(Non-)linear confocal scanning microscopy of nanorings and oligomers using cylindrical vector beams

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Cylindrical vector beams (CVBs) with radial or azimuthal polarization exhibit locally varying electric field components. Such higher order laser beams offer attractive possibilities for the excitation of radially symmetric nanostructures [1]. In gold nanostructures, localized surface plasmon resonances can be excited by an incident electromagnetic wave. For oligomers that consist of a number of identical gold nanoparticles in a particular arrangement, excitation can be maximized if all constituents are simultaneously resonantly excited. Additionally, collective resonances of the coupled constituents may occur that show a behavior other than a pure sum of the individual resonances.

In this presentation the method of linear and nonlinear confocal scanning microscopy with CVBs will be discussed. Radially symmetric gold nanostructures mimicking the local geometry of the electric field distributions of focused CVBs are fabricated by electron beam lithography. As a first example, the mapping of the in-plane electrical field distribution in the focus of radially and azimuthally polarized CVBs will be shown using gold nanorings [2]. As a second example, second harmonic (SH) imaging of radially or azimuthally arranged gold oligomers with radially or azimuthally polarized CVBs will be demonstrated [3]. Interactions between the respective electric field distributions and the nanostructures lead to characteristic intensity patterns, see Figure 1. By matching the geometry of the local electric fields to that of the nanostructures, as well as matching the plasmon resonances to the excitation wavelength, maximum signal intensity from the structures can be achieved.

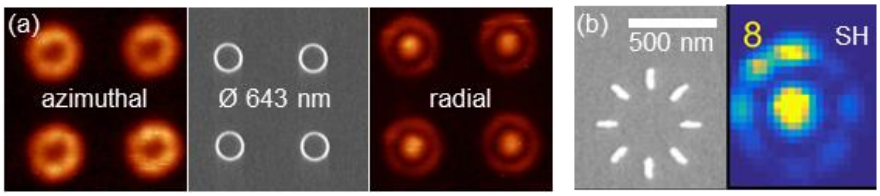

Figure 1. (a) Gold nanorings and resulting confocal scan images using focused azimuthally and radially polarized vector beams; (b) radial oligomer and confocal SH scan image using a radially polarized beam.

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[3] G. Bautista, C. Dreser, X. Zang, D. P. Kern, M. Kauranen, M. Fleischer, *Nano Lett., doi:10.1021/acs.nanolett.8b00308* (in press, 2018).