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# 11D2-1 (Invited)

**Invited Talk**

## Nano- and Micro-photonic devices for Inter- and Intra-Board Level Optical Interconnects

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**Abstract**

**The role of polymer-based and silicon-based** Nano- and Micro-photonic passive and active devices will be presented under the consideration of plausible applications in intra- and inter-board level interconnects beyond 10 Gbit/sec with acceptable bit error rates.

**Summary**

The speed and complexity of integrated circuits are increasing rapidly as integrated circuit technology advances from very-large-scale integrated (VLSI) circuits to ultra-large-scale integrated (ULSI) circuits. As the number of devices per chip, the number of chips per board, the modulation speed, and the degree of integration continue to increase, electrical interconnects are facing their fundamental bottlenecks, such as speed, packaging, fan-out, and power dissipation. In the quest for high-density packaging of electronic circuits, the construction of multichip modules (MCM), which decrease the surface area by removing package walls between chips, improved signal integrity by shortening interconnection distances and removing impedance problems and capacitances. The employment of copper and materials with lower dielectric constant materials can release the bottleneck in a chip level for the next several years. The International Technology Roadmap for Semiconductors (ITRS) expects that on-chip local clock speed will constantly increase to 10 GHz by the year 2011. Electrical interconnects operating at a high-frequency region have many problems to be solved, such as crosstalk, impedance matching, power dissipation, skew, and packing density. Optical interconnection has several advantages, such as immunity to the electromagnetic interference, independency to impedance mismatch, less power consumption, and high-speed operation. Although the optical interconnects have great advantages compared with the copper/low K interconnection, they still have some difficulties regarding packaging, multilayer technology, signal tapping, and reworkability[1-7]. In this presentation, the progress of optical interconnects for intra and inter-board levels will be presented with both nano and micro photonic passive and active components suitable for system integration. These include thin film planar waveguides, vertical cavity surface emitting lasers (VCSELs), PIN photodiode array (figure 1) and silicon nano-photonic crystal waveguide modulators and 3D photonic devices for laser beam steering. Optical bandwidth of 150GHz has been experimentally confirmed for a 51 cm long polymer waveguide as shown in Fig.2 [2].

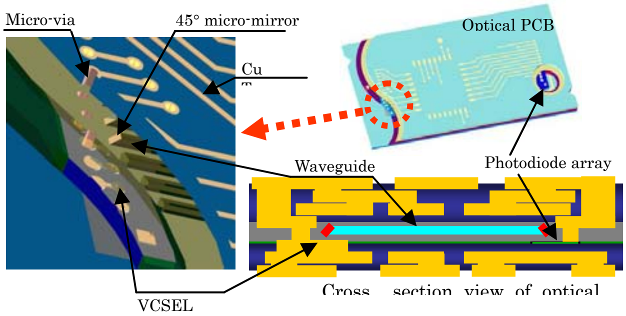


Figure 1 Schematic of board level fully embedded optical interconnects

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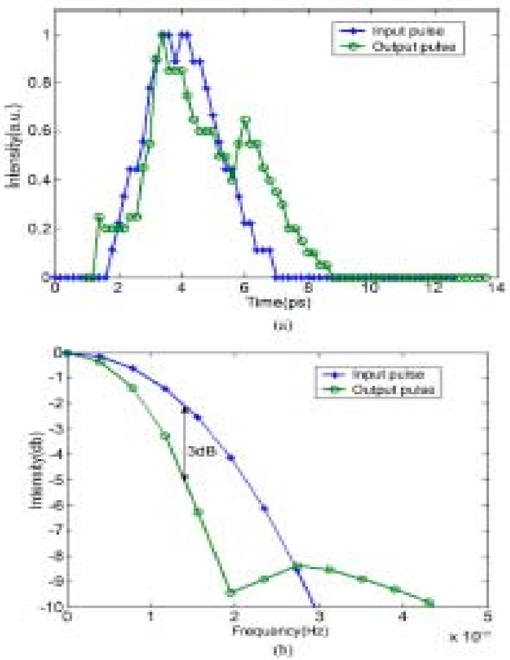


Figure 2 (a) Input and output pulses in the time domain. (b) Input and output pulses in the frequency domain.

## The author

Dr. Chen is the Cullen Trust endowed professor at UT Austin. He received his BS degree in Physics from National Tsing-Hua University in 1980 in Taiwan and his MS degree in physics in 1983 and his PhD degree in Electrical Engineering in 1988, both from the University of California. He joined UT Austin as a faculty to start optical interconnect research program in the ECE Department in 1992. Prior to his UT's professorship, Chen was working as a research scientist, manager and director of the Department of Electrooptic Engineering in Physical Optics Corporation in Torrance, California from 1988 to 1992.

Chen also served as the CTO/founder and chairman of the board of Radiant Research from 2000 to 2001 where he raised 18 million dollars A-Round funding to commercialize polymer-based photonic devices. His research work has been awarded with more than 84 research grants and contracts from such sponsors as DOD, NSF, DOE, NASA, the State of Texas, and private industry. Chen's group at UT Austin has reported its research findings in more than 430 published papers including over 60 invited papers. He holds 14 issued patents. He has chaired or been a program-committee member for more than 60 domestic and international conferences organized by IEEE, SPIE (The International Society of Optical Engineering), OSA, and PSC. He has served as an editor or co-editor for eighteen conference proceedings. Chen has also served as a consultant for various federal agencies and private companies and delivered numerous invited talks to professional societies. Dr. Chen is a Fellow of IEEE, OSA and SPIE. He was the recipient 1987 UC Regent's dissertation fellowship and of 1999 UT Engineering Foundation Faculty Award for his contributions in research, teaching and services. Back to his undergraduate years in National Tsing-Hua University, he led a university debate team in 1979 which received the national championship of national debate contest in Taiwan.

There are 30 students received the EE PhD degree in Chen's research group at UT Austin