimulate or inhibit – depending on the excitation wavelength – the response of nerve cells. Only semiconductor laser diodes with their tiny footprint will allow this functionality to be integrated with neuro-probes as an interface to the brain. This short course will discuss the requirements regarding the devices parameters for GaN-based laser diodes in different applications and the technological challenges in the development of these specialized optoelectronic devices.