Investigating vector local field on optical nanostructure by phase-locked polarization-resolved near-field coherent imaging

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By squeezing optical fields down to the nanoscale, nanophotonics devices allow engineering of the light-matter interactions and thus can challenge technological limits for a broad range of applications. Governed by it vectorial nature, a specific nanostructured electric and magnetic near-field arrangement is induced on such devices and be seen as the key enabling efficiency and functionality.

Here, we present direct near-field imaging on inverted gap nanoantenna at visible wavelength (figure 1a). A near-field scanning optical microscope coupled with a polarization-sensitive interferometric detection provides direct access to quantitative amplitude and phase of the in plane near-field components (figure 1b). For the first time, simultaneous and synchronous detection of both near-field components are performed revealing their apparent phase relation [1]. The electric and magnetic nature of the detected field by such aperture probe is shown regarding the specific spatial distribution of their components phase relation [2]. Based on these phase-locked polarization-resolved coherent mappings, vector local field spatial distribution of the optical antenna is reconstructed and it collective time evolution retrieved. The spatial and temporal structure of the localized field engendered by the narrow gap antenna when squeezing down the field to the nanoscale is highlighted.

Accessing and understanding electric and magnetic field properties directly on nanophotonic structure is crucial, supporting progress in near-field engineering to manipulate light at the nanoscale.

[1] G. Calbris, M. Mivelle, M.F. Garcia-Parajo and N.F. van Hulst in preparation.
[2] B. le Feber, N. Rotenberg, D.M. Beggs and L. Kuipers, Nature Photonics **8** (2014) 43.

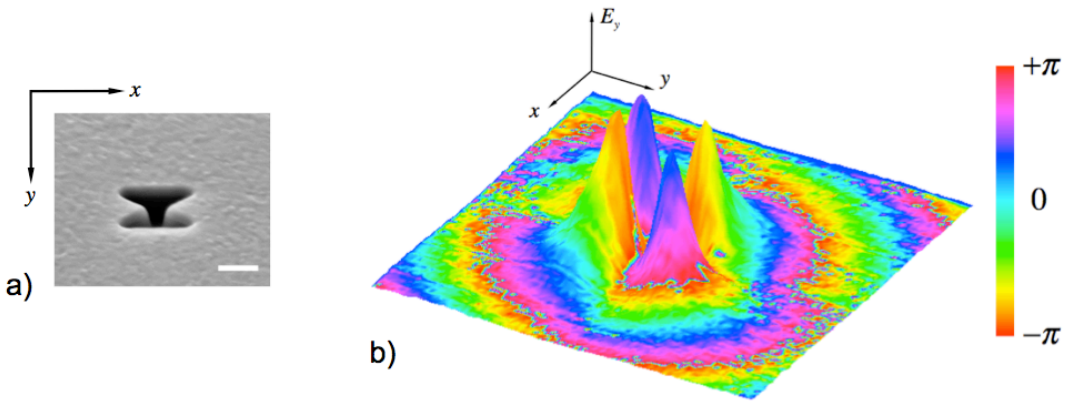

Figure 1: a) SEM picture of the bowtie nanoaperture optical antenna. Scale bar is 200nm. b) Experimental mapping giving four lobes pattern for the field component perpendicular to the gap mode, amplitude (z axe) and phase (map color). Scan size is 2μmx2μm.