Optical component evolution/revolution

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Looking back at the past four decades since the invention of the semiconductor laser, we have witnessed the rapid emergence of a new optoelectronics industry, which is following a path quite similar path to the transistor-driven microelectronics industry. Although the optoelectronics industry is still living in the shadow of microelectronics, its impact on the transition to the information society is dramatically increasing, especially in recent years.

During the past four decades, the development of optoelectronics and micro-optics has progressed tremendously on almost all fronts, with the industry attaining a very rich and diversified base of technologies to support the ever-increasing demand of new applications. Thus, the material technology of microlasers has gone from liquid-phase epitaxy-based to multi-wafer MBE and MOCVD techniques, covering many other III-V and II-VI compound materials beyond the original GaAs, as well as other classes of materials such as polymers. In conjunction with the progress from bulk to quantum-well, quantum-dot, strained layer and superlattice materials, as well as advanced device design approaches, the performance of micro-lasers has improved significantly. Today, available lasing wavelengths span the entire spectral range from blue to deep infrared, the lifetime of semiconductor lasers has gone from minutes to hundred of years under normal operating conditions, VCSEL threshold currents have reached microamperes, output power of quantum dot laser is measured in watts, *etc*.

Optical functionality offered by the optoelectronics/micro-optics technology has also expanded from mainly light emission and detection to other areas, such as optical amplification, optical switching and routing, as well as basic optical signal processing – optical splitting/tapping/ combining, wavelength multiplexing/demultiplexing, *etc*. Nevertheless, the information industry is demanding more sophisticated functionality, such as adaptive optics and intelligent optical signal processing. Individual optical devices may have difficulty in accomplishing this task. Conventional wisdom is pointing towards the integration of multiple optical devices, as well as optical and electronic devices. Photonic integration has been pursued for many years, yet by VLSI standards integration in the optoelectronics industry is still in its infancy. Will the recent progress of photonic bandgap materials pave the way to photonic integration? Will polymer technology eventually offer a platform for photonic integration as well as OEICs? Or does the hybrid integration of optical devices on silicon still hold the most promise? More fundamentally, can optoelectronics alone offer intelligent optical signal processing capability, or will the lack of practical storage and non-destructive detection of photons limit the potentials of all-optical signal processing? Does digital photonics promise all-optical signal processing or does intelligent optical signal processing require a combination of photons and electrons?

In the presentation, I will review evolution/revolution of optical components and technology, as well as the requirements of these components in optical system and network applications. Some speculation about the future progress of photonic integration and all-optical signal processing will be discussed.