Beam polarimetry using silicon nanoantennas

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Abstract

Polarization is a fundamental property of electromagnetic waves. Knowing the state of polarization (SoP) is an essential requirement in several disciplines as chemistry, astronomy and optical communications. 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 wave. This behaviour can be useful to characterize the state of polarization of an incoming light beam using, for instance, dielectric scatterers (acting as nanoantenas) coupled to silicon waveguides. In [1,2] we exploit this concept to create two types of nanoantena, first type is used to characterize linear polarization and the second type can resolve the handedness (or spin) of a circularly polarized light.

Using these tools, we present a silicon on-chip polarization analyzer working at telecom wavelengths that allows for a direct measurement of the state of polarization of an incoming light beam. This polarization analyzer obtains the SoP on the basis of the Stokes parameters. Taking advantage of the polarization-dependent characteristics of the nanoantennas described above, only three nanoantennas (two for lineal polarization and one for circular polarization) are required for full description of the four Stokes parameters defining the SoP of the incident light beam.

We have a six outputs device, where direct combination of the power at each output result in the four Stokes parameters. However, we also present a method to reduce this scheme, achieving the same result with only four outputs. This system is based on the same principle, we need a scatterer for coupling the incoming light into the four waveguides as a result of the spin-orbit interaction taking place in the evanescent region of the silicon waveguides, and a proper study of the scatterer shape and position to be polarization-dependent is needed to. Ensuring these conditions, we achieved a universal approach, valid for any wavelength range and technological platform.

The proposed technology allows high level of integration, and the methodology outlined allows a quick analysis of the incoming SoP in real time and over an ultrabroad bandwidth, and due to the small scattering losses, it could be used in an in-line configuration. Due to all this properties, our device could find application in polarimetry, spectrometry or high speed optical communications.

References

[1] F. J. Rodriguez-Fortuno, I. Barber-Sanz, D. Puerto, A. Griol, and A. Martinez, ACS Photonics, **9** (2014) 762–767.
[2] F. J. Rodriguez-Fortuno, D. Puerto, A. Griol, L. Bellieres, J. Marti, and A. Martinez, Opt. Lett., **6** (2014) 1394–1397.

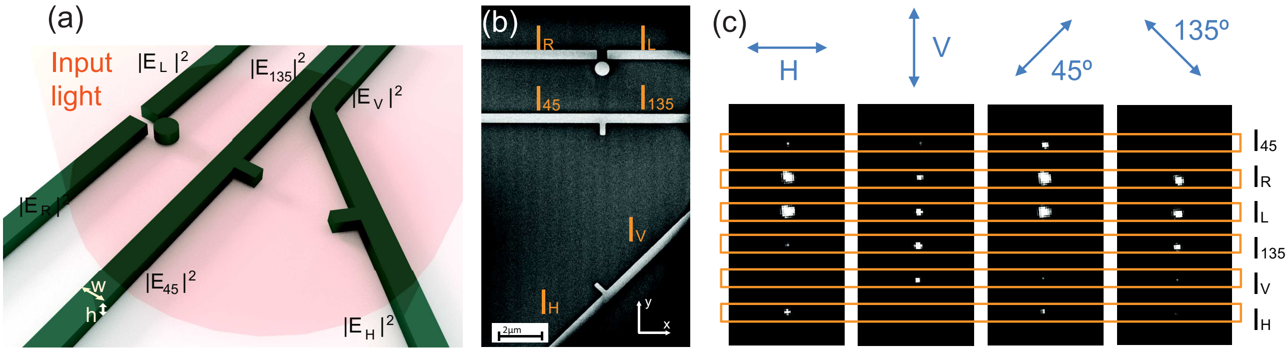

Figure 1. (a) Scheme of the proposed structure. (b) SEM image of the fabricated sample. (d) Experimental measurements verifying the performance of the device for linear input polarizations.