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Photonics for Artificial-Intelligence (AI) Clusters: Drivers and Opportunities for Technology Transfer

Optical interconnects are key to overcoming communication bottlenecks in ultra-scale artificial-intelligence (AI) clusters. However, current devices struggle to keep pace with the underlying scalability challenges, calling for novel technologies with disruptive performance gains. This opens unique opportunities for technology transfer from academic research to industrial adoption.

In this talk, we give an overview on selected technologies that address specific needs in the optical-interconnect ecosystem and that have been transferred to industrial applications over the past years. Silicon-organic hybrid (SOH) integration combines the intrinsic scalability of silicon photonics with the outstanding electro-optic activity of tailored organic materials, enabling modulators with unprecedented speed and efficiency [1,2,3]. As an alternative relying on inorganic materials, thin-film ferroelectrics such as lithium-niobate- and lithium-tantalate-on-insulator (LNOI/LTOI) lend themselves to high-speed electro-optic interfaces and nonlinear optical functionalities [4,5]. For package-level hybrid integration, 3D-printed photonic wire bonds [6,7] and facet-attached microlenses (FaML) [8,9] pave a path towards high-performance hybrid multi-chip systems that combine the complementary advantages of different material platforms and that can be assembled using efficient passive alignment techniques. Wafer-level optical probing of photonic integrated circuits (PICs) using 3D-printed probes [9] addresses the dominant cost driver in photonic manufacturing and is now available as a commercial test solution. Chip-scale Kerr frequency combs lend themselves as multi-wavelength light sources not only for massively parallel wavelength-division multiplexed (WDM) transmission [10,11], but also for optical arbitrary waveform generation and measurement (OAWG/OAWM) [12–14], which may form the basis of next-generation test-and-measurement equipment. In the future, novel integration platforms and system-integration techniques may offer opportunities for transferring academic research results to industrial applications.

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