Electronic-Photonic Integrated Circuits in Silicon-on-Insulator Platforms

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Electronic-photonic integrated circuits (EPICs) are a promising technology for overcoming bandwidth and power-consumption bottlenecks of traditional integrated circuits. Silicon is a good candidate for building such devices, due to its high-index contrast and low propagation loss at telecom wavelengths. This work presents recent advances in demonstrating discrete components built in silicon-on-insulator (SOI) platforms, around 1550 nm, that can be used as building blocks for future EPIC systems. The work covers several microring-based structures suitable for wavelength-division multiplexing (WDM) applications, such as hitless single-ring filters, multi-channel second-order tunable filterbanks, reconfigurable optical add-drop multiplexers (ROADMs) with telecom-grade specifications, and dynamical slow light cells for delay lines and optical memory elements.

The concept of an EPIC system is illustrated in Fig. 1, integrating several optical blocks (e.g. couplers, switches, modulators) and electronic blocks (e.g. microprocessors, analog-to-digital converters) on the same platform. One of the major bottlenecks of silicon is still its indirect electronic bandgap, which makes it unsuitable for many active optical functions such as emission and optical amplification. A way to overcome this problem is to use III-V materials for those functions, forming a hybrid platform.

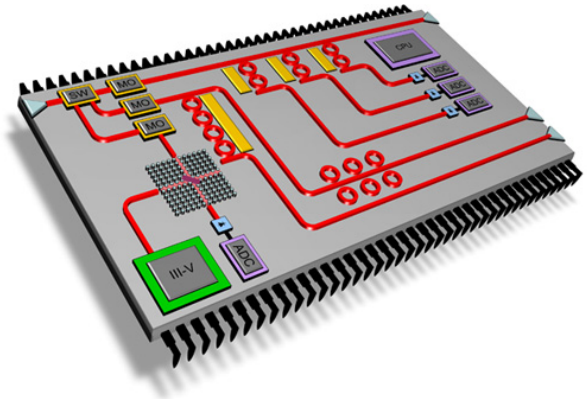

Fig. 1. Illustration of an electronic-photonic integrated circuit, with optics and electronics on the same platform: SW – optical switch, MO – optical modulator, ADC – analog-to-digital converter, CPU – microprocessor. The yellow pads next to the microrings indicate reconfigurability, which can be achieved by thermally actuating the structures.

All the demonstrated devices can be integrated on the same chip. The small device footprints and the use of the SOI platform are ideal for integration with a standard CMOS process, enabling the fabrication of novel electronic-photonic integrated circuits. These new EPIC systems may one day play an important role in the scaling of current computing systems and taking advantage of the WDM capability to increase operational bandwidth, while keeping the power consumption at low levels.

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