Synthesis and measurement of polarization states with silicon nanoantennas

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Abstract

It has been recently shown that the polarization of the source exciting a guided wave via near-field coupling plays a key role in determining the propagation direction of the guided way. This way, point dipoles exhibiting circularly polarization are converted into guided waves so that opposite excitation spins result in counter-propagating guided waves. This powerful concept, firstly demonstrated in plasmonics for visible light [1], can also be applied to other wavelengths and photonic platforms. For instance, it can be implemented in a silicon photonics integrated platform working at telecom wavelengths by inserting a dielectric scatterer (or nanoantenna), which performs as the exciting element, placed in the close proximity of a silicon waveguide. In [2], we used such a concept to demonstrate experimentally at telecom wavelengths that a silicon microdisk nanoantenna can resolve the handedness (or spin) of a circularly polarized light beam (see Fig. 1(a)). If a rectangular nanoantenna is employed (see Fig. 1(b)), linearly polarized photons will be directed towards one side or the waveguide or the opposite one depending on its polarization angle. This enables sorting linearly polarized photons with ideally infinite contrast ratio in a very simple way and with an extremely compact structure [3]. By reciprocity, the silicon nanoantenna-waveguide can also be used to radiate photons with a tailored polarization. This way, in [2] we demonstrated the ability of radiating circularly polarized photons by the microdisk nanoantenna, being the handedness determined by the choice of the feeding waveguide. More importantly, by feeding the nanoantenna simultaneously by its both sides, it becomes feasible to generate compound polarization states [4]. This way, we have demonstrated theoretically and experimentally that any polarization state on the Poincaré sphere can be generated from a single nanoantenna [4]. Finally, by properly combining the different nanoantennas, it is possible to detect the (this is, all the Stokes parameters) in a single measurements. This would lead to a very compact integrated photonic circuit that could dynamically determine the complete polarization state of an impinging plane wave, which could find application in polarimetry, spectrometry or high-speed optical communications.

References

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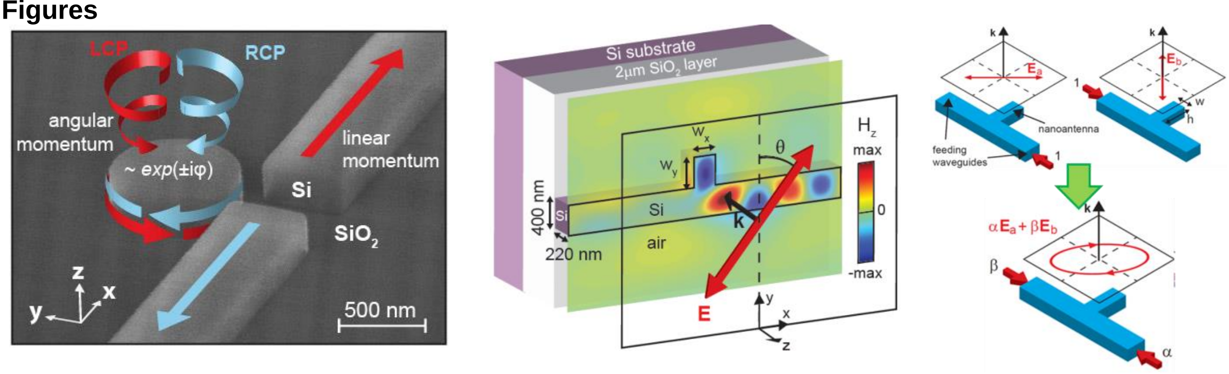
Figures



(a) (b) (c)

Figure 1. Silicon nanoantennas for managing polarization. (a) A silicon microdisk coupled to two waveguides sorts opposite spins of an incoming wave into opposite waveguides; (b) A rectangular silicon nanoantenna can be used to sort linearly polarized photons; (c) By feeding the nanoantenna by its both sides, the polarization of the emitted light can be properly tailored.