Building general-purpose programmable photonic chips: Opportunities and Challenges

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Photonic chips are becoming increasingly complex, combining even more optical building blocks on the same chip. With this growing complexity we also see an expanding need for, and use of electrical tuning. This imposes opportunities, as photonic circuits can now become reconfigurable at run time, even to the point of creating arbitrary connectivity between functional building blocks, serving as a general-purpose optical processor. We will present a brief overview of the current state-of-the-art in programmable photonics, and how this technology can be a game-changer for the widespread adoption of integrated photonics.

However, at the same time, large-scale configurability comes with some tremendous challenges in terms of power consumption, electrical and optical packaging, driver electronics and control algorithms. After all, circuits that come with the capability for reconfiguration will always be larger and more complex that circuits that are designed specifically for a single purpose. This will result in longer optical paths and the need for more electrical control signals, which in turn will require a higher power consumption during operation. We will discuss our recent progress in these domains in our path to building general-purpose programmable photonic chips in the context of different European collaborations. Expanding silicon photonics with high-efficiency electro-optic tuners, high-density packaging solutions, and electronics and software layers to govern the behavior of these photonic circuits that can be used for both photonic and microwave analog signal processing. In particular, we look at the introduction of new technologies such as MEMS, or new materials such as liquid crystals for high-density electro-optic phase shifters on silicon, replacing the power-hungry microheaters that are generally used for this purpose. We also discuss how the introduction of amplifiers can significantly enhance the functionality of programmable photonics.

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