Bricked and evanescently-coupled topologies: expanding the portfolio of subwavelength metamaterial silicon photonic devices

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(Invited)

Abstract

Silicon-on-insulator (SOI) is a prominent platform for the development of compact photonic integrated circuits (PICs). However, the high index contrast between silicon and silicon dioxide hinders designing polarization insensitive structures as well as devices that require a weak perturbation of the propagating field, such as highly collimated beam radiating apertures or ultra-narrow bandwidth Bragg filters, which need feature sizes of only 10 nm if implemented with waveguide sidewall gratings.

Subwavelength grating (SWG) metamaterial waveguides have become a powerful tool for achieving devices with unprecedented performance, including fiber-to-chip couplers, ultra-broadband components, metalenses, MUX/DEMUXs for wavelength and mode division multiplexing, polarization management devices or high-sensitivity waveguide sensors.

In this talk, we present two new topologies of SWG metamaterial waveguides: the bricked SWG and the evanescently coupled SWG. The first pattern enables anisotropy engineering, while maintaining the index and dispersion engineering already offered by conventional SWG waveguides. The second allows us to control the intensity of the perturbation without changing the size of the corrugation. Both patterns make use of a Manhattan-like geometry, with pixel sizes that are compatible with wafer-scale lithography techniques. We will discuss our most recent theoretical and experimental results: polarization-independent multimode interference couplers for the O and C bands and a narrow-beam steerable millimeter-long optical antenna array with angular divergence of only 1.8º × 0.2º.

Summary for the program (100 words)

We present two novel topologies of subwavelength grating (SWG) waveguides: the bricked-SWG and the evanescently-coupled-SWG. The bricked topology enables accurate control of waveguide anisotropy while maintaining the index and dispersion engineering advantage intrinsic to SWG waveguides. The evanescently-coupled-SWG allows unprecedented control of the strength of the modal perturbation in waveguide Bragg gratings and nanophotonic antennas. Both topologies leverage a Manhattan-like pattern, with pixel sizes compatible with deep-uv lithography. Our recent results will be discussed, focusing on polarization-independent multimode interference couplers for the O and C bands and a millimeter-long narrow-beam steerable optical antenna array with angular divergence of only 1.8º×0.2º.

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