Nanophotonic circuits for unconventional computing

Nanophotonic circuits employ waveguiding devices to route light across quasi-planar integrated optical chips in analogy to electrical wires in integrated electrical circuits. Using materials with high refractive index allows for confining light into sub-wavelength dimensions as efficient optical wires. This way complex systems can be assembled from individual photonic building blocks using reliable nanofabrication routines. Besides applications in classical information processing and sensing, nanophotonic circuits provide interesting options for optical computing when combined with functional materials. Here I will give an overview of two recent efforts to realize the constituents for non-traditional computing architectures. Both approaches employ near-field coupling to nanophotonic waveguides as a resource to tailor light-matter interactions within an on-chip circuit architecture. I will introduce phase-change nanophotonic circuits as a platform for arithmetic processing, where calculation and storage of results are carried out in the same physical location. This approach allows for performing basic arithmetic on chip in an all-optical fashion. As an alternative, I will describe how nanophotonic circuits provide a rich toolbox for non-classical computations when operated at the single photon level. In this case, nanoscale fabrication enables the scalable realization of the building blocks required for linear optical quantum computing. I will present recent results on establishing such a platform with pure electronic control and nanoscale footprint.