
# The effect of photonic integration on the evolution of communication systems

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Over the last decades, the ubiquitous necessity for high-bandwidth and low-cost has instigated the penetration of photonic integrated circuits (PICs) though all the major application areas of Photonics, providing the speed, cost and integration density credentials required for preventing the imminent capacity crunch. Ranging from the high-speed low-cost IM/DD links of datacenter networks to the spectrally-efficient flexible coherent systems of the metro and core, the industry is seeking PIC-based solutions offering extensive functionalities, low cost and manufacturability. In this context, III-V materials present their inherent competence to provide a complete set of functionalities, such as light emission, modulation and detection while Silicon Photonics (SiPh) bear the promise of capitalizing on the enormous investments and progresses in CMOS fabs. In addition, dielectric integration platforms based on Silicon Nitride (SiN) and Polymers have made their appearance enabling seamless coupling to optical fibers, significantly reduced propagation losses as well as valuable sensing attributes through enhanced light-matter interaction. This vast set of technology and material options has profoundly extended the capabilities of communication systems, paving the inroad towards next generation Datacom, Telecom and Sensing implementations and future applications, as signified by the most recent technological breakthroughs and developments. In [1] Luxtera presents a 4x26Gb/s transceiver packaged in a QSFP28 module, while in [2] the 300nm wafer-based Si-photonics platform of STMicroelectonics and Luxtera is discussed and in [3] a 3-mode multiplexing and de-multiplexing integrated silicon photonic circuit supporting 240 Gb/s data rate is demonstrated by Intel. Recent advancements in InP photonic integration platforms targeting beyond-telecom applications were recently presented by TU/e [4], whereas a comb-based programmable radio-frequency photonic filter, utilizing an InP arrayed waveguide grating pulse shaper was also demonstrated by Infinera [5]. HP Labs and UC Santa Barbara have proposed a compact, low power consumption and high direct modulation speed hybrid III/V on silicon microring laser [6] while a novel 3D integrated tunable hybrid silicon laser has been experimentally demonstrated in [7]. Hybrid 25Gb/s III-V/silicon transmitters relying on a co-integration scheme were presented in [8] by CEA-LETI and STMicroelectronics. A brief technology description of the TriPleX integration platform is presented in [9], together with some application examples ranging from visible light implementations to photonic (bio-) sensing [10] and microwave photonics, while the building blocks of three mid-IR silicon photonics material platforms suitable for communications and sensing are discussed in [11]. IBM has recently proposed and demonstrated a Polymer-to-SiPh flip-chip adiabatic coupling interface, compatible with

the company's large area capable single-mode polymer waveguide technology [12], whereas the photonic components of HHI's Polyboard platform are summarized in [13] and a 3D integration scheme is proposed enabling 1Tb/s data-center connectivity.
In the following figure, our recent highlights on the field of photonic integration, carried out within the frames of collaborative research projects co-funded by the European Commission, are summarized. Figure 1(a) shows a fully re-configurable 16x1 SiPh MUX/DEMUX device for flex-grid applications, fabricated and packaged within ICT-SPIRIT, while figure 1(b) presents a 40Gbps PAM4 transmitter (top) and a 64Gbps PAM4 linear optical receiver (bottom) developed within ICT-MIRAGE. An assembled and packaged 50Gbaud single polarization coherent receiver relying on HHI's Polyboard, realized during the third year of the ICT-PANTHER project, is demonstrated in Fig. 1(c), whereas photonic ring resonator bio-sensors based on Triplex integration platform, developed within the ICT-BIOFOS project, are depicted in Fig. 1(d).

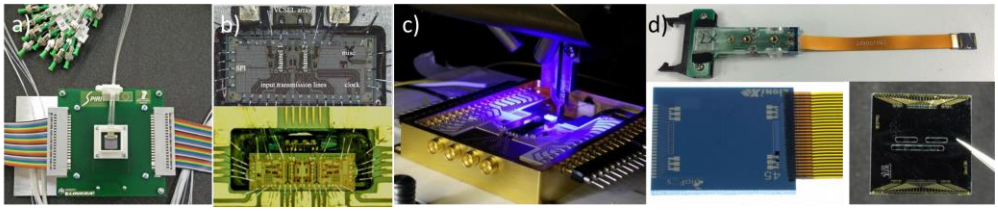


**Fig. 1. (a) 16x1 fully-reconfigurable MUX/DEMUX, (b) 40Gbps PAM4 Tx and 64Gbps PAM4 linear optical Rx, (c) 50Gbaud single polarization Polyboard coherent receiver and (d) photonic ring resonator bio-sensors based on Triplex integration platform**

## References


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