Non-volatile reconfigurable nanophotonic devices

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Abstract

Optical phase-change materials (O-PCMs) enable the sought-after nonvolatile reconfiguration in photonic devices – those able to switch between configurations and retain any with no power consumption, thus representing a new paradigm for photonics. This is possible given the large refractive index modulation when switching between the stable amorphous and the crystalline solid-state phases of, for instance, Ge-Sb-Se-Te chalcogenide alloys. In recent years, these materials were employed in proof-of-concept devices for diverse optical applications, namely bistable displays, photonic neuromorphic computing devices, reconfigurable metasurfaces, tunable polaritonics and plasmonics, among others. These experimental achievements used evanescent fields or external laser radiation as switching mechanisms, which are challenging to scale up in architectures comprising hundreds or thousands of active and larger devices. To tackle the scaling challenge, current efforts employ hybrid optoelectronic approaches based on CMOS scalable processes. Namely, metallic and transparent heaters—based on graphene and doped-silicon—for simultaneous electro-thermal switching of O-PCMs. In this talk, I will review the current state-of-the-art of non-volatile reconfigurable nanophotonic devices based on O-PCMs, and their use in electrically reconfigurable metasurfaces, bi-stable displays, tunable topological photonics, and integrated nonvolatile optoelectronic components. These results are crucial for the development of reconfigurable devices and architectures able to retain its configuration with zero power consumption and provide a platform for novel applications such as neuromorphic computing, free-space light shaping, and switching networks.

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